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ევროპის უნივერსიტეტის საერთაშორისო
სამეცნიერო-პრაქტიკული ჟურნალი

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სარედაქციო კოლეგიის წევრები:

მთავარი რედაქტორი – **გოჩა თუთბერიძე** – ეკონომიკის დოქტორი, აფილირებული პროფესორი, ევროპის უნივერსიტეტი. რექტორი, პროფესორი, ევროპის ცენტრალური უნივერსიტეტი. განათლების ხარისხის განვითარების ეროვნული ცენტრის აკრედიტაციის ექსპერტი. (საქართველო)

ილია ბოცვაძე ბიზნესის ადმინისტრირების დოქტორი, შავი ზღვის საერთაშორისო უნივერსიტეტი, ასოცირებული პროფესორი, ევროპის უნივერსიტეტის ბიზნესისა და ტექნოლოგიების ფაკულტეტის დეკანი. (საქართველო)

ნუგზარ თოდუა ეკონომიკის მეცნიერებათა დოქტორი, ივანე ჯავახიშვილის სახელობის თბილისის სახელმწიფო უნივერსიტეტის პროფესორი. (საქართველო)

ეკატერინე ლომია პოლიტიკის მეცნიერების დოქტორი. ივანე ჯავახიშვილის სახელობის თბილისის სახელმწიფო უნივერსიტეტის კვლევით ცენტრში „საქართველოს სამეზობლოს კვლევის ინსტიტუტი“ მკვლევარი. ა(ა)იპ საქართველოს მეცნიერთა საბჭოს წევრი. (საქართველო)

ქუჯი ბიჭია (ევროპის ეკონომიკის დოქტორი, ევროპის უნივერსიტეტის ასოცირებული აფილირებული პროფესორი. (საქართველო)

ეკატერინე ნაცვლიშვილი ფილოსოფიის დოქტორი, ევროპის უნივერსიტეტის აფილირებული პროფესორი, ბიზნესის ადმინისტრირების საბაკალავრო პროგრამის ხელმძღვანელი, განათლების ხარისხის განვითარების ეროვნული ცენტრის აკრედიტაციის ექსპერტი. (საქართველო)

გოჩა თოდუა ფიზიკა-მათემატიკურ მეცნიერებათა დოქტორი, პროფესორი, ევროპის უნივერსიტეტი. (საქართველო)

თორნიკე ხოშტარია ბიზნეს ადმინისტრირების დოქტორი, ევროპის უნივერსიტეტის პროფესორი, სასწავლო უნივერსიტეტი გეომედის ჯანდაცვის ეკონომიკისა და მენეჯმენტის ფაკულტეტის დეკანი. (საქართველო)

ლია ჩარექიშვილი ეკონომიკურ მეცნიერებათა აკადემიური დოქტორი, ევროპის უნივერსიტეტი. (საქართველო)

არჩილ ჩოჩია სამართლის დოქტორი, ტალინის ტექნოლოგიური უნივერსიტეტი. (ესტონეთი)

ლიუდმილა ალექსეიევა ასისტენტ-პროფესორი, ეკონომიკის დეპარტამენტი, დაუგავპილსის უნივერსიტეტი. (ლატვია)

მოშე ბარაკი ემერიტუსი პროფესორი, მეცნიერებისა და ტექნოლოგიების განათლება, ნეგევის ბენგურიონის უნივერსიტეტი. (ისრაელი)

ოლიონა ბაქენოვა ეკონომიკის დოქტორი, ეკონომიკური კიბერნეტიკის დეპარტამენტი, ტარას შევჩენკოს სახელობის კიევის სახელმწიფო უნივერსიტეტი. (უკრაინა)

ვისემ აჯილი ბენ იუსეფი დოქტორი, ასოცირებული პროფესორი, ESLSCA პარიზის ბიზნეს სკოლა. (საფრანგეთი)

ენკარნ ალვარეს ვერდეხო დოქტორი, კვანტიტატიური მეთოდები ეკონომიკაში და ბიზნესში, გრანადას უნივერსიტეტი. (ესპანეთი)

პატრიცია გაზზოლა ასოცირებული პროფესორი, ინსუბრიის უნივერსიტეტი. (იტალია)

ფიტიმ დიარი ასოცირებული პროფესორი, ბიზნესისა და ეკონომიკის ფაკულტეტი, სამხრეთ-აღმოსავლეთ ევროპის უნივერსიტეტი. (ჩრდილოეთ მაკედონია)

რიმა ტამოსიუნიენე პროფესორი, ფინანსური ინჟინერიის დეპარტამენტი, ვილნიუსის გედიმინასის სახელობის ტექნიკური უნივერსიტეტი. (ლიეტუვა)

მანუელა ტვარონოვიჩენი პროფესორი, ბიზნეს ეკონომიკისა და მენეჯმენტის დეპარტამენტი, ვილნიუსის გედიმინასის სახელობის ტექნიკური უნივერსიტეტი. (ლიეტუვა)

რეჯინა დემიანიუკი ასისტენტ პროფესორი, სოციალურ მეცნიერებათა ფაკულტეტი, შიდელცეს უნივერსიტეტი. (პოლონეთი)

ჯოზეფა გარსია მასტანზა პროფესორი, ეკონომიკისა და ბიზნესის ადმინისტრირების დეპარტამენტი, მალაგას უნივერსიტეტი. (ესპანეთი)

იზეთ ზექირი პროფესორი, ბიზნესისა და ეკონომიკის ფაკულტეტი, სამხრეთ-აღმოსავლეთ ევროპის უნივერსიტეტი. (ჩრდილოეთ მაკედონია)

განნა ჟოსანი ეკონომიკის დოქტორი, ხერსონის სახელმწიფო აგრარული უნივერსიტეტი. (უკრაინა)

ძინტრა ილისკო დოქტორი, პროფესორი, დაუგავპილსის უნივერსიტეტი. (ლატვია)

მოჰამედ შაფიუდინი დოქტორი, ასისტენტ-პროფესორი, მენეჯმენტისა და ტექნოლოგიის კოლეჯი (ომანი), მკვლევარი, ამერიკის საფინანსო ასოციაციის წევრი მენეჯმენტისა და კომერციის საერთაშორისო კვლევითი ჟურნალის სარედაქციო კოლეგიის წევრი. (ომანი)

ლიუდმილა დემიდენკო ასოცირებული პროფესორი, ტარას შევჩენკოს სახელობის კიევის სახელმწიფო უნივერსიტეტი. (უკრაინა)

ვლადიმერ მენშიკოვი პროფესორი, დაუგავპილსის უნივერსიტეტი. (ლატვია)

ნაზიმ მუსაფარლი იმანოვი დირექტორი, ეკონომიკის ინსტიტუტი, აზერბაიჯანის მეცნიერებათა ეროვნული აკადემია. (აზერბაიჯანი)

როსიცა იალამოვა ასოცირებული პროფესორი, ლეტბრიჯის უნივერსიტეტი. (კანადა)

ოლგა ლავრინენკო ეკონომიკის დოქტორი, მკვლევარი, დაუგავპილსის უნივერსიტეტი. (ლატვია)

გორდონ ლ. ბრედი ლექტორი, ჩრდილოეთ კაროლინის უნივერსიტეტი, გრინსბორო. (აშშ)

ელიტა ერმოლაევა პროფესორი, ეკონომიკისა და სოციალური განვითარების ფაკულტეტი, ლატვიის სასოფლო-სამეურნეო და ტექნოლოგიების უნივერსიტეტი. (ლატვია)

სირჯე ვირკუსი დოქტორი, ციფრული ტექნოლოგიების სკოლა, ტალინის უნივერსიტეტი. (ესტონეთი)

ინტა ოსტროვსკა პედაგოგიურ მეცნიერებათა დოქტორი, დოცენტი, დაუგავპულსის უნივერსიტეტი. (ლატვია)

ლინა პილელინე ბიზნეს ადმინისტრირების დოქტორი, პროფესორი, ვიტაუტას მაგნუს უნივერსიტეტი. (ლიეტუვა)

მჰერ საჰაკიანი საერთაშორისო ურთიერთობების დოქტორი, ჩინეთის ნანჯინგის უნივერსიტეტი, ლექტორი, მეცნიერებათა ეროვნული აკადემია. დამფუძნებელი და დირექტორი, ჩინეთ-ევრაზიის პოლიტიკური და სტრატეგიული კვლევების საბჭო. (სომხეთი)

ალექსანდრ სტრატანი ეკონომიკის დოქტორი, პროფესორი, ეკონომიკური კვლევების აკადემია. (მოლდოვა)

ემანუელ მორუჩი სოციოლოგიის დოქტორი, ბრესტის დასავლეთის კათოლიკური უნივერსიტეტი, ბრესტი, ბრეტანი. ევროკომისიის «ევროპის გუნდი საფრანგეთი»-ის წევრი. CECI - ევროპის მოქალაქეობისა და იდენტობების წრის პრეზიდენტი. (საფრანგეთი)

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ARTICLE

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INTERNATIONAL COMMODITY PRICE SHOCKS AND THE INFLATION, CONSUMPTION, AND INVESTMENT EFFECTS IN AFRICA

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Abstract. *African countries' participation in the global value chain and trade has evolved steadily. Amidst the recent spike in commodity prices, this trend has important implications for the propagation of trade-price shocks in African economies. This study examines how commodity price shocks shape inflation, consumption, and investment in Africa. We find that the effects of commodity price shocks on inflation, consumption, and investment exhibit significant heterogeneity and qualitative commonalities across countries. We tested the possibility that different commodities may have a disparate bearing on a country's economic development. The analysis shows that price increases in all commodity types – energy, non-energy, and food commodities–produce similar influences qualitatively, but not in magnitude. Interestingly, non-energy commodities exert greater quantitative effects than energy commodities. Our results indicate that, in most instances, disruptions in the international commodity market may reflect global economic uncertainty, with attendant effects on consumption, investment, and policy decisions in the domestic economy.*

KEYWORDS: COMMODITY PRICES, INFLATION, INVESTMENT, CONSUMPTION, AFRICA, LOCAL PROJECTIONS.

JEL classification: C22, E21, E22, E31, F62, Q02.

INTRODUCTION

The global economy has increasingly been characterized by internationally fragmented production processes. The globalization of production processes has given rise to global value chains (GVCs) with many suppliers located in several countries. This trend has important implications for the transmission of trade shocks across countries. Recently, the crisis-plagued world has faced three parallel shocks: energy, fertilizer, and food price shocks. These overlapping crises have renewed interest in the impact of commodity market dynamics on the economy.

African countries have made little but growing strides in GVCs.[1] Siba estimates that Africa's performance in global value chain trade averaged 8% of GDP over the period 2000-2015. Africa's participation in GVCs is concentrated in a few resource-based and light-manufacturing sectors. Agricultural products, transport services, and mining and related sectors (e.g., petroleum and minerals) were among the leading GVC participation sectors in all African regions in 2015.[2] Africa's limited integration into global value chains (GVCs) is consistent with the continent's trade patterns. According to ElGanainy et al.,[3] Africa's recorded cross-border trade has grown relatively modestly in recent decades, with limited growth in merchandise trade, whereas the continent's exports to the rest of the world are commodity-dominated. Africa's involvement in global trade and GVCs has important implications for the region's vulnerability to external shocks, including commodity-price shocks.

The globalization of production processes naturally births the analysis of the international propagation of adverse external shocks. This includes policy-oriented studies on the effects of globalization.[4] In recent years, an increasing number of studies have investigated the role of GVCs in the international transmission of business cycle shocks.[5] According to Kim, Lee, and Park;[6] Athukorala and Kohpaiboon;[7] and Pula and Peltonen,[8] East Asia has become more vulnerable to business cycle movements in the EU and the U.S. as the region has become increasingly integrated in GVCs. The large trade collapse during the Great Recession of 2008–2009 was attributed to the growing role of GVCs in international trade.[9]

Other global trade-related studies have analyzed the propagation of trade shocks to the domestic economy. Kilian[10] observes that energy price shocks may have immediate and large effects on the U.S. economy, despite recent observations that the impacts of energy price shocks may have weakened since the second half of the 1980s. Wei[11] demonstrates the effects of oil prices on the stock market, whereas Polgreen and Silos[12]

1 Allard, C., Kriljenko, M. J. I. C., Gonzalez-Garcia, M. J. R., Kitsios, E., Trevino, M. J. P., Chen, M. W. (2016). Trade integration and global value chains in sub-Saharan Africa: In pursuit of the missing link. International Monetary Fund.

2 Siba, E. (2022). Value chains in Africa: What role for regional trade? OECD Development Matters.

3 El Ganainy, A., Hakobyan, S., Liu, F., Weisfeld, H., Allard, C., Balima, H. W., Bteish, C., Giri, R., Kanda, D. S., Meleshchuk, S., Ramirez, G. (2023). Trade integration in Africa: Unleashing the continent's potential in a changing world (IMF Departmental Paper No. 2023/003). International Monetary Fund.

4 See for example, Saito, M., Ruta, M., Turunen, J. (2013). Trade interconnectedness: The world with global value chains (Policy Paper). International Monetary Fund.

5 For example, Gangnes, B., Ma, A. C., Van Assche, A. (2012). Global value chains and the transmission of business cycle shocks (Economics Working Paper Series No. 29). Asian Development Bank.

6 Kim, S., Lee, J. W., Park, C. Y. (2011). Emerging Asia: Decoupling or recoupling. World Economy, 34(1), 23–53. <https://doi.org/10.1111/j.1467-9701.2010.01320.x>.

7 Athukorala, P. C., Kohpaiboon, A. (2011). East Asia in world trade: The decoupling fallacy, crisis, and policy challenges (FIW Working Paper No. 52). Research Centre International Economics.

8 Pula, G., Peltonen, T. A. (2011). Has emerging Asia decoupled? In The evolving role of Asia in global finance (pp. 255–286). Emerald Group Publishing.

9 Bems, R., Johnson, R. C., Yi, K. M. (2010). Demand spillovers and the collapse of trade in the global recession. IMF Economic Review, 58(2), 295–326. <https://doi.org/10.1057/imfer.2010.16>.

10 Kilian, L. (2008). The economic effects of energy price shocks. Journal of Economic Literature, 46(4), 871–909. <https://doi.org/10.1257/jel.46.4.871>.

11 Wei, C. (2003). Energy, the stock market, and the putty–clay investment model. American Economic Review, 93(1), 311–323. <https://doi.org/10.1257/000282803321455223>.

12 Polgreen, L., Silos, P. (2006). Crude substitution: The cyclical dynamics of oil prices and the college premium (FRB Atlanta Working Paper No. 2006–14). Federal Reserve Bank of Atlanta.

study the propagation of oil price shocks to labour market outcomes. Parra and Wodon[13] argued that while the issue of oil prices remains important, recent attention has focused on food prices. Parra and Wodon reported that oil prices may have larger multiplier effects than food prices, whereas food prices tend to have a larger direct impact on consumers. These findings have important implications for the macroeconomic impact of recent commodity-price crises.

Testament to the nature of globalization, the food, energy, and fertilizer crises are not just overlapping but also reinforcing. Energy and fertilizers are notable inputs in industrial food production and supply. At the same time, fertilizer production relies heavily on energy.[14] Thus, the energy crisis has exacerbated the fertilizer crisis. The much costlier fertilizers, together with the fuel crisis, add to the mounting pressure on the global food supply chains. The unfolding triple crisis highlights the central role of global commodity price shocks in driving domestic production, consumption, and economic progress. In addition, commodity exports are major revenue sources for most commodity-dependent African countries, and the dynamics in international commodity markets have important implications for public finances and fiscal measures that can affect private consumption and investments. These caveats are important because they provide anecdotal evidence to support the supply and demand channels through which global commodity price shocks are expected to exert major impacts on the domestic economy.

This current contribution addresses the question of the vulnerability of price takers to external shocks and adds to the debate on commodity dependence syndrome. In contrast to previous studies, we provide a comparative analysis of the dynamic impacts of energy, non-energy, and food price shocks on consumer and producer prices. This study relates to previous analyses that highlight how the dynamics of international commodity prices affect domestic prices and the challenges posed to price stabilization policies. However, we advance the discussion and examine whether different commodities exert disparate effects on domestic inflation.

Kilian indicates that while recent literature has yielded many insights, there is still more to be learned about how energy price shocks are transmitted through the economy. Against this backdrop, this study provides an in-depth analysis of the quantitative importance of the effects of international commodity prices on domestic consumption and investment. This analysis is important because changes in commodity prices affect the domestic economy through their effects on consumption and investment decisions. Meanwhile, the consumption and investment effects of commodity market dynamics have received little attention. Our contribution covers both private and public consumption and investments, and includes whether various commodities affect consumption and investment decisions differently in different countries.

Our empirical analysis employs the local projection method and reveals highly heterogeneous and common impacts of international commodity price shocks on inflation, consumption, and investment. We find no general pass-through of these shocks to headline CPI inflation, with inflationary effects primarily observed in The Gambia, a net-importer. This reflects potential monetary policy responses and exchange rate appreciation, which may directly reduce imported inflation and overall CPI. Producer price inflation responses varied, being largely negative for most countries but positive for South Africa, though nearly all eventually showed some upward pressure. Crucially, both household and government consumption, as well as public and private investment, exhibited significant cross-country variations in their responses. These diverse findings underscore the critical importance of country-specific macroeconomic structures and policy frameworks in mediating external shocks. Practically, this implies that policy architecture in these commodity-dependent African economies must be highly tailored, recognizing that a 'one-size-fits-all' approach is ineffective. Understanding these specific transmission channels is crucial for designing

13 Parra, J. C., Wodon, Q. (2008). Comparing the impact of food and energy price shocks on consumers: A social accounting matrix analysis for Ghana (World Bank Policy Research Working Paper No. 4741). World Bank.

14 Nitrogen fertilizers require a large amount of natural gas/fossil fuels for production.

targeted interventions that can effectively manage inflation, stabilize consumption, and foster investment in the face of volatile global commodity markets.

The remainder of this paper is organized as follows. In Section 2, we discuss the related literature. In Section 3, we present our measures of prices, consumption, and investment, and then present some stylized facts. In Section 4, we introduce the econometric methods. Section 5 presents our empirical results and discussion. Section 6 concludes the paper.

1. RELATED LITERATURE: MACROECONOMIC IMPACTS OF COMMODITY PRICE SHOCKS

Commodity market disruptions tend to have large and far-reaching real effects. Energy is an essential input for all industrial production processes. In addition, energy and food account for a considerable portion of consumption baskets: approximately 25% in advanced economies (Aes), 50% in Low-Income and Developing Economies (LIDE), and almost 40% in Emerging Market Economies (EMEs).

According to Avalos et al.,[15] two economic features underscore the variations in the macroeconomic impact of trade price shocks. The first is reliance on imports: for net importing countries, high prices represent a loss of real purchasing power. For net exporting countries, although consumers also face higher prices, real income increases for the entire country. Industrial structure is another dimension of differential impact; energy-intensive sectors, such as manufacturing, may experience more severe impacts than other sectors. Although most African countries are particularly vulnerable to the first count, the prospect of spillover effects of energy price shocks on industrial applications is high.

Kilian explains that the traditional view of trade price shocks is that they act as technological or aggregate-supply shocks. Despite important advances, the nature of this supply channel of transmission and its quantitative importance remain unexhausted. An alternative proposition is that trade price shocks affect the economy primarily through their effects on producer and consumer expenditures. From this alternative view, higher energy prices cause both a shift in expenditure and a reduction in aggregate demand. This causes firms to adjust their production plans, with attendant ripple effects throughout the economy. The demand channel of transmission is consistent with anecdotal evidence that oil price shocks are typically perceived as adverse demand shocks at the industry level.

Hamilton[16] posited that energy price shocks are transmitted not only through adjustments in consumer expenditures but through similar shifts in firms' investment expenditures. Energy price shocks may affect non-residential investments via two main channels. First, the cost channel through which an increase in the price of energy raises the marginal cost of production. This channel depends on the energy share of the cost structure. The second channel is the demand channel. Through this channel, a fall in consumer expenditure leads to a decline in the demand for firm output. The literature on the macroeconomic effects of commodity price variability in developing countries has primarily focused on two aspects of variability: ex ante uncertainty about future prices and discrete ex post price shocks.[17] These two manifestations of variability affect investment decisions. Collier and Gunning[18] show that commodity price shocks strongly impact investment. Similarly, Dixit and Pindyck[19] find evidence supporting the view that investment decisions may be very sensitive to the uncertainty generated by commodity market dynamics.

Empirically, few studies have sought to ascertain the impact of commodity price shocks on

15 Avalos, F., Cap, A., Igan, D., Kharroubi, E., Nodari, G. (2022). Energy markets: Shock, economic fallout and policy response (BIS Quarterly Review No. 64). Bank for International Settlements.

16 Hamilton, J. D. (2013). Historical oil shocks. In R. Whaples R. E. Parker (Eds.), Routledge handbook of major events in economic history (pp. 239–265). Routledge.

17 Dehn, J. (2000). Private investment in developing countries: The effects of commodity shocks and uncertainty (Working Paper No. 2000-11). Centre for the Study of African Economies, University of Oxford.

18 Collier, P., Gunning, J. W. (1999). Trade shocks in developing countries. Oxford University Press.

19 Dixit, A. K., Pindyck, R. S. (1994). Investment under uncertainty. Princeton University Press.

investment decisions. In his work, Dehn showed that the positive effects of commodity price shocks on private investment rates in low-income developing countries are conditional on commodity price levels. On the other hand, Collier and Gunning argue that both the quantity and quality of investment are reduced during shocks due to a combination of factors, including excessive and misdirected public expenditures. In this study, we examine the dynamic impact of commodity price shocks on both public and private investments and ascertain whether different commodities exert disparate influences.

Our study builds on the literature regarding the macroeconomic effects of energy price shocks. Park et al.[20] employed a structural vector autoregressive model to examine the impact of oil price variations on Korean macroeconomic indicators and discovered a negative reaction to industrial output and prices. In related studies, He and Lee;[21] and Greenwood-Nimmo et al.[22] concluded that the real economy and financial markets are extremely sensitive to fluctuations in oil prices in South Korea. In their study of the US, Kilian and Zhou[23] found no evidence that gasoline price shocks caused persistent inflationary effects or moved long-run household inflation expectations. Roch[24] determined that macroeconomic volatility and business cycle fluctuations are influenced by commodity price shocks while Qian, Zhang and Li[25] demonstrated that the impact of international commodity price shocks on macro fundamentals in the US and China exhibits temporal variation.

2. DATA AND STYLIZED FACTS

Data sources

The data for the analysis include world commodity prices in real terms (all commodities, energy, non-energy, and food), consumer and producer prices, household consumption, government consumption, private investment, and public investment. The dataset is yearly and runs over the period 1960-2022. The data were sourced from the World Bank database (World Development Indicators and the World Bank Commodity Price Data). The analysis included a sample of six (6) countries, selected solely based on data availability. These countries included Ethiopia (ETH), Ghana (GHA), The Gambia (GMB), Senegal (SEN), Mauritius (MUS), and South Africa (ZAR). We proxy consumer and producer prices using consumer (CPI) and producer (PPI) inflation, gauge household and government consumption using household final and government consumption expenditures, respectively, and private and public investment using fixed capital formations.

Evolution of trade[26] in major African economies

African countries have had divergent experiences in global trade. The wide disparity in the trade experiences of individual countries reflects the fragmented trade policy landscape in Africa and an overall trade environment that has limited greater trade integration both within the continent and with the rest of the world. Trade is highest in Mauritius, with trade as a percentage of GDP remaining above 100 percent in the last six decades (see Figure 1). In contrast, Ethiopia has experienced

20 Park, C., Chung, M., Lee, S. (2011). The effects of oil price on regional economies with different production structures: Evidence from Korea using a SVAR model. Energy Policy, 39(12), 8185–8195. <https://doi.org/10.1016/j.enpol.2011.09.041>.

21 He, Y., Lee, M. (2022). Macroeconomic effects of energy price: New insights from Korea. Mathematics, 10(15), 2653. <https://doi.org/10.3390/math10152653>.

22 Greenwood-Nimmo, M., Nguyen, V. H., Shin, Y. (2012). Probabilistic forecasting of output growth, inflation and the balance of trade in a GVAR framework. Journal of Applied Econometrics, 27(4), 554–573. <https://doi.org/10.1002/jae.1230>.

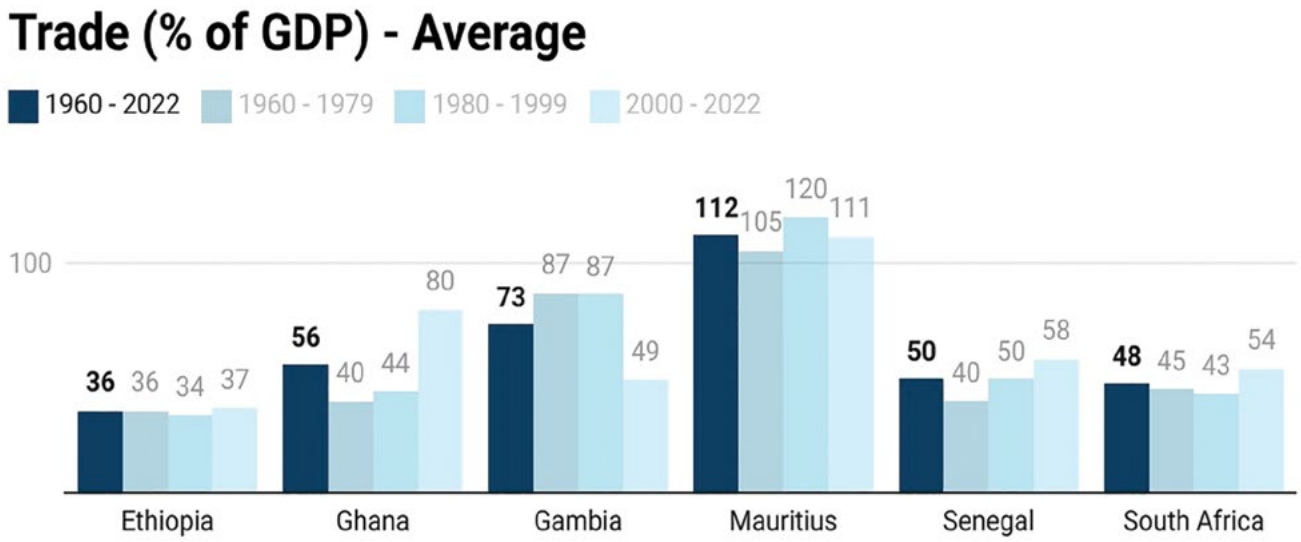
23 Kilian, L., Zhou, X. (2022). The impact of rising oil prices on U.S. inflation and inflation expectations in 2020–2023. Energy Economics, 113, 106228. <https://doi.org/10.1016/j.eneco.2022.106228>.

24 Roch, F. (2019). The adjustment to commodity price shocks. Journal of Applied Economics, 22(1), 437–467. <https://doi.org/10.1080/15140326.2019.1665316>;

25 Qian, C., Zhang, T., Li, J. (2023). The impact of international commodity price shocks on macroeconomic fundamentals: Evidence from the U.S. and China. Resources Policy, 85, 103904. <https://doi.org/10.1016/j.resourpol.2023.103904>.

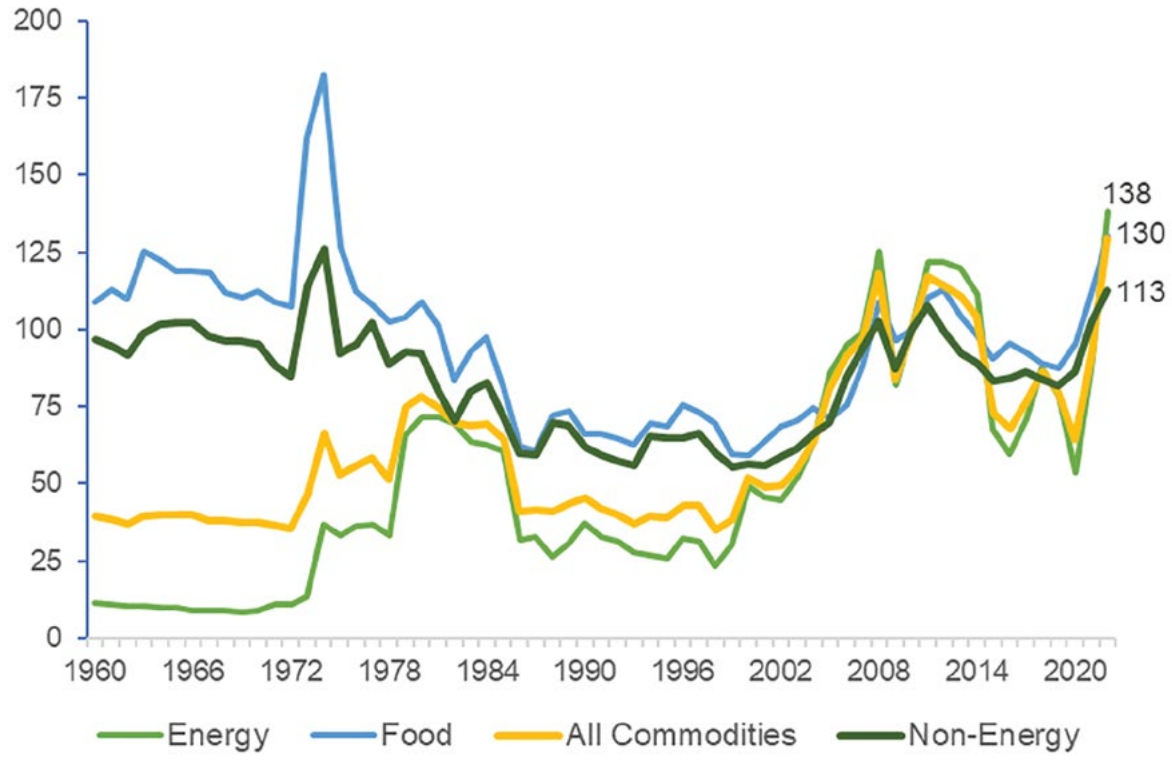
26 Trade is measured as the sum of exports and imports as a share of GDP.

FIGURE 1: Trade evolution in selected African countries



Data source: World Development Indicators and Author's own computation.

FIGURE 2: Commodity Prices



Data Source: World Bank Commodity Price. The last observation is 2022.

very limited trade openness, with trade accounting for less than 40 percent of GDP in the last 60 years. Trade in Ghana has almost doubled over the last two decades, largely because of the emergence of crude oil exports. In sharp contrast, trade has declined considerably in Gambia, from an average of about 87 percent to 49 percent in the last 22 years. Trade in the six countries has expanded only modestly, reflecting the modest growth in trade in Africa as a whole in recent decades.[27] (See Fig.1,2).

Energy, Food, and fertilizer markets developments

Energy and food prices have historically comoved (See Figure 2). Nonetheless, the recent surges in energy and food market prices differ from recent historical precedents in several respects. Notably, prices have increased further. The World Bank's real food price index stood at 130 in 2022, an increase of 36.7% from 2020, and the highest value since 1975. Energy prices rose more than twice, while non-energy prices rose 31 percent above their troughs in 2020, dwarfing all previous episodes except for the price surges between 1972 and 1981 (Figure 2). But for the 1972-1981 episode of commodity price rise, energy prices experienced the most increases.

3. ECONOMETRIC METHODOLOGY

The question of the economic impact of trade price shocks may be an empirical one. Thus, this research seeks a data-driven answer to the question. The empirical analysis considers that commodity market development depends on global macroeconomic aggregates such as global real economic activity and interest rates. Thus, the correlation between macroeconomic outcomes and energy, fertilizer, and food prices does not imply causation. One solution is to extract the exogenous components of trade prices via appropriate statistical transformations[28] and quantify the dynamic impacts of commodity price shocks using impulse responses.

Our framework uses Jordà's[29] local projection method to estimate the impulse responses. Jordà's local projection approach requires estimating a series of regressions for each horizon, *h*, for each variable. For $h = 0,\ldots,H$, we estimated the following linear model:

$$E^{j}_{t+h} = c_h + \beta_h Com_t + \varepsilon_{t+h} \quad (1)$$

where *E* is the economic aggregate of interest for country *j*, and *Com* is the commodity price. The local projection model directly forecasts *E* using covariates on the right-hand side of Equation (1). Hence, all estimated coefficients are indexed by *h*, which is the horizon considered when estimating Equation (1). The coefficient captures the response of *E* at time $t + h$ to a shock to commodity prices at time *t*. Thus, we can construct the impulse response function as a sequence of the coefficients , which are estimated in a series of single regressions for each horizon.

In contrast, the standard vector auto-regressions (VAR) method provides the parameters for horizon 0 and then uses them to iterate forward to construct the impulse response functions. The local projection method has the advantage of being relatively robust to misspecification of the structural vector auto-regression (SVAR) and does not constrain the shape of the impulse response function. Thus, local projections (LP) do not require any restrictions on VAR systems and are less sensitive to lag length misspecifications. Second, LP does not require all variables to enter all equations, allowing for a more parsimonious specification. Finally, the left-hand side variables do not have to be in the same form as those on the right-hand side. Ramey and Zubairy;[30] and Montiel Olea and Plagborg-Møller[31] provide a more comprehen-

27 Trade in Africa as a whole has expanded from 49 percent of GDP in 2000 to 53 percent by 2019 (El Ganainy et al., 2023).

28 Kilian, L. (2008). The economic effects of energy price shocks. Journal of Economic Literature, 46(4), 871–909.

29 Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. American Economic Review, 95(1), 161–182. <https://doi.org/10.1257/0002828053828518>.

30 Ramey, V. A., Zubairy, S. (2018). Government spending multipliers in good times and in bad: Evidence from U.S. historical data. Journal of Political Economy, 126(2), 850–901. <https://doi.org/10.1086/696277>.

31 Montiel Olea, J. L., Plagborg-Møller, M. (2021). Local

sive comparison of VAR and LP impulse responses.

We follow Ramey and Zubairy; and Castelnuovo[32] use Newey and West's[33] correction for our standard errors as a remedy for the serial correlation in the error terms because of the successive leading of the dependent variable. Finally, we set $H = 6$ so that the maximum horizon considered for our impulse responses was six years.

The variables are expressed as annual growth rates (log-differences). Thus, the impulse responses represent the impact of a 1 percentage point change in commodity price growth on the annual growth rate of the respective macroeconomic variable (CPI, PPI, consumption, or investment). This transformation is standard practice for macroeconomic time series and allows for a clear interpretation of impulse responses as percentage point changes in growth rates.

4. EMPIRICAL RESULTS AND DISCUSSIONS

In our framework, the commodity price shock is treated as an exogenous variable. This is particularly appropriate for small open economies, where the findings of Arezki et al.[34] underline the role of international commodity prices as external drivers rather than outcomes of domestic macroeconomic variables. This approach is consistent with Jordà and Taylor,[35] who argue that the exogeneity of such shocks ensures the consistency of estimates, even in a two-variable system. This is because omitted macroeconomic or financial factors do not bias the coefficients since they do not predict the shock. While we also experimented with treating the shock as endogenous, it did not significantly alter the impulse responses. This robustness aligns with findings in the literature on local projection (LP) models, which are known to be resilient to misspecification. Several studies, including Montiel Olea and Plagborg-Møller; Møntiel Olea et al.;[36] Li et al.,[37] and Plagborg-Møller et al.,[38] have found no evidence of systematic changes in impulse response estimates when control variables are added. As Jordà emphasizes, LP models often include lags of variables as controls to account for autocorrelation and dynamic effects, ensuring that residuals are white noise. However, these controls are primarily for robustness and efficiency and do not fundamentally change the impulse response itself. Following the methodology of Montiel Olea and Plagborg-Møller, we include up to four lags of the variables as controls to ensure robustness and account for autocorrelation.

Impact on consumption

The relationship between international commodity prices and government expenditure is profoundly significant for commodity-exporting African countries. These economies heavily rely on commodity exports as a primary source of fiscal revenue, implying that positive price shocks directly translate into increased government income and expanded fiscal space for public spending,

projection inference is simpler and more robust than you think. Econometrica, 89(4), 1789–1823. <https://doi.org/10.3982/ECTA18756>.

32 Castelnuovo, E. (2019). Yield curve and financial uncertainty: Evidence based on U.S. data. Australian Economic Review, 52(3), 323–335. <https://doi.org/10.1111/1467-8462.12324>.

33 Newey, W. K., West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica, 55(3), 703–708. <https://doi.org/10.2307/1913610>.

34 Arezki, R., Imam, P. A., Kpodar, K., Le-Van, D. (2025). Shocks and shields: Macroeconomic institutions during commodity price swings (Working Paper No. 25/15). International Monetary Fund. <https://www.imf.org/en/Publications/WP/Issues/2025/01/24/Shocks-and-Shields-Macroeconomic-Institutions-During-Commodity-Price-Swings-560031>.

35 Jordà, Ò., Taylor, A. M. (2025). Local projections. Journal of Economic Literature, 63(1), 59–110. <https://doi.org/10.1257/jel.20241521>.

36 Montiel Olea, J. L., Plagborg-Møller, M., Qian, E., Wolf, C. K. (2024). Double robustness of local projections and some unpleasant VARithmetic. NBER Working Paper Series, No. 32463. National Bureau of Economic Research. <https://doi.org/10.3386/w32463>.

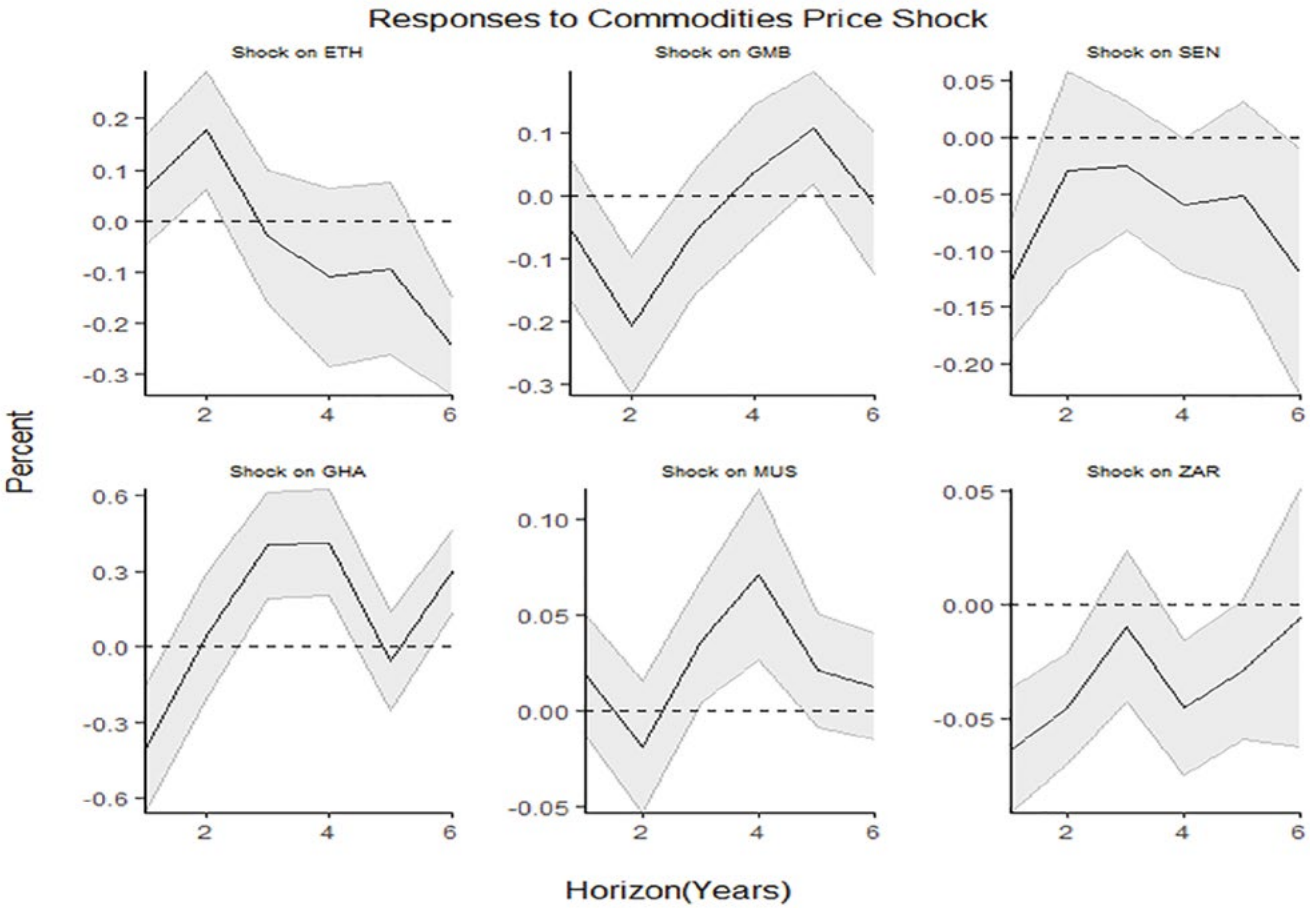
37 Li, D., Plagborg-Møller, M., Wolf, C. K. (2024). Local projections vs. VARs: Lessons from thousands of DGPs. Journal of Econometrics, 244(2), Article 105650. <https://doi.org/10.1016/j.jeconom.2023.105650>.

38 Montiel Olea, J. L., Plagborg-Møller, M., Qian, E., Wolf, C. K. (2025). Local projections or VARs? A primer for macroeconomists. NBER Macroeconomics Annual 2025, 40. <https://doi.org/10.48550/arXiv.2503.17144>.

including consumption and investment. However, this dependence often leads to pro-cyclical fiscal policies, where spending surges during booms but faces abrupt cuts during busts, contributing to macroeconomic instability and increased debt burdens, as seen in countries like Ethiopia and Ghana. Furthermore, windfall revenues can sometimes fuel discretionary spending driven by political cycles. Understanding this direct channel through which commodity-price shocks influence domestic public finances and aggregate demand is therefore crucial for assessing fiscal sustainability, designing effective fiscal rules, and implementing counter-cyclical policies to mitigate volatility and foster stable economic development.

The impulse response plots for government consumption are shown in Figure 3. The magnitude of commodity price shock diffusion on government consumption is negative for most countries, except for Ethiopia and Mauritius. In 2 years after 1 percent increase in commodity prices, government consumption decreased by 0.2 percentage points for The Gambia, 0.12 percentage points for Senegal, 0.4 percentage points for Ghana, and 0.07 percentage points for South Africa. For Ethiopia and Mauritius, government consumption increased by 0.2 and 0.08 percentage points, respectively. We examine whether the impact of commodity price shocks differs according to commodity type. The impulse response plots (Appendix – Figures A1, A2, and A3) show that the impact of energy, non-energy, and food commodity price shocks on government consumption are qualitatively indistinguishable. In terms of size, non-energy commodities have a greater impact on government consumption than energy commodities (See Fig.3).

FIGURE 3: Impulse responses of government consumption

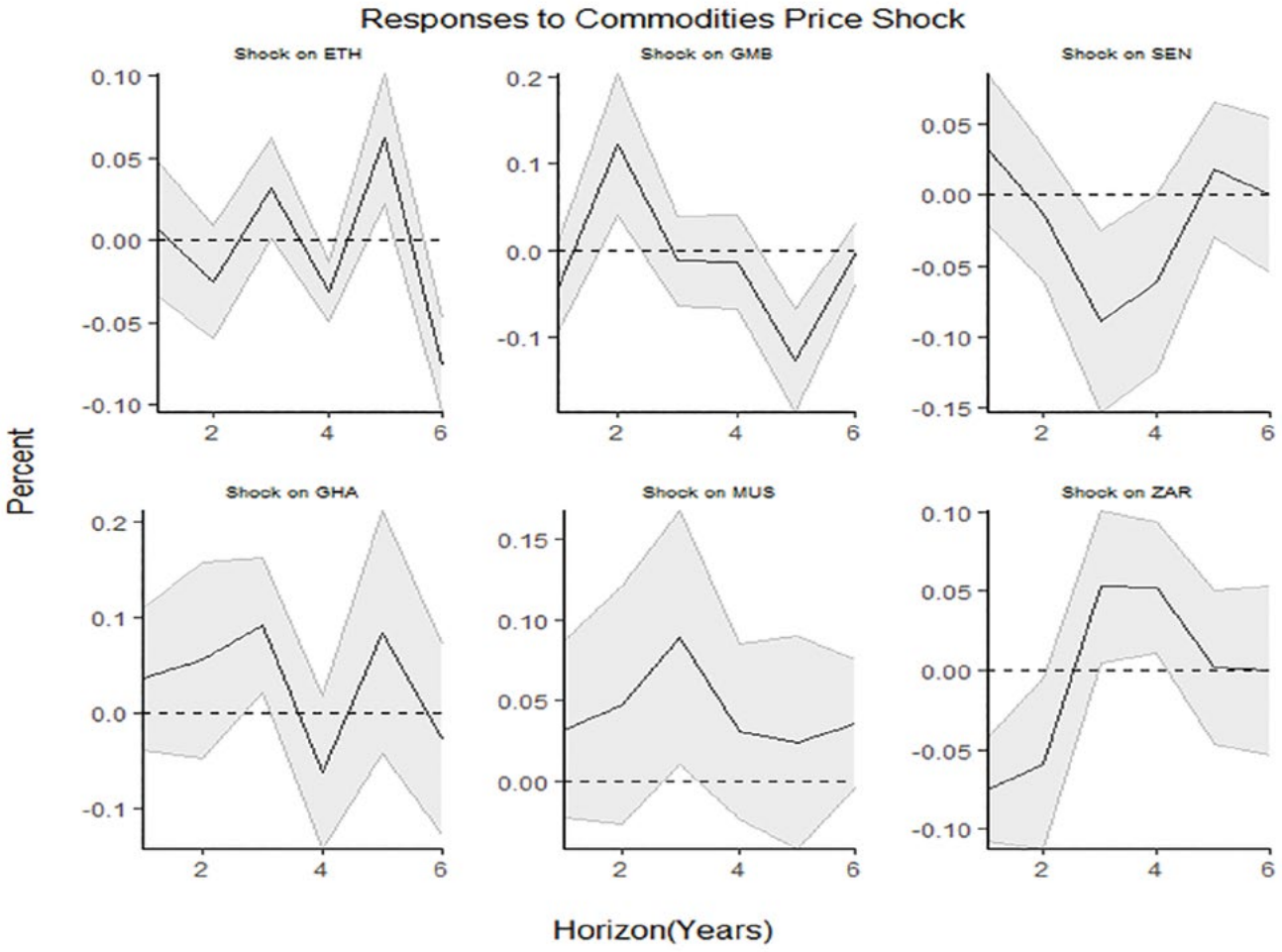


Notes: Responses to a 1 percent increase in commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded gray) lines.

Furthermore, we test the propagation of commodity price shocks on household consumption; the impulse responses are shown in Figure 4. For Senegal, we observed a delayed but negative and significant response. In Senegal, household consumption slumped by 0.09 percentage points, 3 years after a 1 percent unanticipated increase in commodity prices, before returning to pre-shock levels 5 years after the shock. However, for Ghana and Mauritius, household consumption increased in reaction to a positive commodity price shock, reaching a peak of about 0.1 percentage points 3 years after the shock.

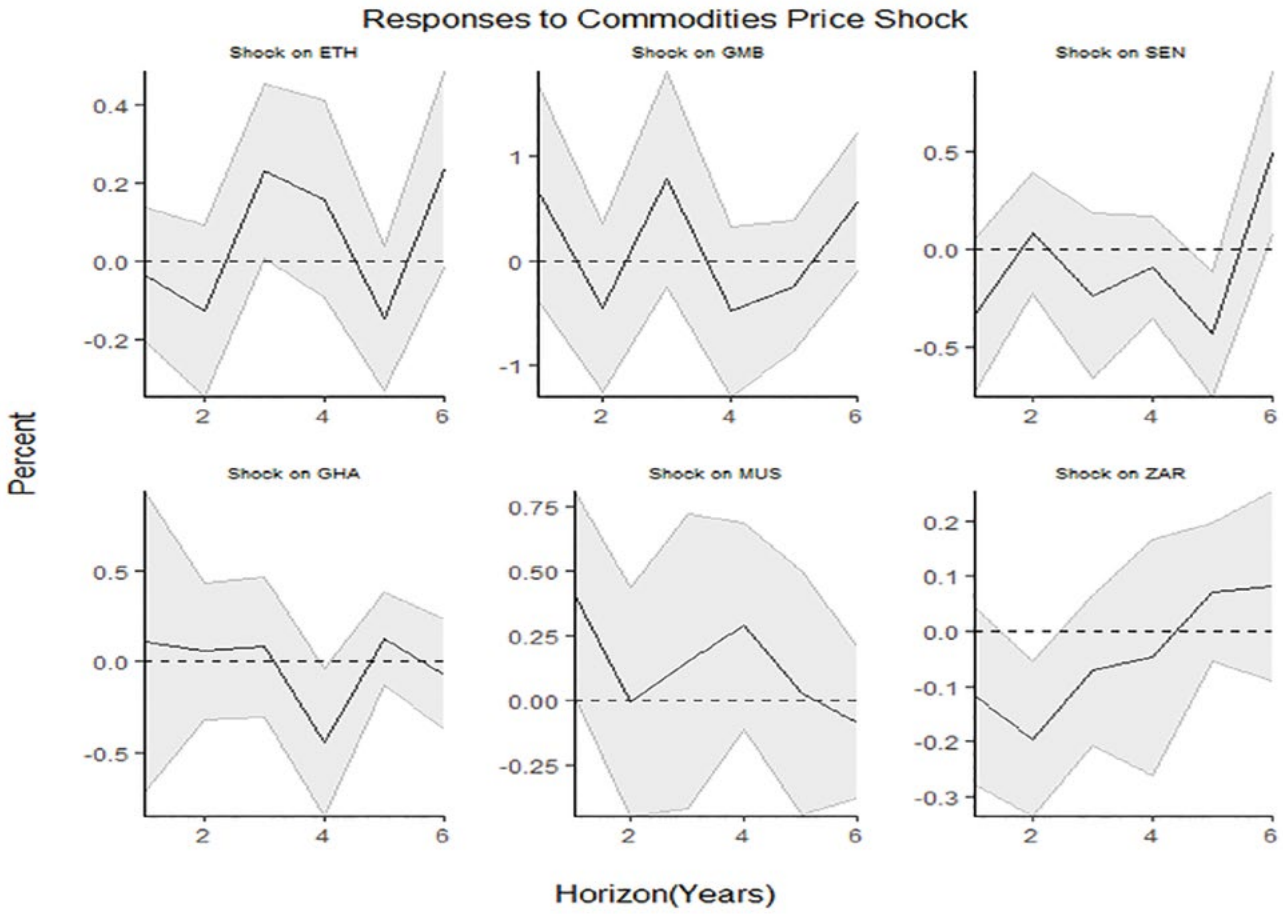
In Ethiopia, The Gambia, and South Africa, household consumption declines initially on impact but increases in the second to fourth years after the commodity price shock. This response pattern may suggest that, in the short run, commodity price increases directly decrease consumer expenditures, but in the second-round effect, there is an increase in consumption given the relatively inelastic demand for energy and food commodities. Disaggregating commodities into energy, non-energy, and food commodities exerts similar impacts in shape (Appendix – Figures A4, A5, and A6). However, in terms of size, price increases for non-energy commodities, including food, exert a greater impact than energy commodities. Kilian explains that higher energy prices are expected to shift consumption expenditures by reducing discretionary income, as consumers have less money to spend after paying their energy bills. However, the less elastic the demand for energy, the larger this discretionary income effect will be, all else being equal. The quantitative effect of energy price changes is bounded by the energy share in consumption, even with a perfectly inelastic energy demand (See Fig.4).

FIGURE 4: Impulse responses of household consumption



Notes: Responses to a 1 percent increase in commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

FIGURE 5: Impulse responses of public investment



Notes: Responses to a 1 percent increase in commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

For commodity-dependent countries like Ghana, the fall in government consumption from a surge in commodity prices is surprising. However, it is noteworthy that for Ghana, after the initial fall, government consumption increased between the third and fifth years, reaching a peak of about 0.2 percentage points. This response pattern may suggest that the reaction of government consumption is conditional on the level of commodity price surges.

Income, cost, and uncertainty effects are manifested in the response of government and household consumption to commodity price shocks among African countries. High commodity prices may translate into improved real income and cause a northward movement in consumption expenditures. Through the cost-effect, increased commodity prices would raise the cost of imported energy and non-energy goods and lead to higher consumption expenditure. However, this is dependent on the availability of substitutes and the elasticity of demand for the affected goods. Changing commodity prices may heighten economic uncertainty, causing consumers and governments to consolidate and increase precautionary savings. This is consistent with the submissions by Bernanke,[39] Pindyck, and Solimano[40] that prompted by heightened uncertainties from commodity price dynamics, consumers may postpone irreversible purchases of consumer durables.

39 Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. Quarterly Journal of Economics, 98(1), 85–106. <https://doi.org/10.2307/1885568>.

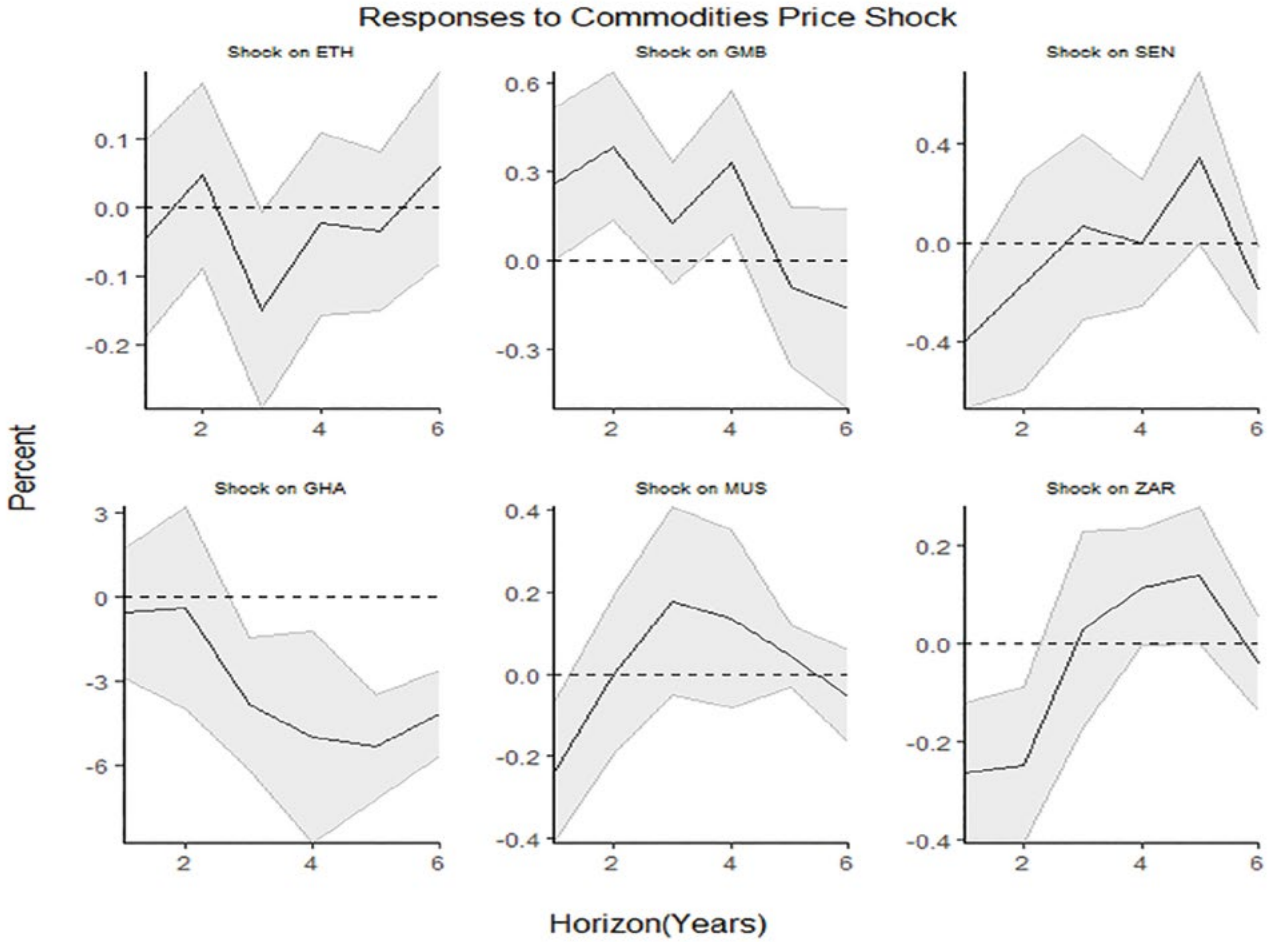
40 Pindyck, R. S., Solimano, A. (1993). Economic instability and aggregate investment. NBER Macroeconomics Annual, 8, 259–303.

Impact on investment

Figure 5 shows the results of public investment responses to commodity price hikes. The responses are positive for Ethiopia, The Gambia, and Mauritius, and negative for Senegal, Ghana, and South Africa, though not statistically significant. When we examine the effects of different commodities separately, we find that the pattern of responses to energy commodity price shocks is very similar to that obtained for all commodity price shocks (the impulse responses are shown in Appendix Figures A7, A8, and A9). We observe that non-energy community price shocks have a greater impact on public investment than unanticipated hikes in energy commodities for all countries, except for The Gambia and Mauritius. In contrast to energy commodities, the impact of non-energy commodity price increases on public investment in Ethiopia is delayed and negative. In Ghana, public investment increased at some points in reaction to upsurges in non-energy commodity prices, in contrast to the influence of energy price increases (See Fig.5).

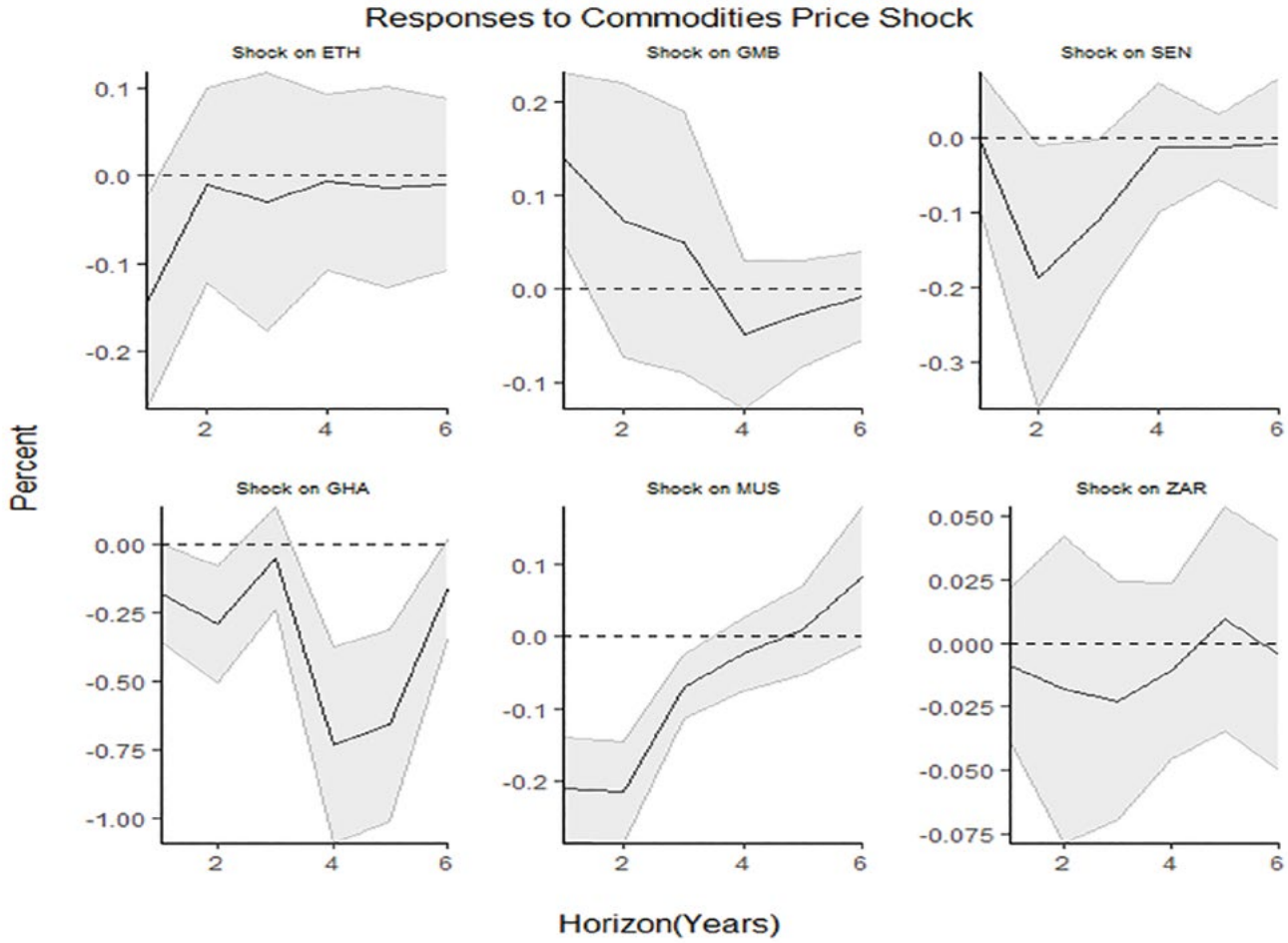
We examine the impact of commodity price hikes on industrial investment. As illustrated in Figure 6, commodity price shocks negatively impacted industrial production in most of the sample countries. In contrast, private investment in The Gambia has been positively impacted. Our results are consistent with those of Inoue, Okimo-

FIGURE 6: Impulse responses of private investment



Notes: Responses to a 1 percent increase in commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

FIGURE 7: Impulse responses of CPI Inflation



Notes: Responses to a 1 percent increase in commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

to,[41] and Kim.[42] Kim discovered that an oil price increase has led to a decline in both the level of industrial output and the price level of goods, and demonstrated that a rise in oil prices had a negative effect on industrial production activities by slowing demand. The respective effects of energy and non-energy commodity price shocks on private investment are almost the same quantitatively and qualitatively (see the impulse response plots in Appendix – Figures A10, A11, and A12). However, food price shocks exerted initial positive effects in Ethiopia and Ghana and a delayed but positive impact in Mauritius (See Fig.6).

For most commodity-exporting countries, the a priori expectation is that the bulk of the transitory gains from high commodity prices is saved and invested; therefore, investment should increase. Therefore, the observed fall in investment rates during shocks, which occur when prices are high, may be surprising. Instructively, commodity price hikes have increased investment at some point for all the sampled countries except Ghana. This pattern may suggest that a commodity price shock has both growth-enhancing and growth-declining effects on the economy. On the one hand, an unanticipated expansion of the business cycle in global commodity markets may stimulate investment and growth via improved global de-

41 Inoue, T., Okimoto, T. (2017). Measuring the effects of commodity price shocks on Asian economies (ADBI Working Paper No. 693). Asian Development Bank Institute.

42 Kim, Y. (2005). The impact of oil price change on the Korean manufacturing sector. Environmental and Resource Economics Review, 14(2), 291–336.

mand, real income, and savings. However, it raises the cost of energy and non-energy goods, creates uncertainty, and thereby slows investment and growth. Our findings indicate that even resource-rich countries are subject to the volatility of commodity prices, which may undermine investments and growth.

The evidence from our analysis is in line with the findings of Gubler and Hertweck[43] and shows that fluctuations in the international commodities market are necessary signals of impending economic downturns and significantly drive consumption and investment decisions. Consistent with Dehn and other studies, we find that commodity prices have a strong effect on investment. Our results show that, contrary to Dehn's observations, commodity price uncertainty matters for investment decisions in developing countries (See Fig.7).

Impact on inflation

Figure 7 shows a plot of the responses of headline CPI inflation among the sampled African countries. The magnitude of the commodity price shock diffusion on headline CPI inflation is negative for most countries, except for The Gambia. A one percent increase in commodity prices raises the headline CPI inflation by 0.14 percentage points for The Gambia. For other African countries, Ghana responds the most (-0.75 percentage point), followed by Mauritius (-0.21 percentage point), Senegal (-0.19 percentage point), Ethiopia (-0.14 percentage point), and South Africa (-0.03 percentage point). We also examine the responses of headline CPI inflation to different commodity price shocks. The responses of headline CPI inflation to the energy commodity price shock (Appendix – Figure A13), non-energy commodity price shock (Appendix – Figure A14), and food price shock (Appendix – Figure A15) resemble those of the all-commodity price shock qualitatively. In terms of magnitude, non-energy and food price shocks generate larger effects for all countries except for Ghana. This may suggest that energy products exert a relatively great pressure on CPI inflation in Ghana (See Fig.8).

We investigate the responses of PPI inflation, as shown in Figure 8. We observe negative and significant responses for all the countries, except for South Africa. Except for The Gambia, the rest of the countries with negative responses exhibit a positive response at some point within the five years after the shock. Non-energy commodities wielded greater quantitative effects on PPI inflation than energy commodities in all the countries. The impulse response plots for the effects of energy, non-energy, and food commodity price hikes on PPI inflation are shown in the Appendix, Figures A14, A15, and A16, respectively.

Our empirical estimates are consistent with theory and other results in the literature. Kilian and Zhou[44] estimated that the energy price shocks were not primarily responsible for the 2021 and 2022 inflationary pressures in the US. In Korea, Greenwood-Nimmo et al.[45] found that oil price shocks have had a minor effect on inflation. Sekine and Tsuruga[46] observed that the effect of commodity price shocks on inflation varies across country groups and is transitory, suggesting a low risk of a persistent second-round effect on inflation.

Despite popular opinion and expectations, there was no general evidence of a pass-through of commodity prices, including energy and food price shocks to inflation. Conventionally, an increase in commodity prices, especially energy, is expected to feed into domestic inflation through increased production costs (for PPI) and higher consumer prices (for CPI). The evidence from our analysis shows that international commodity price surges would, in most instances, not be likely to create persistent inflation. For commodity-export-

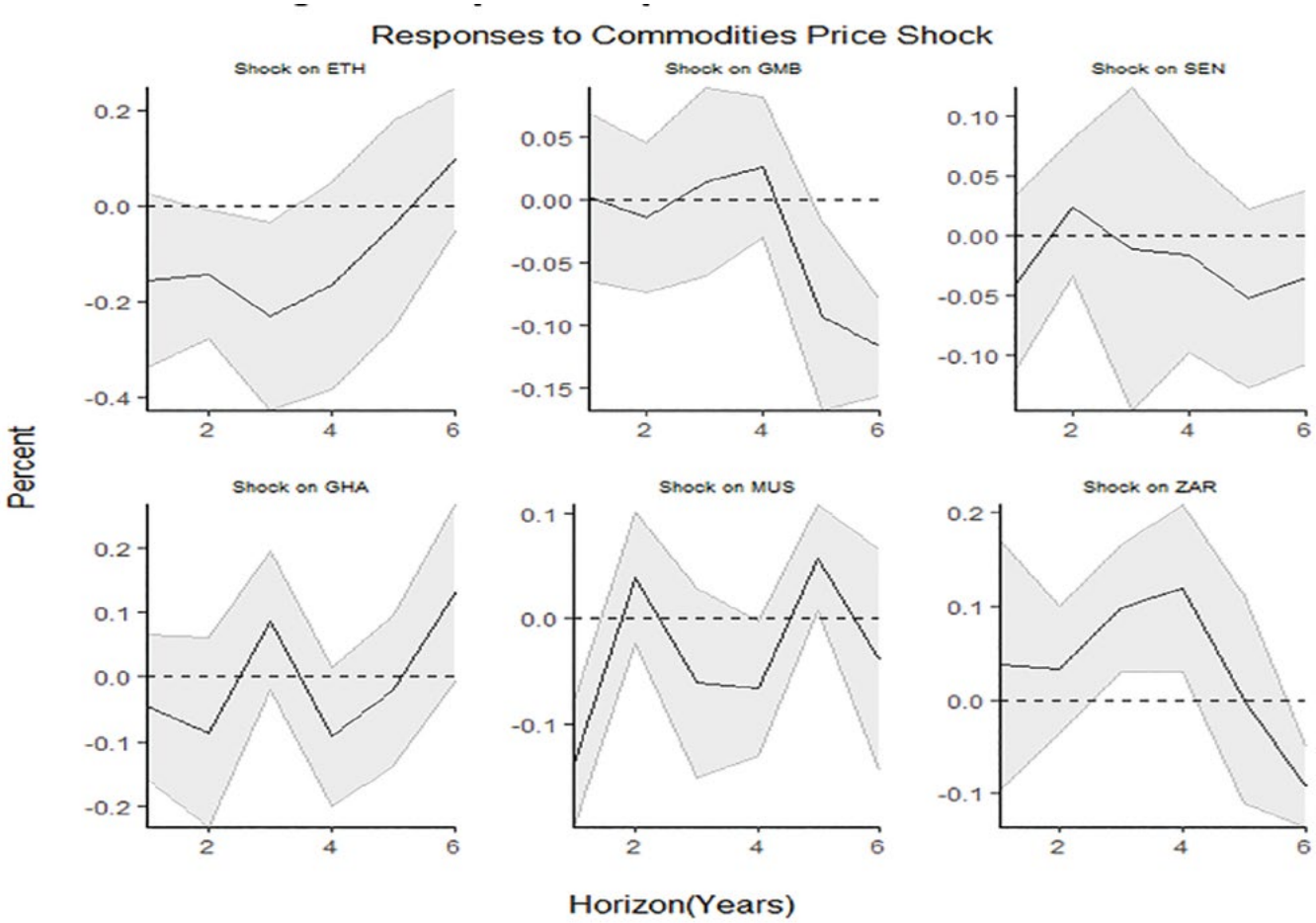
43 Gubler, M., Hertweck, M. S. (2013). Commodity price shocks and the business cycle: Structural evidence for the U.S. Journal of International Money and Finance, 37, 324–352. <https://doi.org/10.1016/j.jimonfin.2013.06.005>.

44 Kilian, L., Zhou, X. (2022). The impact of rising oil prices on U.S. inflation and inflation expectations in 2020–2023. Energy Economics, 113, 106228.

45 Greenwood-Nimmo, M., Nguyen, V. H., Shin, Y. (2012). Probabilistic forecasting of output growth, inflation and the balance of trade in a GVAR framework. Journal of Applied Econometrics, 27(4), 554–573.

46 Sekine, A., Tsuruga, T. (2018). Effects of commodity price shocks on inflation: A cross-country analysis. Oxford Economic Papers, 70(4), 1108–1135. <https://doi.org/10.1093/oep/gpy025>.

Figure 8: Impulse responses of PPI Inflation



Notes: Responses to a 1 percent increase in commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

ing countries like Ghana, Senegal, or South Africa, a positive commodity price shock can lead to an appreciation of the domestic currency, backed by increased foreign exchange inflows. A stronger currency makes imported goods cheaper, which directly reduces imported inflation and overall CPI, especially in economies heavily reliant on imports. This supply-side disinflationary effect could outweigh demand-side inflationary pressures.

Do our estimates suggest any role for policy in moderating the dynamic impacts of commodity price changes on the macroeconomy? One possible explanation for our results is that policy tightening in response to the expected inflationary pressures and the uncertainty generated by the commodity market turmoil may have kept inflationary impulses muted. While this is confirmed by the fiscal consolidation in reaction to unanticipated commodity price surges, the case for monetary policy would have to be tested. Besides, governments in commodity-rich countries might use increased revenues from commodity booms to subsidise essential goods, including fuel and food, thereby dampening inflationary pressures on consumers and producers. This is a common policy response aimed at mitigating the cost of living.

Notwithstanding, our results show that external drivers, including international commodity dynamics, play a considerable role in the inflation transformation in The Gambia. The results confirm the findings of Nachega et al.[47] that there is

47 Nachega, J. C., Kwende, G., Barroeta, F. A. M., Kemoe, L. (2024). Domestic and external drivers of inflation: The Gambia (IMF Selected Issues Paper No. 2024/004). International Monetary Fund.

a strong co-movement between global food inflation and CPI inflation in The Gambia, which can be explained by the fact that The Gambia is a net importer of essential foods and energy, and the weight of food items and non-alcoholic beverages in The Gambia's CPI basket is around 50 percent. In South Africa, the cost channel appears to be important, making the prospect of spillover effects of commodity price shocks on industrial applications high. However, it appears the shifts in producer prices are not passed on to consumers.

These results have important implications for policymakers. The sensitivity of the domestic economy to international commodity dynamics may not be entirely dependent on the integration into GVCs and global trade per se. But more importantly, it is the fact that international commodity markets' dynamics reflect global economic uncertainty and demand, with the attendant reactions in the domestic economy. The results suggest that a combination of the policy stance at the time of the shock and policy changes made in response to the shock is critical in maintaining economic stability and mitigating any adverse effects from the international commodity markets' dynamics.

CONCLUSIONS

The sharp rise in energy and food prices in recent years has renewed interest in the question of how much higher commodity prices affect economic development. Our analysis allows us to assess the overall effects of such a price increase on CPI and PPI inflation, household and government consumption, and public and private investments.

First, we find no evidence of a general pass-through of commodity prices, including energy and food price shocks to inflation. Indeed, the inflationary impacts of commodity price shocks on headline CPI inflation are confirmed for only one country, The Gambia, a net-importer of essential foods and energy. Concerning the PPIs, the responses are negative and significant for all the sampled countries except South Africa. For South Africa, the PPI inflation responded positively to commodity price hikes. Even for the countries with negative responses, only The Gambia has not exhibited a positive response at some point within the five years following an unanticipated increase in commodity prices. This implies that the surge of commodity prices has generated some inflationary pressure on a country's PPI.

Secondly, we find cross-country differences in the response of household and government consumption to commodity price shocks. On impact, government consumption initially increased in Ethiopia and Mauritius after a positive shock to commodity prices. For Ghana, The Gambia, Senegal, and South Africa, the response of government consumption was negative. Similarly, the response of household consumption to increases in commodity prices shows considerable cross-country variations. The initial response of household consumption was negative for Senegal, Ethiopia, The Gambia, and South Africa. For Ghana and Mauritius, the response was positive.

Lastly, we investigate the impact of a commodity price hike on investment. For public investment, the responses are significantly positive for Ethiopia, The Gambia, and Mauritius, and negative for Senegal, Ghana, and South Africa. Private investment, on the other hand, responded negatively in all countries except in The Gambia.

Our analysis includes separating energy and non-energy commodities and evaluating their dynamic impacts. While energy, non-energy, and food commodities exert similar effects qualitatively, non-energy commodities have wielded greater quantitative impacts than energy commodities do. This is quite instructive given that the literature has generally focused on the effects of energy commodities. While energy products have important applications in the economy and are therefore the subject of concern, our empirical estimates show that the dynamics of non-energy commodities have equal prospects in affecting the domestic economy.

The overriding conclusion from the analysis is that propagation of commodity price shocks is dominantly through the uncertainty channel, and their ripple effect on the domestic economy is via adjustments in consumer and firm expenditures. This uncertainty has implications for both supply-side and demand-side accounts of the transmission of commodity price shocks. Specifically, consumption expenditures may shift as consumers increase their precautionary savings, while

firms may scale back investment in response to uncertainty about demand, cost, and the general economic environment. Thus, when commodity prices rise, the uncertainty effect will reinforce the decline in firms' investment expenditures due to reduced consumer demand and higher costs.

Given the profound structural reliance of many African economies on commodity exports, the fluctuations in commodity prices directly affect fiscal revenues, affect government consumption and investments, influence exchange rate dynamics, and alter household incomes, thereby posing substantial challenges to economic management. Practically, our findings reflect the need for robust fiscal frameworks, including stabilisation funds and debt management strategies, to manage commodity revenue volatility and avoid pro-cyclical spending. The analysis re-establishes the importance of economic diversification and strengthening non-commodity sectors to reduce vulnerability to commodity price fluctuations.

The inherent vulnerability of commodity-dependent economic structures means that international commodity price movements are not merely minor disturbances but represent a fundamental driver of business cycle fluctuations and broader macroeconomic instability. This underscores the critical policy relevance of the current research, moving beyond a general statement of importance to highlight the deep-seated structural challenges faced by these nations.

In the future, it is worth examining the importance of endogenous policy responses in the macroeconomic implications of commodity price shocks. Thus, we need to understand how the configuration and the response of key policy instruments, especially monetary policy, moderate the macroeconomic dynamics caused by commodity price shocks. The bivariate approach provides the total effect of commodity price shocks, which may implicitly capture omitted channels. Notwithstanding, future empirical work that incorporates a more comprehensive set of control variables within a multivariate LP framework or a Structural Vector Autoregression (SVAR) model is also likely to be promising. This would allow for a more nuanced understanding of the shock transmission mechanisms and address potential endogeneity concerns.

REFERENCES

Allard, C., Kriljenko, M. J. I. C., Gonzalez-Garcia, M. J. R., Kitsios, E., Trevino, M. J. P., Chen, M. W. (2016). Trade integration and global value chains in sub-Saharan Africa: In pursuit of the missing link. International Monetary Fund;

Arezki, R., Imam, P. A., Kpodar, K., Le-Van, D. (2025). Shocks and shields: Macroeconomic institutions during commodity price swings (Working Paper No. 25/15). International Monetary Fund. <https://www.imf.org/en/Publications/WP/Issues/2025/01/24/Shocks-and-Shields-Macroeconomic-Institutions-During-Commodity-Price-Swings-560031>;

Athukorala, P. C., Kohpaiboon, A. (2011). East Asia in world trade: The decoupling fallacy, crisis, and policy challenges (FIW Working Paper No. 52). Research Centre International Economics;

Avalos, F., Cap, A., Igan, D., Kharroubi, E., Nodari, G. (2022). Energy markets: Shock, economic fallout and policy response (BIS Quarterly Review No. 64). Bank for International Settlements;

Bems, R., Johnson, R. C., Yi, K. M. (2010). Demand spillovers and the collapse of trade in the global recession. IMF Economic Review, 58(2). <https://doi.org/10.1057/imfer.2010.16>;

Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. Quarterly Journal of Economics, 98(1). <https://doi.org/10.2307/1885568>;

Castelnuovo, E. (2019). Yield curve and financial uncertainty: Evidence based on U.S. data. Australian Economic Review, 52(3). <https://doi.org/10.1111/1467-8462.12324>;

Collier, P., Gunning, J. W. (1999). Trade shocks in developing countries. Oxford University Press;

Dehn, J. (2000). Private investment in developing countries: The effects of commodity shocks and uncertainty (Working Paper No. 2000-11). Centre for the Study of African Economies, University of Oxford;

Dixit, A. K., Pindyck, R. S. (1994). Investment under uncertainty. Princeton University Press;

El Ganainy, A., Hakobyan, S., Liu, F., Weisfeld, H., Allard, C., Balima, H. W., Bteish, C., Giri, R., Kanda, D. S., Meleshchuk, S., Ramirez, G. (2023). Trade integration in Africa: Unleashing the continent's potential in a changing world (IMF Departmental Paper No. 2023/003). International Monetary Fund;

Gangnes, B., Ma, A. C., Van Assche, A. (2012). Global value chains and the transmission of business cycle shocks (Economics Working Paper Series No. 29). Asian Development Bank;

Greenwood-Nimmo, M., Nguyen, V. H., Shin, Y. (2012). Probabilistic forecasting of output growth, inflation and the balance of trade in a GVAR framework. Journal of Applied Econometrics, 27(4). <https://doi.org/10.1002/jae.1230>;

Gubler, M., Hertweck, M. S. (2013). Commodity price shocks and the business cycle: Structural evidence for the U.S. Journal of International Money and Finance, 37. <https://doi.org/10.1016/j.jimonfin.2013.06.005>;

Hamilton, J. D. (2013). Historical oil shocks. In R. Whaples R. E. Parker (Eds.), Routledge handbook of major events in economic history. Routledge;

He, Y., Lee, M. (2022). Macroeconomic effects of energy price: New insights from Korea. Mathematics, 10(15). <https://doi.org/10.3390/math10152653>;

Inoue, T., Okimoto, T. (2017). Measuring the effects of commodity price shocks on Asian economies (ADBI Working Paper No. 693). Asian Development Bank Institute;

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. American Economic Review, 95(1). <https://doi.org/10.1257/0002828053828518>;

Jordà, Ò., Taylor, A. M. (2025). Local projections. Journal of Economic Literature, 63(1). <https://doi.org/10.1257/jel.20241521>;

Kilian, L. (2008). The economic effects of energy price shocks. Journal of Economic Literature, 46(4). <https://doi.org/10.1257/jel.46.4.871>;

Kilian, L., Zhou, X. (2022). The impact of rising oil prices on U.S. inflation and inflation expectations in 2020–2023. Energy Economics, 113, 106228. <https://doi.org/10.1016/j.eneco.2022.106228>;

Kim, S., Lee, J. W., Park, C. Y. (2011). Emerging Asia: Decoupling or recoupling. World Economy, 34(1). <https://doi.org/10.1111/j.1467-9701.2010.01320.x>;

Kim, Y. (2005). The impact of oil price change on the Korean manufacturing sector. Environmental and Resource Economics Review, 14(2);

Li, D., Plagborg-Møller, M., Wolf, C. K. (2024). Local projections vs. VARs: Lessons from thousands of DGPs. Journal of Econometrics, 244(2). <https://doi.org/10.1016/j.jeconom.2023.105650>;

Montiel Olea, J. L., Plagborg-Møller, M. (2021). Local projection inference is simpler and more robust than you think. Econometrica, 89(4). <https://doi.org/10.3982/ECTA18756>;

Montiel Olea, J. L., Plagborg-Møller, M., Qian, E., Wolf, C. K. (2024). Double robustness of local projections and some unpleasant VARithmetic. NBER Working Paper Series, No. 32463. National Bureau of Economic Research. <https://doi.org/10.3386/w32463>;

Montiel Olea, J. L., Plagborg-Møller, M., Qian, E., Wolf, C. K. (2025). Local projections or VARs? A primer for macroeconomists. NBER Macroeconomics Annual 2025. <https://doi.org/10.48550/arXiv.2503.17144>;

Nachega, J. C., Kwende, G., Barroeta, F. A. M., Kemoe, L. (2024). Domestic and external drivers of inflation: The Gambia (IMF Selected Issues Paper No. 2024/004). International Monetary Fund;

Newey, W. K., West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica, 55(3). <https://doi.org/10.2307/1913610>;

Park, C., Chung, M., Lee, S. (2011). The effects of oil price on regional economies with different production structures: Evidence from Korea using a SVAR model. Energy Policy, 39(12). <https://doi.org/10.1016/j.enpol.2011.09.041>;

Parra, J. C., Wodon, Q. (2008). Comparing the impact of food and energy price shocks on consumers: A social accounting matrix analysis for Ghana (World Bank Policy Research Working Paper No. 4741). World Bank;

Pindyck, R. S., Solimano, A. (1993). Economic instability and aggregate investment. NBER Macroeconomics Annual, 8;

Polgreen, L., Silos, P. (2006). Crude substitution: The cyclical dynamics of oil prices and the college premium (FRB Atlanta Working Paper No. 2006–14). Federal Reserve Bank of Atlanta;

Pula, G., Peltonen, T. A. (2011). Has emerging Asia decoupled? In The evolving role of Asia in global finance. Emerald Group Publishing;

Qian, C., Zhang, T., Li, J. (2023). The impact of international commodity price shocks on macroeconomic fundamentals: Evidence from the U.S. and China. Resources Policy, 85, 103904. <https://doi.org/10.1016/j.resourpol.2023.103904>;

Ramey, V. A., Zubairy, S. (2018). Government spending multipliers in good times and in bad: Evidence from U.S. historical data. Journal of Political Economy, 126(2). <https://doi.org/10.1086/696277>;

Roch, F. (2019). The adjustment to commodity price shocks. Journal of Applied Economics, 22(1). <https://doi.org/10.1080/15140326.2019.1665316>;

Saito, M., Ruta, M., Turunen, J. (2013). Trade interconnectedness: The world with global value chains (Policy Paper). International Monetary Fund;

Sekine, A., Tsuruga, T. (2018). Effects of commodity price shocks on inflation: A cross-country analysis. Oxford Economic Papers, 70(4). <https://doi.org/10.1093/oep/gpy025>;

Siba, E. (2022). Value chains in Africa: What role for regional trade? OECD Development Matters;

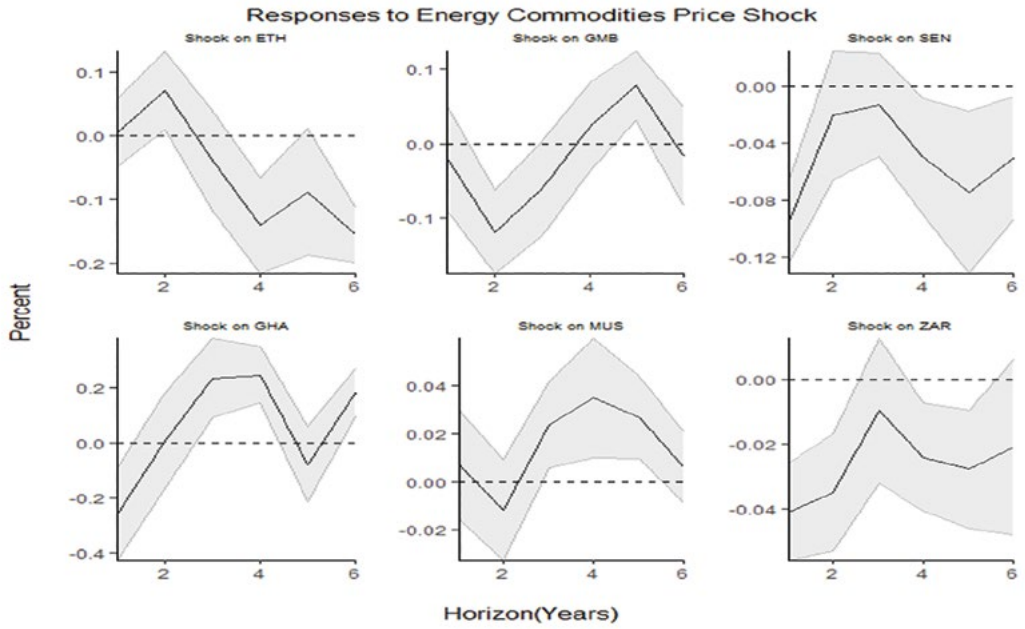
Wei, C. (2003). Energy, the stock market, and the putty–clay investment model. American Economic Review, 93(1). <https://doi.org/10.1257/000282803321455223>.

APPENDIX

Table A1: Augmented Dickey-Fuller Unit Root Test

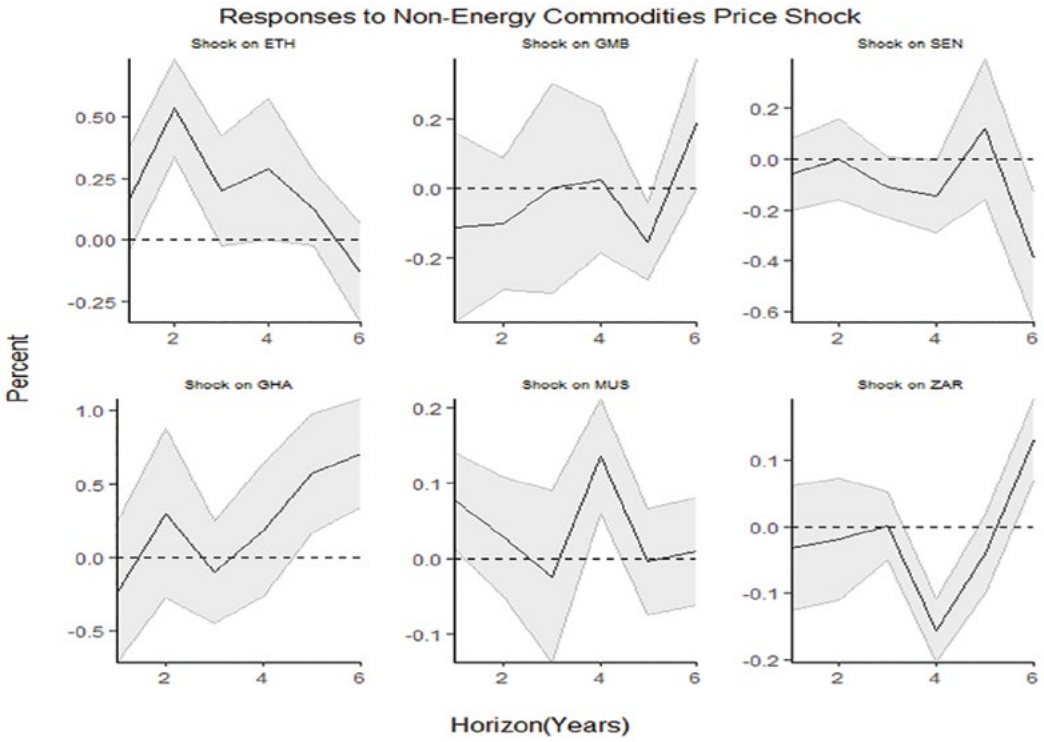
Variable		Ethiopia	Ghana	Gambia	Mauritius	Senegal	South Africa
Commodity Prices (Annual %)	t-Stat	-6.52	-6.52	-6.52	-6.52	-6.52	-6.52
	P-value	0.00	0.00	0.00	0.00	0.00	0.00
Energy Commodity (Annual %)	t-Stat	-7.20	-7.20	-7.20	-7.20	-7.20	-7.20
	P-value	0.00	0.00	0.00	0.00	0.00	0.00
Non-Energy Commodity (Annual %)	t-Stat	-7.42	-7.42	-7.42	-7.42	-7.42	-7.42
	P-value	0.00	0.00	0.00	0.00	0.00	0.00
Food Commodity (Annual %)	t-Stat	-7.21	-7.21	-7.21	-7.21	-7.21	-7.21
	P-value	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Inflation	t-Stat	-4.99	-1.79	-2.82	-2.74	-4.20	-7.22
	P-value	0.00	0.07	0.01	0.01	0.00	0.00
Producer Inflation	t-Stat	-5.41	-5.58	-4.43	-6.46	-4.87	-2.78
	P-value	0.00	0.00	0.00	0.00	0.00	0.07
Household Consumption (Annual %)	t-Stat	-7.51	-9.69	-5.51	-5.31	-8.85	-5.35
	P-value	0.00	0.00	0.00	0.00	0.00	0.00
Private Investment (Annual %)	t-Stat	-7.00	-7.98	-6.27	-5.17	-8.05	-4.62
	P-value	0.00	0.00	0.00	0.00	0.00	0.00
Government Consumption (Annual %)	t-Stat	-5.52	-8.73	-9.14	-6.76	-7.05	-5.22
	P-value	0.00	0.00	0.00	0.00	0.00	0.00
Public Investment (Annual %)	t-Stat	-6.37	-5.84	-9.06	-10.75	-9.05	-574
	P-value	0.00	0.00	0.00	0.00	0.00	0.00

Figure A1: Impulse responses of government consumption to energy commodity price shock



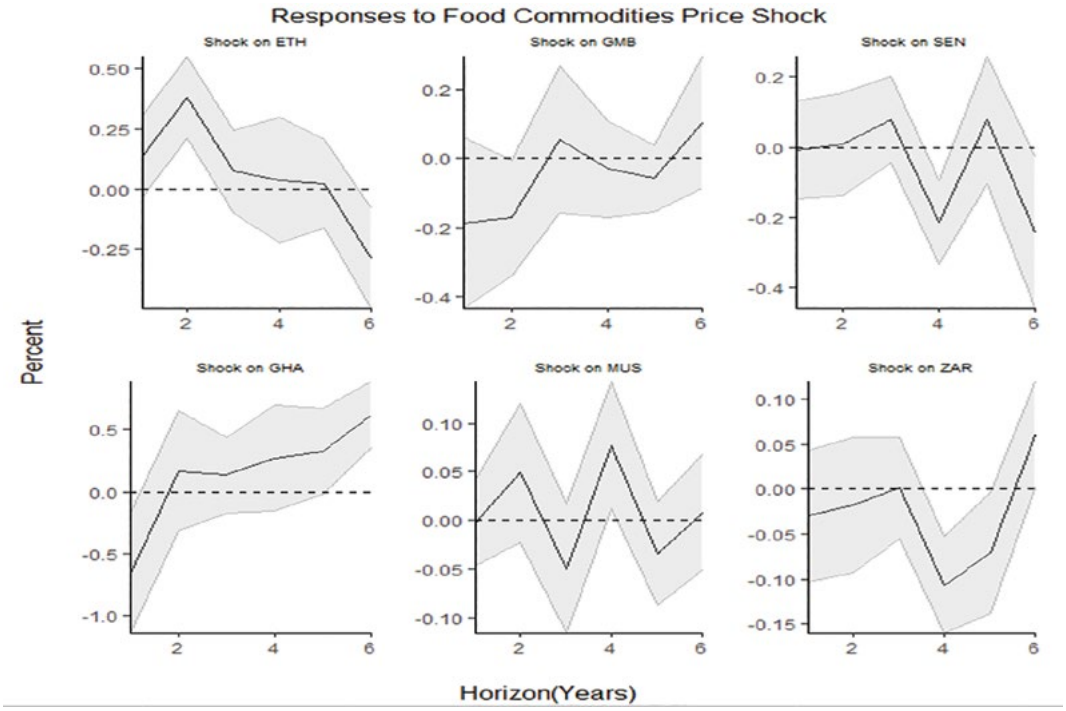
Notes: One-standard-deviation shock equals a 1 percent increase in energy commodity prices. Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A2: Impulse responses of government consumption to non-energy commodity price shock



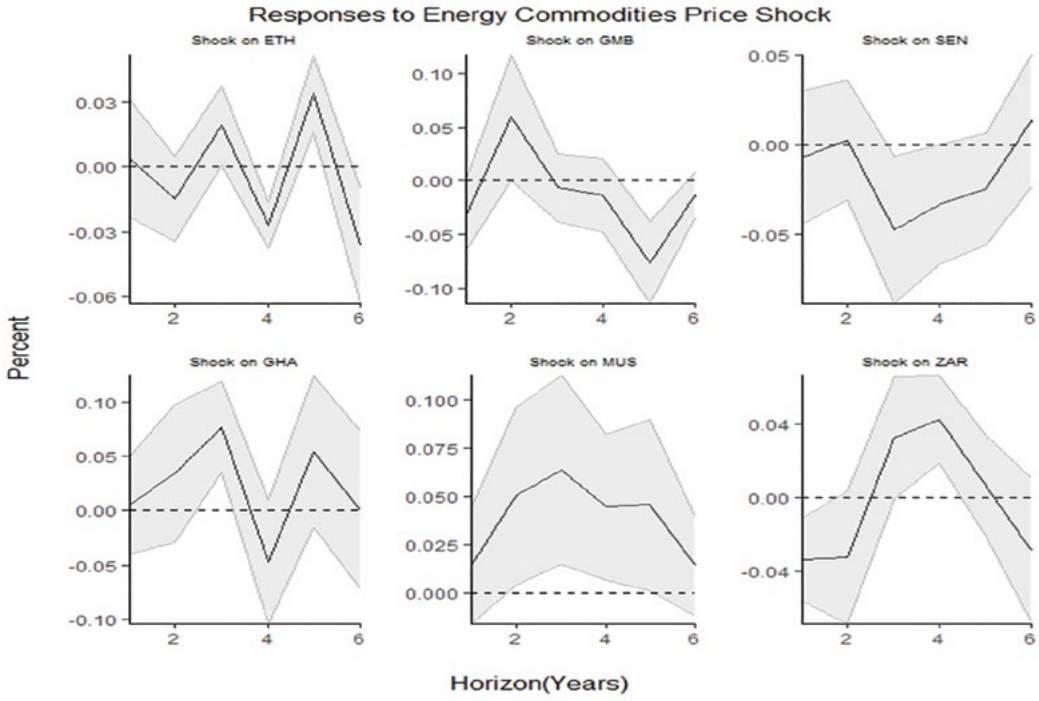
Notes: Responses to a 1 percent increase in non-energy commodity prices. Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A3: Impulse responses of government consumption to food commodity price shock



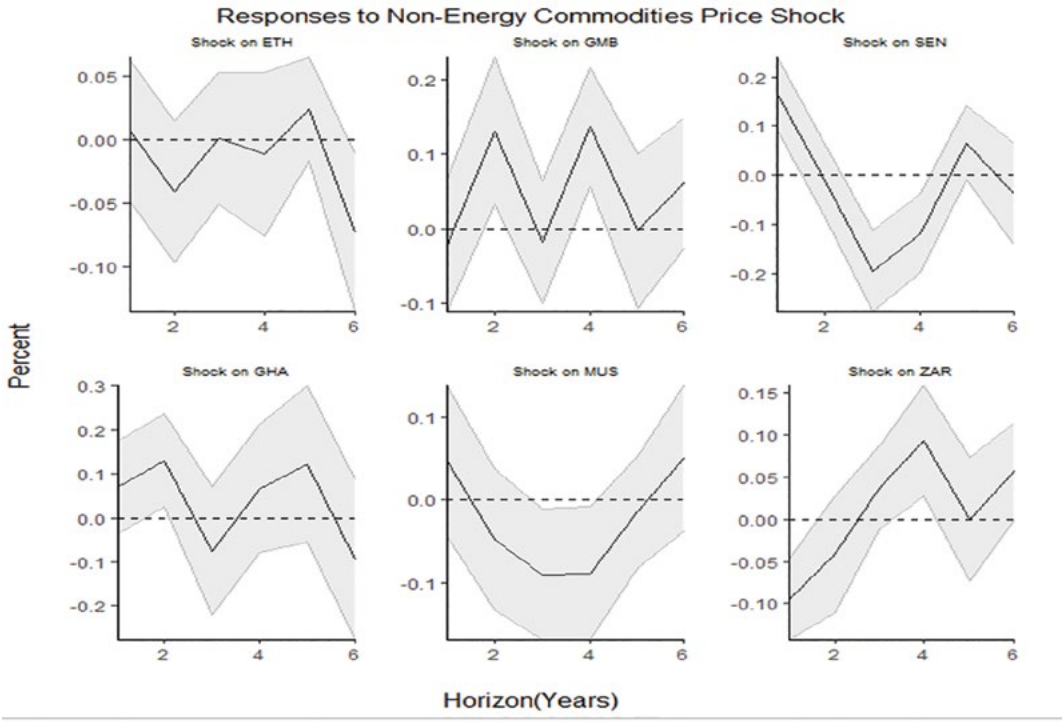
Notes: Responses to a 1 percent increase in food commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A4: Impulse responses of household consumption to energy commodity price shock



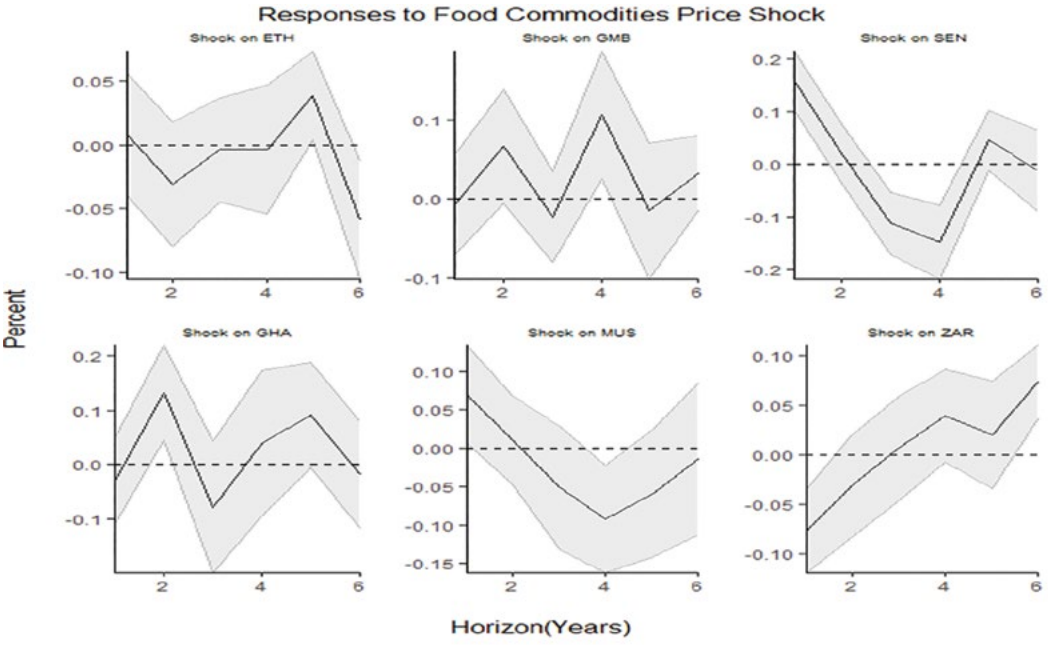
Notes: Responses to a 1 percent increase in energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A5: Impulse responses of household consumption to non-energy commodity price shock



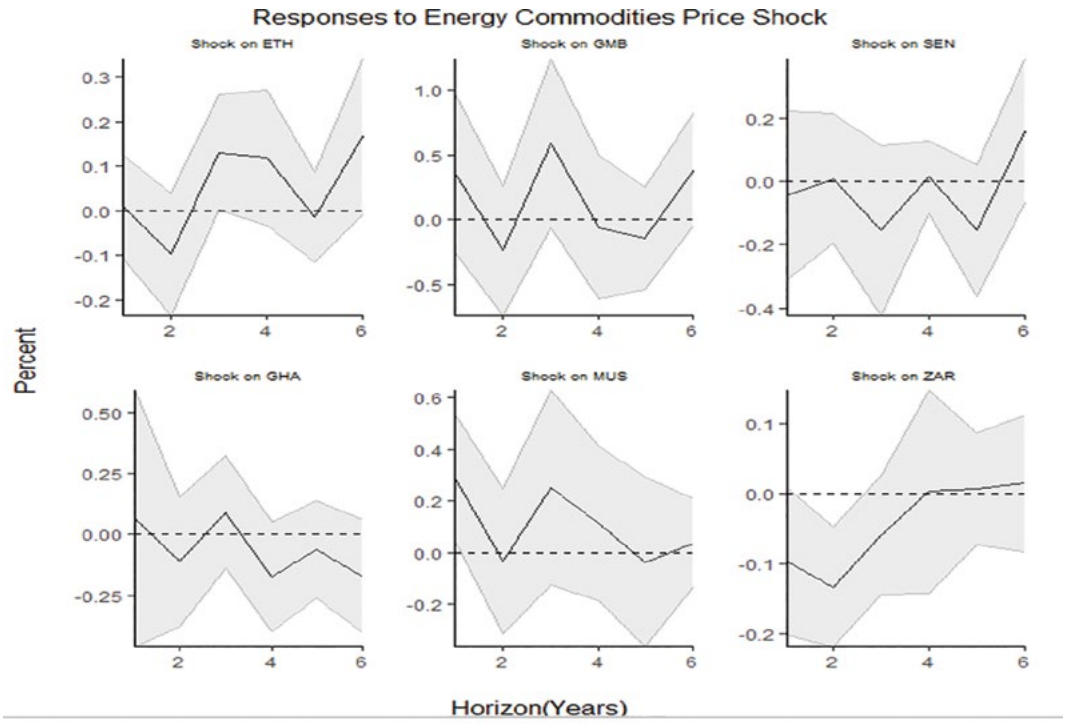
Notes: Responses to a 1 percent increase in non-energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A6: Impulse responses of household consumption to food commodity price shock



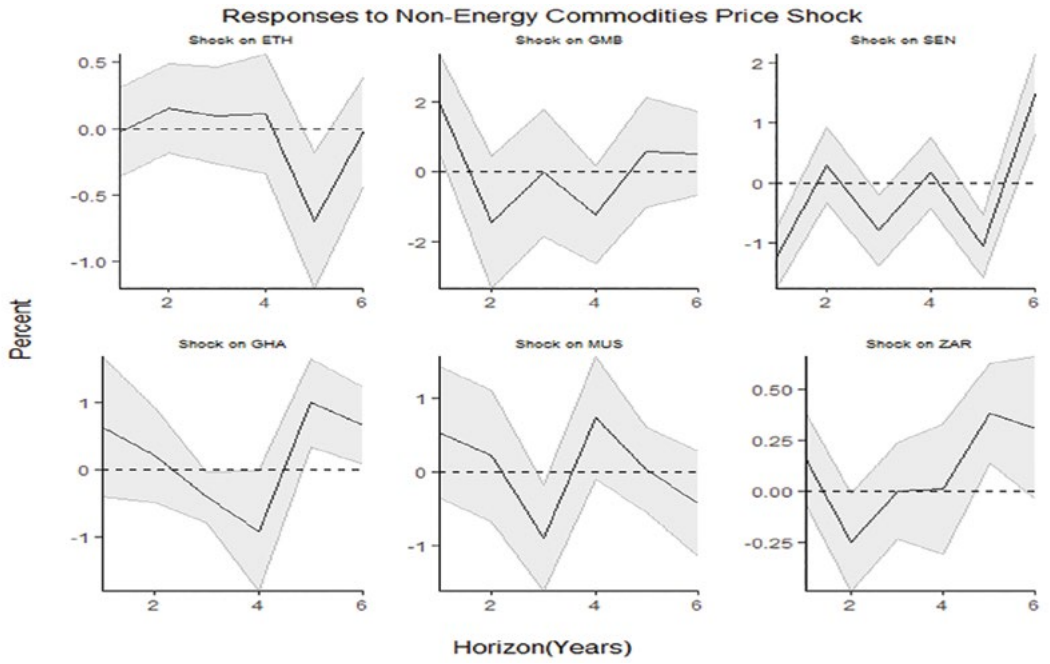
Notes: Responses to a 1 percent increase in food commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A7: Impulse response of public investment to energy commodity price shock



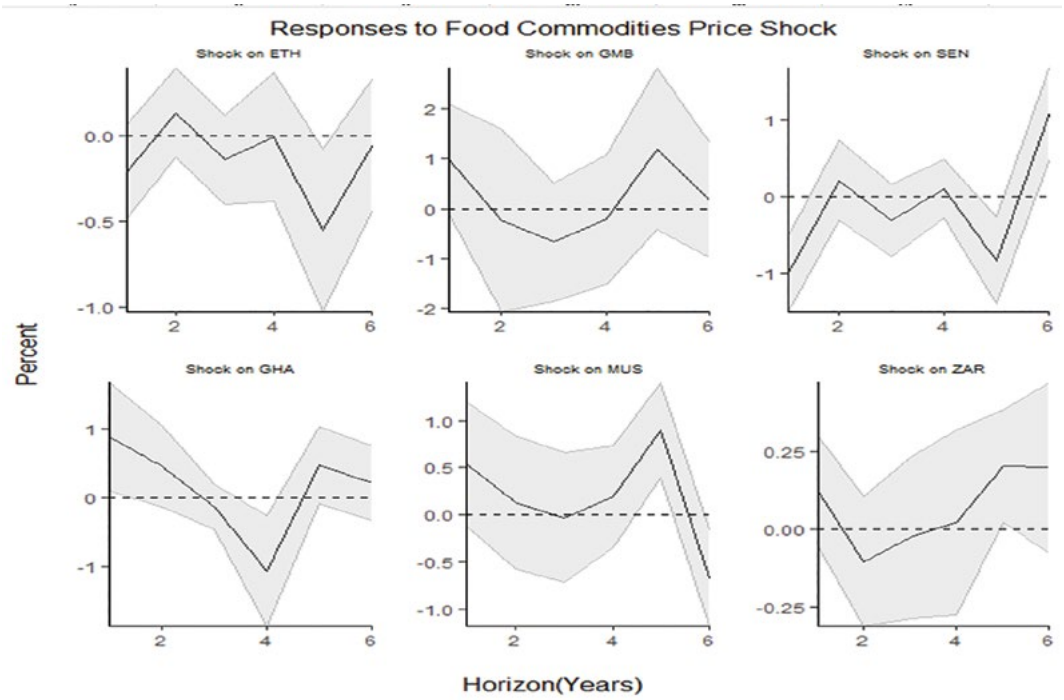
Notes: Responses to a 1 percent increase in energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A8: Impulse response of public investment to non-energy commodity price shock



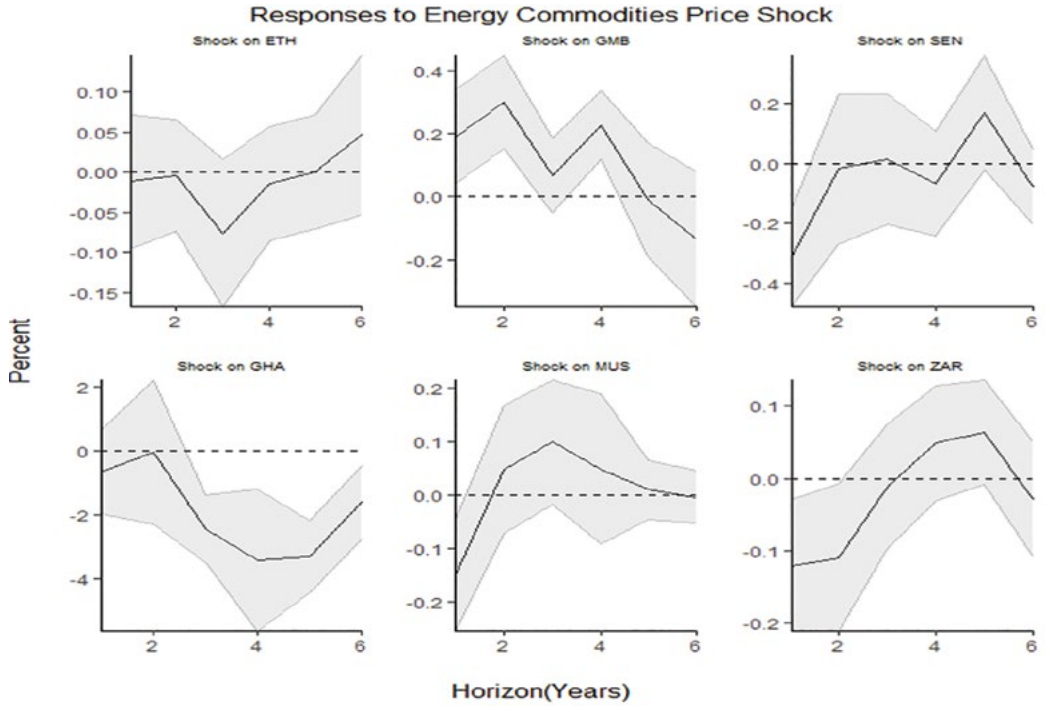
Notes: Responses to a 1 percent increase in non-energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A9: Impulse response of public investment to food commodity price shock



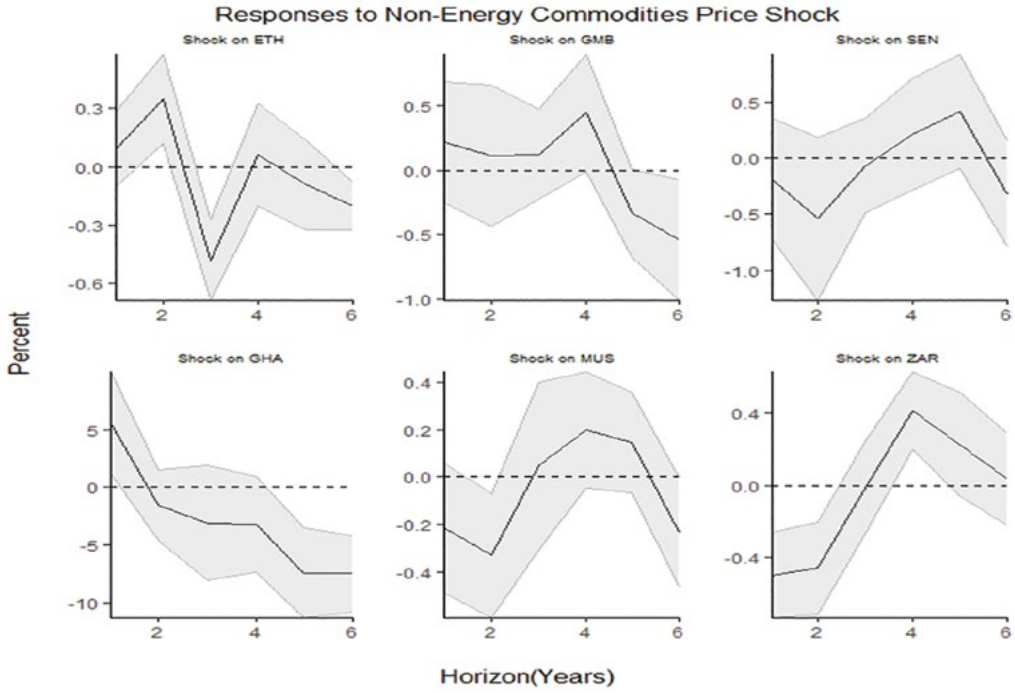
Notes: Responses to a 1 percent increase in food commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A10: Impulse responses of private investment to energy commodity price shock



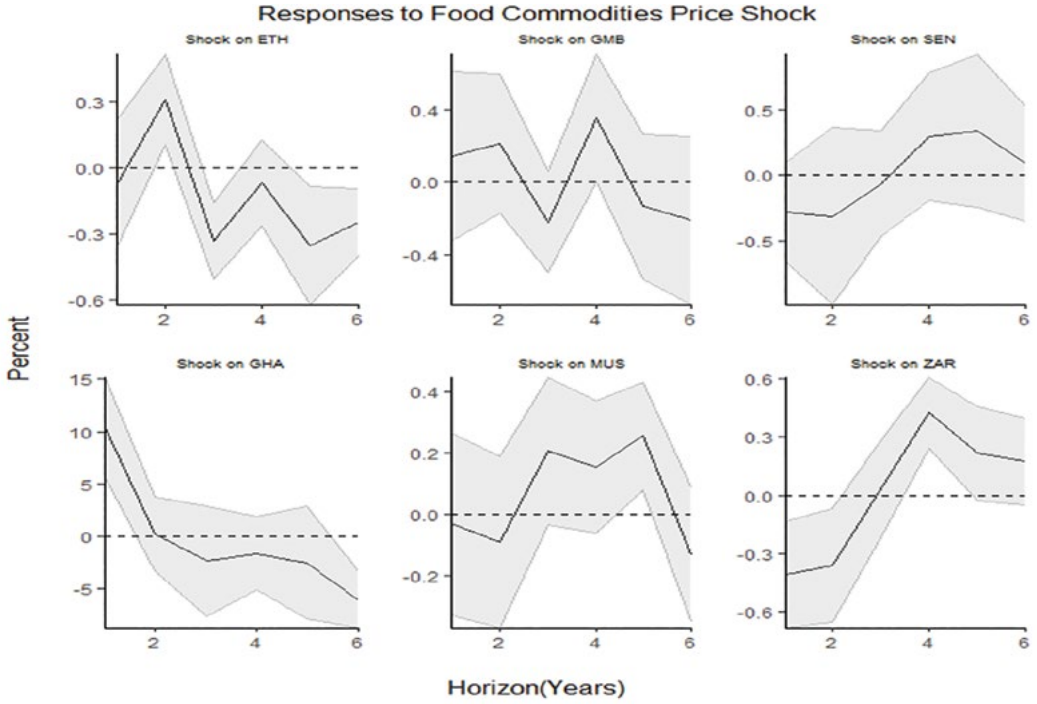
Notes: Responses to a 1 percent increase in energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A11: Impulse responses of private investment to non-energy commodity price shock



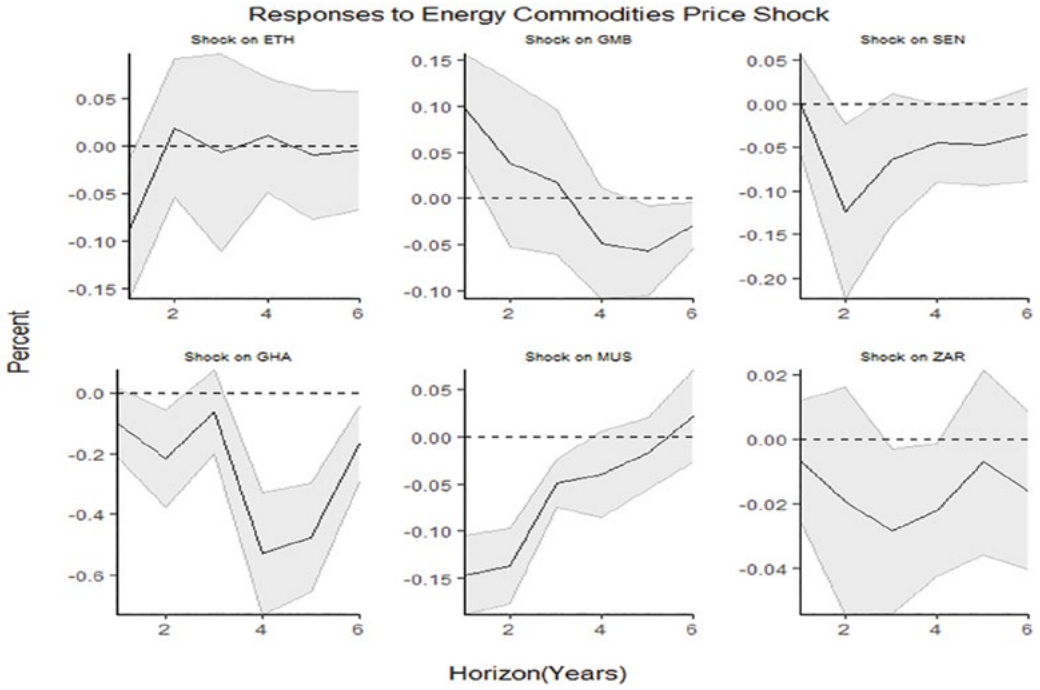
Notes: Responses to a 1 percent increase in non-energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A12: Impulse responses of private investment to food commodity price shock



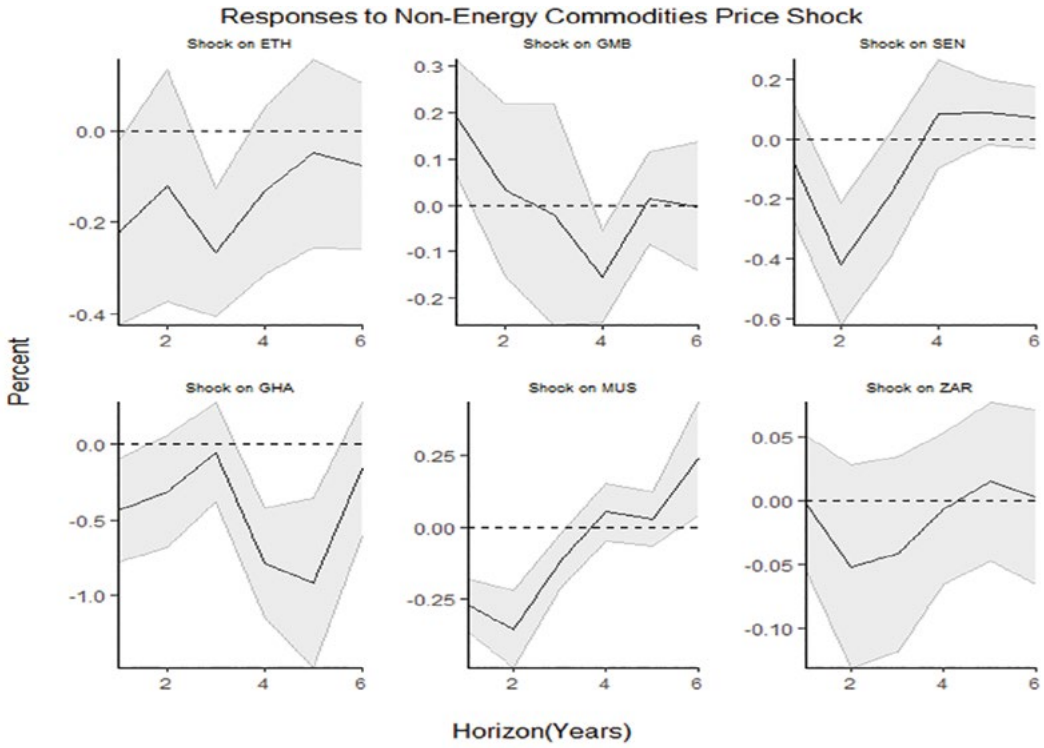
Notes: Responses to a 1 percent increase in food commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A13: Impulse response of CPI inflation to energy commodity price shock



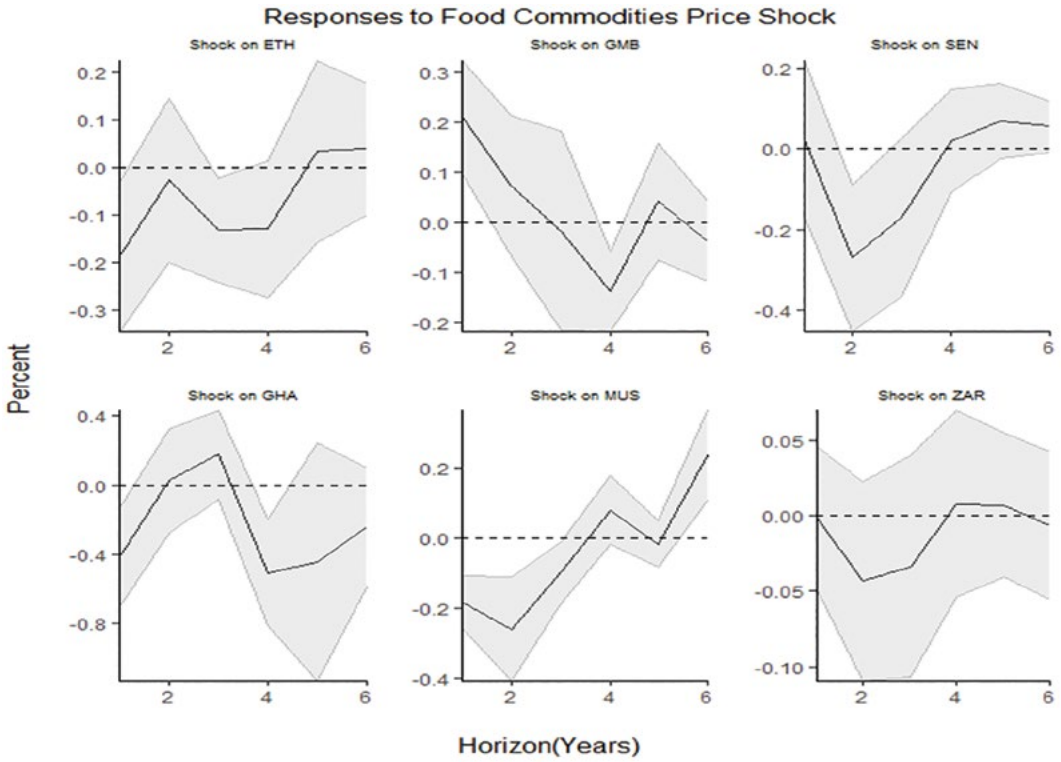
Notes: Responses to a 1 percent increase in energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A14: Impulse response of CPI inflation to non-energy commodity price shock



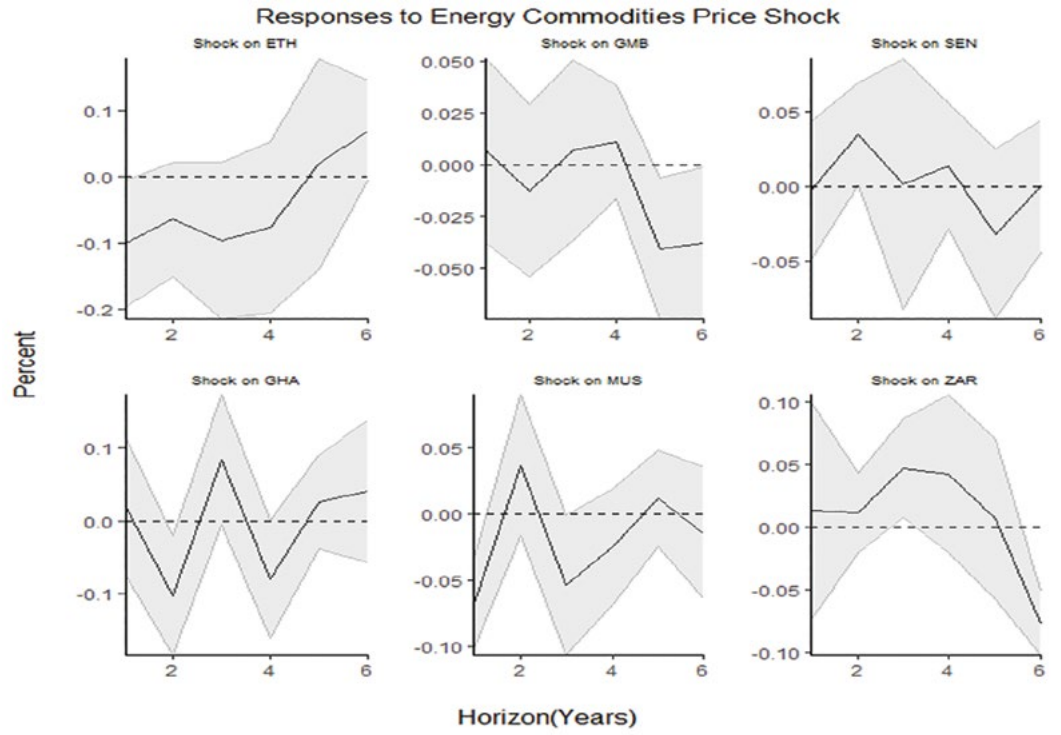
Notes: Responses to a 1 percent increase in non-energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A15: Impulse response of CPI inflation to food commodity price shock



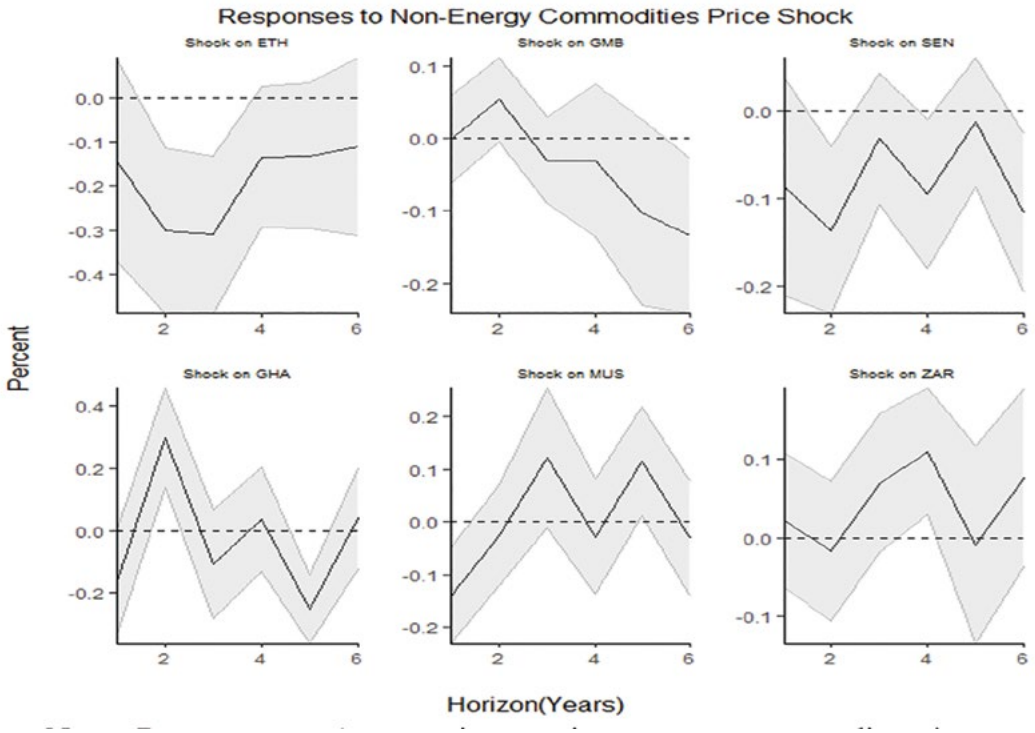
Notes: Responses to a 1 percent increase in food commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A16: Impulse responses of PPI inflation to energy commodity price shock



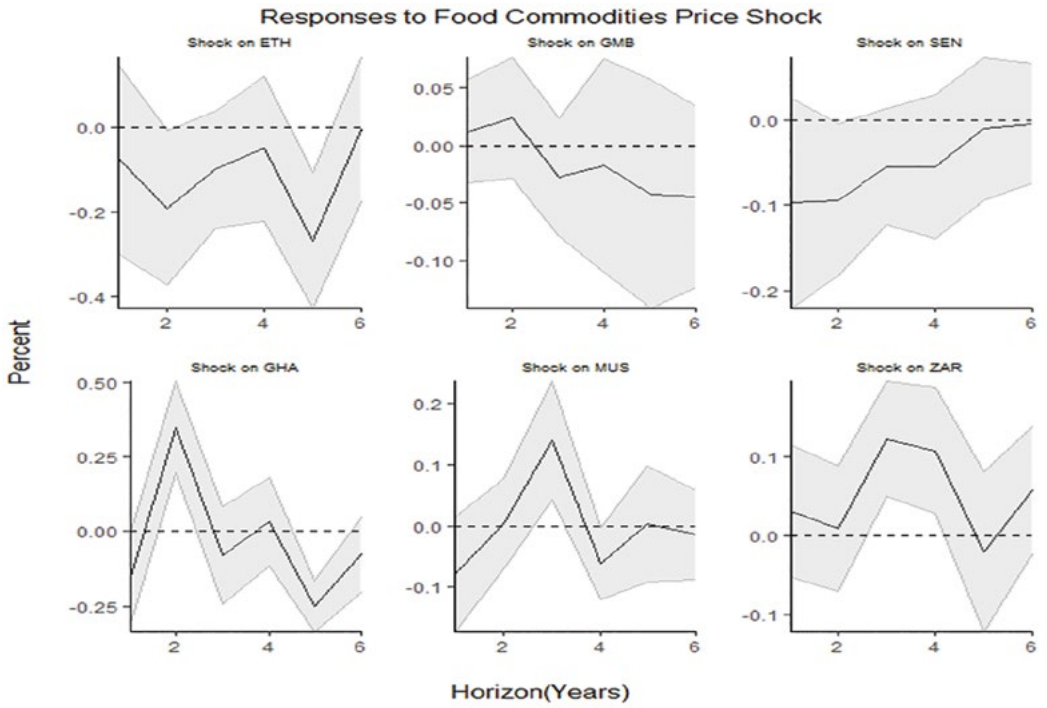
Notes: Responses to a 1 percent increase in energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A17: Impulse responses of PPI inflation to non-energy commodity price shock



Notes: Responses to a 1 percent increase in non-energy commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

Figure A18: Impulse responses of PPI inflation to food commodity price shock



Notes: Responses to a 1 percent increase in food commodity prices.
Point estimates (90% confidence bands) are identified by solid black (shaded grey) lines.

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ARTICLE

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FINTECH AND CLIMATE RESILIENCE IN BANKING: Navigating Risk and Opportunity

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Abstract. *Climate-related financial risks, encompassing both physical and transition dimensions, present an escalating threat to global financial stability, necessitating sophisticated risk management responses from the banking sector. This literature review synthesizes existing academic and industry research on the intersection of financial technology (Fintech) and bank climate risk management. The review establishes Fintech's critical role in enhancing banks' capacity to assess, monitor, and mitigate these complex risks through solutions such as Artificial Intelligence (AI), Machine Learning (ML), blockchain, big data analytics, and digital platforms for green finance. It examines methodologies, identifies key trends, and analyzes evolving perspectives from academic scholarship and industry practice on integrating climate risk into operational and strategic frameworks. Furthermore, this work investigates the challenges and limitations confronting fintech adoption, including data scarcity, regulatory hurdles, technological integration barriers, and ethical considerations such as algorithmic bias and the threat of "greenwashing". The review concludes by highlighting emerging best practices and innovative approaches, synthesizing gaps in the existing literature, and proposing a research agenda designed to inform researchers, policymakers, and financial institutions. This foundation enables these stakeholders to navigate this dynamic landscape, contributing to a more resilient and sustainable financial system.*

KEYWORDS: BANK RISK MANAGEMENT, FINTECH, CLIMATE-RELATED FINANCIAL RISK, BLOCKCHAIN, GREEN FINANCE.

JEL Classification: *G32, G20, Q54, O31, Q56.*

INTRODUCTION

Global economic losses from climate-related disasters have surged to over $200 billion annually in recent years, with projections indicating a potential 10% reduction in global GDP by 2050 under severe climate scenarios[1]. This reality establishes a critical imperative for the banking sector: climate risk management is a central pillar of financial stability[2]. In this perspective, climate-related risks must be understood not only as environmental concerns, but also as direct threats to banking resilience and financial stability. The financial system is exposed to climate-related risks through its lending, investment, and insurance activities[3]. Addressing these challenges requires enhanced data and analytical capabilities, robust supervisory frameworks, and international cooperation[4]. Climate-related risks manifest in distinct, interconnected typologies:

Physical Risks: These stem from the direct impacts of climate change, such as extreme weather events, rising sea levels, and chronic shifts in temperature and precipitation patterns[5]. For banks, physical risks threaten collateral values, increase loan defaults, and disrupt operational continuity. Examples include real estate portfolios exposed to recurrent flooding or agricultural loans vulnerable to prolonged droughts[6].

Transition Risks: These arise from the transition to a low-carbon economy, including policy changes (e.g., carbon pricing), technological innovation, and shifts in market sentiment and consumer preferences[7]. Such risks can lead to stranded assets, reduced profitability for carbon-intensive sectors, and increased credit and market risks for banks with exposure to these industries.

Liability Risks: These stem from legal claims against entities for climate-related damages or insufficient climate action. Banks face indirect liability through their financing activities for companies exposed to such litigation.

These risks are not externalized costs; they are internalized as direct financial exposures, altering asset valuations and balance sheet stability. The "tragedy of the horizon"[8], where long-term climate impacts conflict with short-term financial planning, creates a key tension requiring immediate attention.

Fintech, encompassing Artificial Intelligence (AI), Machine Learning (ML), blockchain, big data analytics, and digital platforms, emerges as a transformative force in navigating these complex financial risks. More broadly, this role reflects the wider transformation of financial services through fintech-driven innovation, disruption, and digital reconfiguration[9]. Technological innovation, including big data analytics and AI, plays a significant role in improving climate-related risk assessment, though these tools are still nascent in this application area[10]. Fintech enhances data collection, processing, and risk modeling, improving financial institutions' ability to monitor and mitigate climate-related financial risks[11]. This connection between the urgency of climate risk and

1 International Monetary Fund. (2024, April). Navigating Climate Transitions: The Role of Financial Policies. Global Financial Stability Report, Chapter 2. Washington, DC: International Monetary Fund.

2 Nieto, M. J. (2019). Banks, Climate Risk and Financial Stability. Journal of Financial Regulation and Compliance, 27, no. 2: 243–262. <https://doi.org/10.1108/JFRC-03-2018-0043>.

3 International Monetary Fund. (2024). Fintech and Climate Risk Management in Banking. IMF Working Paper, 24/8. Washington, DC: International Monetary Fund, p. 4.

4 Ibid.

5 Arner, D., Barberis, J., Buckley, R. P. (2020). Fintech, Bigtech, and the interoperability of digital financial infrastructure. Journal of Financial Regulation, 6(2), pp. 211-244. <https://www.bis.org/publ/bppdf/bispap117.pdf>.

6 International Monetary Fund. (2024, April). Navigating Climate Transitions: The Role of Financial Policies. Global Financial Stability Report, Chapter 2. Washington, DC: International Monetary Fund.

7 International Monetary Fund. (2024). Fintech and Climate Risk Management in Banking. IMF Working Paper, 24/8. Washington, DC: International Monetary Fund, p. 5.

8 International Monetary Fund. (2024, April). Navigating Climate Transitions: The Role of Financial Policies. Global Financial Stability Report, Chapter 2. Washington, DC: International Monetary Fund.

9 Gomber, P., Kauffman, R. J., Parker, C., Weber, B. W. (2018). On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. Journal of Management Information Systems, 35(1), pp. 220-265. <https://doi.org/10.1080/07421222.2018.1440766>.

10 International Monetary Fund. (2024). Fintech and Climate Risk Management in Banking. IMF Working Paper, 24/8. Washington, DC: International Monetary Fund, p. 17.

11 Ibid., p. 1.

the necessity of technological innovation forms the foundational premise of this literature review. While Fintech offers capabilities for strengthening climate risk management, its full potential can only be realized by systematically addressing data fragmentation, regulatory incoherence, and the complexities of technological integration, necessitating a concerted global effort. This literature review therefore aims to examine how fintech tools can strengthen bank's capacity to identify ,assess, and mitigate climate-related financial risks, while also highlighting the regulatory, operational, and ethical challenges associated with their adoption.

1. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

1.1. Foundational Frameworks for Climate Risk in Banking and Finance (2018-2021)

Early scholarship between 2018 and 2021 established the conceptual groundwork for understanding climate-related financial risks in banking, predating the widespread discussion of fintech solutions. This period was characterized by a push to integrate climate considerations into financial stability mandates, with researchers identifying climate change as a systemic risk requiring new regulatory paradigms[12]. An initial focus was on developing macroprudential policies to manage these novel risks and steer investments toward a low-carbon economy. Concurrently, scholars began dissecting the specific transmission channels through which climate change affects financial stability, such as the risks posed by declining "sunset" industries heavily reliant on fossil fuels. These studies argued that the transition to a low-carbon economy could trigger abrupt asset revaluations and defaults, threatening the entire financial system. Methodologically, this era saw proposals for climate stress tests to gauge institutional resilience and the advocacy for a 'precautionary approach' to policymaking, which argues that the radical uncertainty of climate impacts necessitates proactive regulatory action even without complete scientific certainty. Collectively, these works framed climate change not merely as an environmental issue but as a core threat to financial stability, creating the intellectual and regulatory justification for the technological interventions that would follow[13].

1.2. The Dual Role of Fintech in Climate Risk and Resilience (2022-2025)

Building on the foundational risk frameworks, the literature from 2022 to 2025 shifts to the practical, yet complex, role of fintech in addressing climate challenges. This contemporary body of work highlights a significant tension: while fintech is often lauded for its potential to enhance climate resilience, recent empirical work also suggests it can significantly amplify climate risk in financial markets. Some studies illustrate how fintech can cushion firms from the adverse impacts of climate risk and improve resilience against climate shocks for both households and companies. More specifically, green fintech solutions are seen as critical for improving sustainability, mitigating risks, and achieving financial stability. These technologies are positioned as key enablers of sustainable finance, capable of accelerating the shift to a carbon-neutral economy. This broader interpretation is consistent with recent scholarship that situates fintech within a wider nexus linking climate challenges , green finance, digitalization, and environmental quality[14]. For instance, AI and blockchain are identified as tools that can improve the efficiency of green financing, enhance risk management related to ESG events, and increase the transparency of sustainable transactions. However, research also cautions that integrating fintech for sustainability is not straightforward, with one study on the Indonesian banking sector finding that fintech adaptation had a limited direct im-

12 Wu, Q. (2024). From bits to emissions: how FinTech benefits climate resilience? Empirical Economics. <https://doi.org/10.1007/s00181-024-02609-9>.

13 Singhvi, S., Dadhich, M. (2023). FinTech Revolution and Future of Sustainable Banking: Opportunities and Risks Analysis. International Journal of Management and Development Studies, vol. 12, no. 04, pp. 12-21. <DOI:10.53983/ijmds.v12n04.003>.

14 Cen .Y and J. Yin. (2024). Navigating Climate Challenges: Focusing on the Effectiveness of Natural Resource Rents, Fintech, Green Finance, Environmental Quality, and Digitalisation. Resources Policy 95: 105102. <https://doi.org/10.1016/j.resourpol.2024.105102>.

pact on sustainability performance, pointing to the need for better regulatory frameworks and strategic implementation. This duality underscores that while fintech offers powerful instruments for building a climate-resilient banking system[15], its deployment requires careful management to avoid exacerbating the high risks it aims to mitigate.

2. FINTECH SOLUTIONS: ADVANCED ANALYTICS, TRANSPARENCY, AND GREEN FINANCE

2.1. Advanced Analytics, Transparency, and Green Finance Facilitation

Fintech solutions offer transformative capabilities for enhancing climate risk management in banking, moving beyond static risk assessment to dynamic, data-driven approaches. These tools address the "Climate Risk Imperative" by providing granular insights and fostering greater transparency in green finance[16].

2.1.1.Artificial Intelligence and Machine Learning: Advanced Data Analytics and Modeling

Artificial Intelligence (AI) and Machine Learning (ML) are fundamental to significant advancements in climate risk assessment. These technologies process vast, disparate datasets, enabling predictive modeling of physical risks and granular analyses for transition risk scenarios.

Physical Risk Modeling. AI/ML models downscale global climate projections, such as CMIP6, to regional and asset-level resolutions, sometimes as fine as 90 meters[17]. These models integrate historical climatic data with specific asset characteristics, like property elevation or construction materials, to project future physical damages from hazards such as floods or wildfires. Satellite imagery and geospatial data serve as critical inputs, facilitating near-real-time monitoring and dynamic risk adjustments[18]. For instance, SatSure's "SatSure Sage" platform and CropIn's "SmartRisk" platform employ ML with satellite and weather data to assess agroclimatic risk for Indian banks, correlating crop performance with historical risks to inform loan underwriting and portfolio monitoring[19]. The conceptual data flow for AI-driven physical risk assessment transforms raw environmental and asset data into actionable risk scores, as illustrated in the following diagram.

Transition Risk Scenario Analysis. AI-driven sentiment analysis, particularly through Natural Language Processing (NLP) models, parses unstructured data from regulatory texts, corporate climate disclosures (e.g., TCFD reports), and news articles. U-Reg's NLP-based algorithms, for instance, process vast quantities of ESG disclosure data to identify inconsistencies and extract insights on policy foresight, litigation risk indicators, and market sentiment shifts[20]. These models enable banks to anticipate the financial impact of decarbonization policies and market shifts.

2.1.2. Blockchain and Distributed Ledger Technology: Transparency and Verifiability

Blockchain and Distributed Ledger Technology (DLT) enhance transparency and verifiability in sustainable finance, addressing concerns such

15 Mhlanga, D. (2022). The role of financial inclusion and FinTech in addressing climate-related challenges in the industry 4.0: Lessons for sustainable development goals. Front. Clim. 4:949178. <DOI:10.3389/fclim.2022.949178>.

16 Bank for International Settlements (BIS) Innovation Hub, Central Bank of the United Arab Emirates (CBUAE), Emirates Institute of Finance (EIF). (2023). Scaling climate action: Unleashing innovative technologies in sustainable finance. <https://www.bis.org/innovation_hub/projects/2023_cop28_techsprint.pdf>.

17 The International Finance Corporation (IFC). (2023). Mapping of Digital Solutions to Support Financial Services Providers in Assessing Climate Impact on Agricultural Portfolios. <https://www.ifc.org/content/dam/ifc/doc/2024/mapping-of-digital-solutions-to-support-financial-services-providers-in-assessing-climate-impact-on-agricultural-portfolios-ifc-2023.pdf>.

18 Ibid., Executive Summary, p. 4.

19 Kouhizadeh, M., Sarkis, J. (2020). Blockchain Practices, Potentials, and Perspectives in Greening Supply Chains. <https://iaeme.com/MasterAdmin/Journal_uploads/IJRCAIT/VOLUME_7_ISSUE_2/IJRCAIT_07_02_017.pdf>.

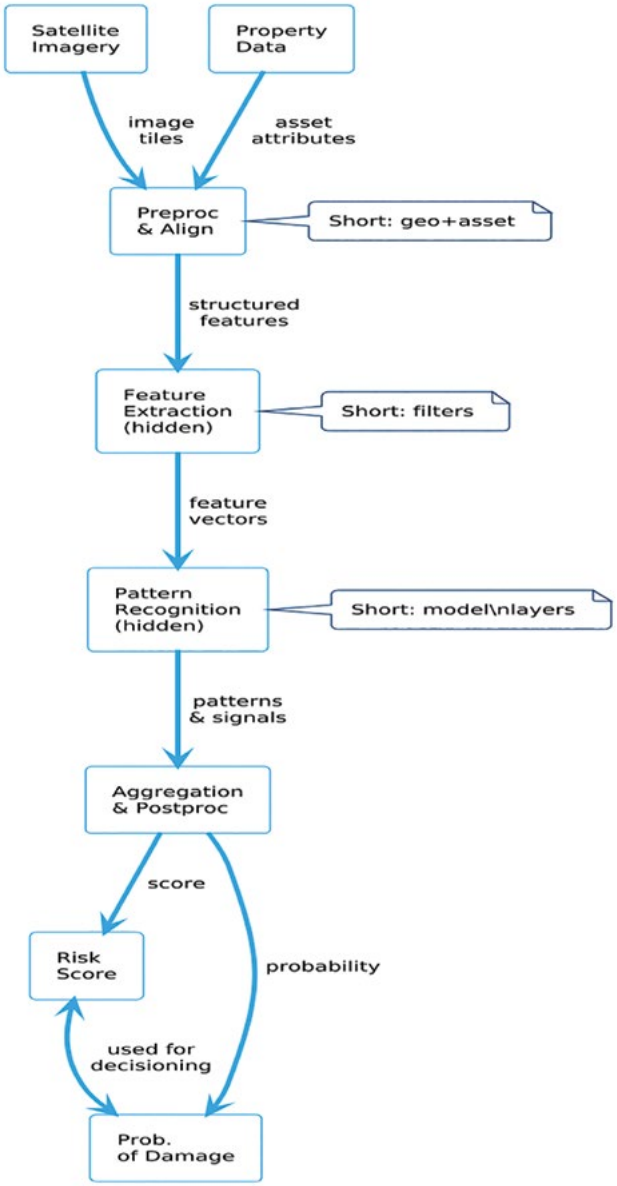
20 Bank for International Settlements (BIS) Innovation Hub, Central Bank of the United Arab Emirates (CBUAE), Emirates Institute of Finance (EIF). (2023). Scaling climate action: Unleashing innovative technologies in sustainable finance, Part 2, Finalist showcase - U-Reg Technology. <https://www.bis.org/innovation_hub/projects/2023_cop28_techsprint.pdf>.

as greenwashing and data integrity[21]. In this regard, the literature on greenwashing provides an important framework for understanding how misleading environmental claims can weaken the credibility of sustainable financial innovation[22].

Green Bonds and Impact Verification. Blockchain creates immutable records of green bond issuance, ensuring funds are allocated to stated environmental projects. Fever Tokens, for example, proposes an open-source solution for on-chain monitoring throughout the life cycle of tokenized green bonds, adhering to ICMA's Green Bond Principles and the EU's Green Bond Standard[23]. This significantly boosts transparency and investor trust by providing verifiable impact metrics recorded on a distributed ledger.

Carbon Credit Markets. Blockchain technology improves the tracking of carbon credits, providing an auditable history for each credit's origin and transaction[24], and offers a blockchain-driven platform for trading, clearing, and settlement of carbon credits and ESG assets, eliminating greenwashing and double-counting through robust data verification and traceability[25]. Triangle's Asset OS platform links asset data with verifiable information using blockchain, facilitating TCFD reporting compliance and enabling the minting of fungible carbon credits[26] (See Fig.1).

Figure 1: Conceptual Data Flow for AI-driven Physical Risk Assessment Model



Source: Perez, C. (2002). Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages. Edward Elgar Publishing.

This diagram illustrates satellite imagery and property data as inputs, hidden layers for feature extraction and pattern recognition, and outputs as a risk score or probability of damage.

21 Ibid., p. 2.

22 Yang, Z., Nguyen T. T. H., Nguyen H. N., Nguyen T. T. N., Cao T. T. (2020). Greenwashing behaviours: Causes, taxonomy and consequences based on a systematic literature review. Journal of Business Economics and Management (JBEM), ISSN 2029-4433, Vilnius Gediminas Technical University, Vilnius, Vol. 21, Iss. 5, pp. 1486-1507. <https://doi.org/10.3846/jbem.2020.1322>.

23 Babu, R. (2024). Blockchain-Enabled Carbon Credit Trading: Revolutionizing Sustainability Efforts. International Journal of Research. Computer Applications and Information Technology (IJRCAIT), 7(2), pp. 228-238.

24 Bartlett, R., Morse, A., Stanton, R., Wallace, N. (2019). Consumer-lending discrimination in the FinTech era. National Bureau of Economic Research. <https://faculty.haas.berkeley.edu/morse/research/papers/discrim.pdf>.

25 Bank for International Settlements (BIS) Innovation Hub, Central Bank of the United Arab Emirates (CBUAE), Emirates Institute of Finance (EIF). (2023). Scaling climate action: Unleashing innovative technologies in sustainable finance, Part 2, Finalist showcase - ZERO13, p. 27. <https://www.bis.org/innovation_hub/projects/2023_cop28_techsprint.pdf>.

26 Ibid. Finalist showcase - Triangle Solution proposed, p. 25. <https://www.bis.org/innovation_hub/projects/2023_cop28_techsprint.pdf>.

2.1.3. Digital Platforms and RegTech: Green Finance Facilitation and Compliance

Digital platforms and RegTech solutions facilitate green finance flows and automate climate-related disclosures.

Green Finance Platforms. These platforms direct capital toward climate-aligned initiatives. Examples include crowdfunding platforms like Abundance Investment for renewable energy projects, and investment marketplaces such as STACS' ESGpedia. ESGpedia aggregates and harmonizes sustainability data, creating standardized ESG company profiles mapped to financial sector regulatory formats[27]. This enhances market efficiency and transparency in sustainable investment.

RegTech for Climate Reporting. RegTech solutions automate climate-related disclosures and ensure compliance with evolving regulatory mandates. U-Reg's U-Green module leverages AI and RegTech to address fragmentation and standardization challenges in ESG reporting, processing unstructured data at scale through NLP-based algorithms[28]. These tools streamline the complex process of reporting climate-related financial exposures, reducing administrative burdens on banks.

Gaps in Literature. Despite these advancements, significant gaps persist in the literature. Comprehensive research on the long-term efficacy and robustness of AI/ML models under deep uncertainty remains limited. Interoperability standards for diverse Fintech solutions and climate data platforms require further development. Scalability challenges for blockchain applications in large-scale financial markets, particularly for tokenized assets, are not fully resolved. The "Crisis of Actionable Data", characterized by pervasive deficiencies in granularity, standardization, and verifiability, implicitly constrains the full potential of these advanced tools, leading to an "Algorithmic Greenwashing" paradox if transparency is not rigorously enforced[29]. These identified gaps directly inform the subsequent discussion of implementation challenges.

27 Ibid., Finalist showcase -STACS Solution proposed, p. 20. <https://www.bis.org/innovation_hub/projects/2023_cop28_techsprint.pdf>.

28 Ibid., Finalist showcase - U-Reg Technology, p. 21.

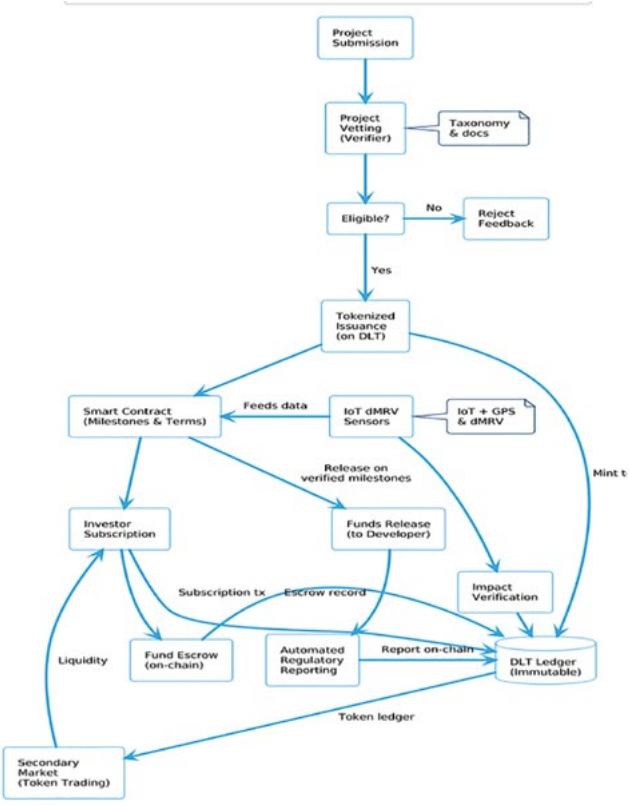
29 Ibid., p. 2.

3. INTEGRATING FINTECH AND CONFRONTING LIMITATIONS

3.1. Integration Dynamics and Foundational Impediments

The integration of Fintech solutions into banking operations for climate risk management reveals a "translation gap" between academic ideals and industry pragmatism. Academic research often prioritizes theoretical completeness, aiming for universal models and long-term systemic impact. Industry, by contrast, operates under immediate pressures of shareholder value, operational efficiency, and the constraints of legacy systems. This divergence means that while academia may critique inherent simplifications in industry climate models, industry prioritizes solutions readily integrated into existing risk frameworks with minimal disruption and cost. This gap impedes Fintech's transformative potential (See Fig.2).

Figure 2: Blockchain – Enabled Green Bond Issuance Flow



Source: King & Wood Mallesons. (2021). Blockchain and ESG: Blockchain for Sustainability and Green Finance.

This flowchart illustrates the stages from project vetting and tokenized green bond issuance on a DLT to fund allocation based on smart contracts, impact verification via IoT sensors, and automated regulatory reporting.

The journey towards climate resilience through Fintech is fraught with significant challenges, stemming from pervasive data scarcity, regulatory hurdles, technological integration barriers, and multifaceted ethical considerations. These challenges constrain Fintech capabilities and demand a utility-driven research agenda.

Data Scarcity, Quality, and Standardization. The most fundamental impediment is not merely a lack of data, but a "Crisis of Actionable Data" characterized by deficiencies in granularity, standardization, and verifiability. The Network for Greening the Financial System (NGFS) found that 514 out of 1,262 raw data items lacked a linked source, with the largest gaps in biophysical impact, emissions, and geospatial data types[30]. This directly limits the usability of metrics for physical vulnerability and transition sensitivity.

Methodological inconsistencies further compound this problem. Estimating Scope 3 emissions, for example, is hindered by varying boundary definitions, reliance on different emission factor databases, and diverse allocation methods across complex supply chains. This results in incomparable and often unreliable data for financial institutions[31]. Approximately 39% of all climate-related data items are based on estimations, with less than a quarter being official statistics or verified[32]. This reliance on unverified or estimated data undermines the accuracy of Fintech-driven risk assessments, creating an "illusion of precision" that can lead to mispriced assets.

Regulatory Hurdles and Policy Lag. The fragmented and evolving nature of global climate finance regulation creates significant uncertainty, hindering Fintech innovation and adoption. Jurisdictions exhibit varying approaches; the EU's fragmented data sharing standards under GDPR, for instance, complicate cross-border climate data aggregation[33]. Central banks also issue varying levels of prescriptive technological guidelines, from the Bank of England's detailed expectations to the OCC's higher-level principles[34]. This "regulatory lag" means frameworks struggle to keep pace with rapid technological evolution.

Model validation for AI/ML solutions presents further complexities. Demonstrating model explainability (XAI) and robustness under diverse climate scenarios becomes a formidable task given the "black-box" nature of some advanced algorithms. Data residency requirements for global financial operations mandate that climate data remains within specific national borders, complicating the deployment of cloud-based Fintech solutions.

Technological Integration Barriers. Banks face significant challenges in integrating cutting-edge Fintech with entrenched legacy IT systems. The inertia of monolithic core banking platforms resists seamless API integration, creating data silos and inefficient workflows. Harmonizing disparate data formats from various Fintech providers adds another layer of complexity. Pervasive talent gaps also exist, with a scarcity of data scientists possessing both financial and climate expertise, and risk managers capable of interpreting complex AI-driven climate analytics.

Ethical and Reputational Considerations. Ethical dimensions, while not directly financial, generate material financial risks for banks. "Climate washing", where overstated climate credentials inflate valuations, exposes banks to sudden devaluations, regulatory penalties, and reputational damage. Data biases in AI/ML models, if trained on historical data from predominantly developed economies, could misallocate capital by underestimating physical risks in emerging markets or overestimating transition risks for specific sectors, exacerbating existing inequalities. Data privacy breaches of climate-related information expose banks to legal and reputational risks. Algorithmically unfair risk assessments can lead

30 Network for Greening the Financial System (NGFS). (2022). Final report on bridging data gaps. Section 3.2.1. <https://www.ngfs.net/sites/default/files/medias/documents/final_report_on_bridging_data_gaps.pdf>.

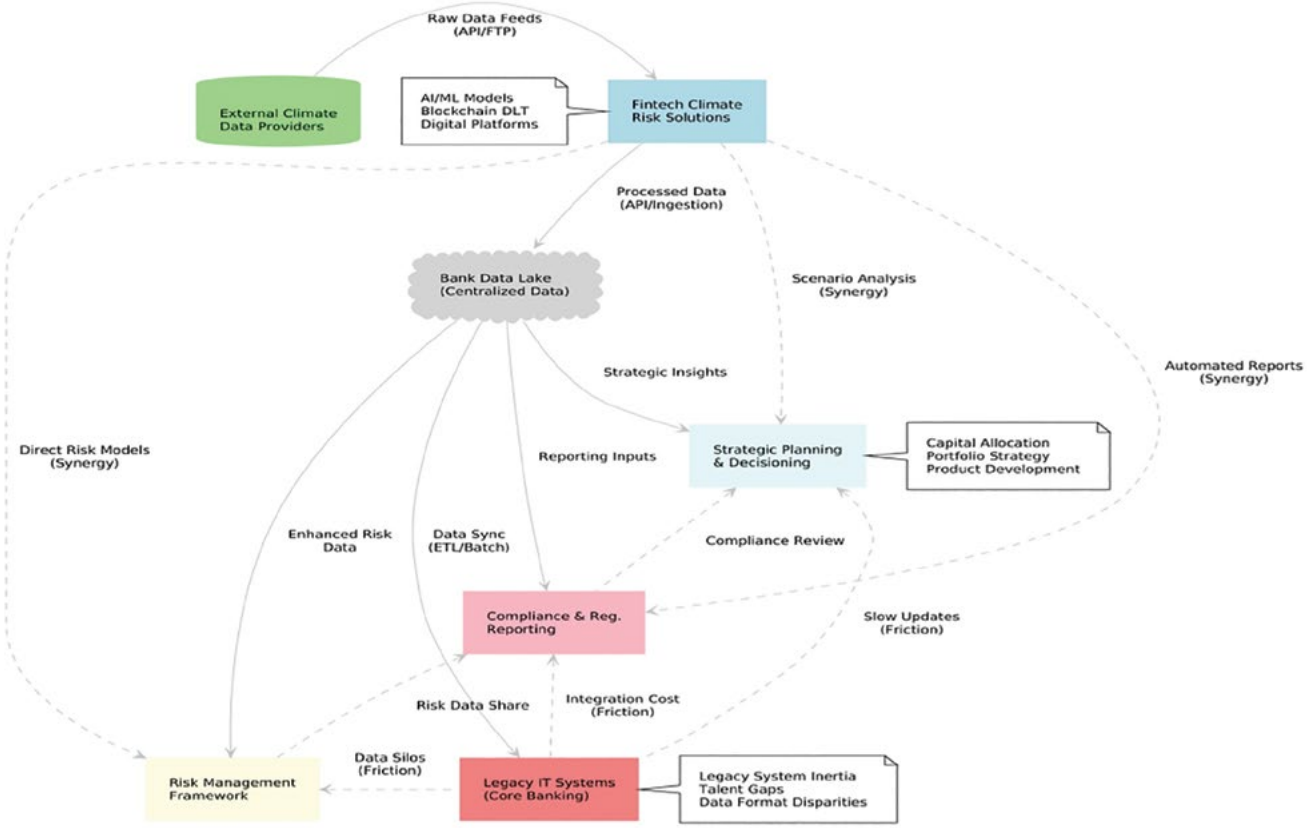
31 Ibid., Section 3.2.2.

32 Ibid., Section 3.1.

33 Office of the Comptroller of the Currency (OCC). (2023). Semiannual Risk Perspective. Part IV, E. <https://www.occ.gov/publications-and-resources/publications/semi-annual-risk-perspective/files/pub-semiannual-risk-perspective-fall-2023.pdf>.

34 Ibid.

Figure 3: Fintech Climate Risk Tools Integration within Bank Operational Frameworks



Source: International Monetary Fund (IMF). (2024). Fintech and Climate Risk Management in Banking. IMF Working Paper, 24/8. Washington, DC: International Monetary Fund.

to legal challenges and regulatory penalties for discriminatory practices. This "Algorithmic Greenwashing" paradox highlights how tools designed for transparency can inadvertently facilitate deception (See Fig.3).

This flowchart details the integration points of Fintech solutions (e.g., API integration, data lake ingestion) within a bank's existing risk management, compliance, and strategic planning processes, highlighting potential points of friction and synergy. It clarifies operational complexities.

The challenges outlined above necessitate a structured approach to addressing data quality and consistency (See Table 1).

This table summarizes the core data availability challenges confronting Fintech solutions in climate risk management and their direct impact on the efficacy of these technologies.

Gaps in the literature related to integration costs, the effectiveness of various regulatory sandboxes, and the full scope of systemic risks arising from Fintech dependencies demand further investigation. These impediments, from data fragmentation to regulatory incoherence, underscore the imperative for a coordinated, multi-stakeholder effort to bridge the chasm between technological potential and practical implementation.

4. EMERGING PRACTICES AND FUTURE TRAJECTORIES

4.1. Innovative Approaches and Best Practices

The banking sector's pursuit of climate resilience, despite formidable impediments, drives the emergence of innovative Fintech approaches and best practices. These solutions enhance capabil-

Table 1: Key Data Availability Challenges and Impact on Fintech Efficacy.

Assumption	Traditional View	Challenge and Implications
Linearity of Impact Models	Climate impacts progress predictably and linearly	Non-linear tipping points and feedback loops lead to underestimated risks.[51]
Sufficiency of Historical Data	Past climate data predicts future patterns reliably	Non-stationarity of the climate system invalidates historical extrapolation, leading to misleading forecasts.[52]
Universal Data Availability	Necessary data is accessible and complete	"Crisis of Actionable Data" persists, with gaps in granularity, standardization, and verifiability.[53]
Implicit Biases in AI Models	AI models are objective and unbiased	Training data biases lead to misallocated capital and inaccurate risk estimations for specific regions or sectors.[54]

ities and directly address many of the implementation challenges previously discussed, offering pathways to optimize climate risk management.

Integrated Climate Data Lakes. Data fragmentation, a pervasive challenge, finds mitigation in the development of integrated climate data lakes. These initiatives involve consortia and collaborative efforts where multiple banks and climate science communities pool anonymized climate-related data. Platforms like Dataland, a neutral, open-source data platform, exemplify this approach, focusing on company-specific raw data aligned with regulatory disclosure standards[35]. Dataland operates on principles of integrity, disclosure, transparency, accountability, neutrality, and collaboration, overcoming data availability gaps, reliability issues, and high acquisition costs[36]. This collaborative infrastructure acts as a public good, reducing the prohibitive costs of data acquisition and integration for individual banks and fostering collective intelligence (See Fig.4).

This diagram illustrates the various data sources (e.g., satellite, IoT, corporate disclosures), data ingestion points, processing layers (e.g., AI/ML analytics), and output applications (e.g., risk dashboards, regulatory reports) within an integrated climate data lake, clarifying the flow and aggregation of information.

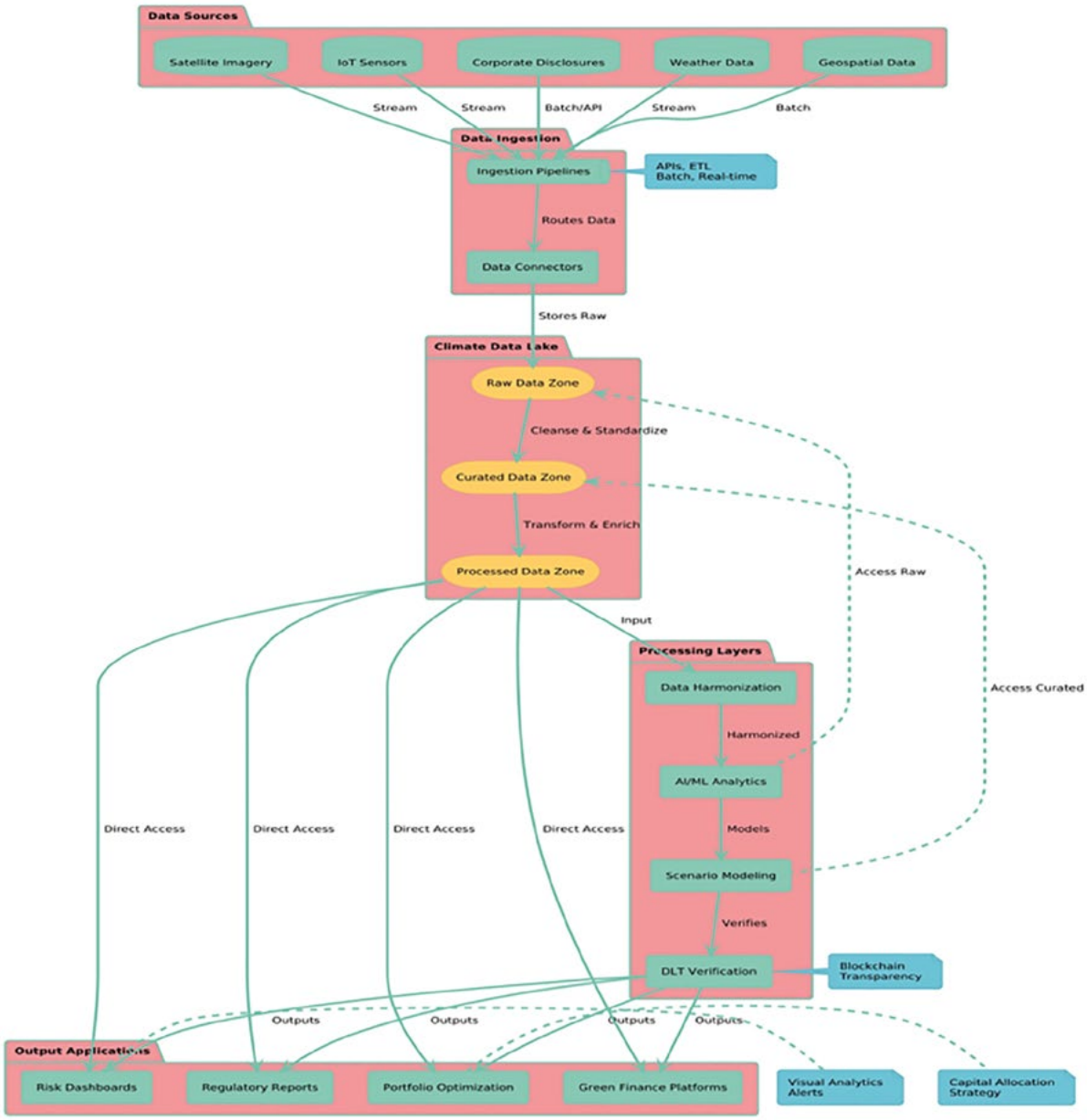
Open-Source Climate Risk Modeling Platforms. To counter the "black-box" nature of proprietary models and mitigate "Algorithmic Greenwashing", open-source climate risk modeling platforms emerge from academic institutions and non-profits. Initiatives such as OS-Climate provide transparent and auditable tools for risk assessment, fostering trust and enabling collaborative development of methodologies[37]. These platforms enhance model explainability and allow for independent validation, addressing concerns about algorithmic bias and the robustness of climate projections.

35 United Nations Environment Programme Finance Initiative (UNEP FI). (2024). The Climate Data Challenge: The Critical Role of Open-Source and Neutral Data Platforms. Technical Supplement to the 2024 Climate Risk Landscape Report. <https://www.unepfi.org/wordpress/wp-content/uploads/2024/05/Dataland-Final-Report-The-Climate-Data-Challenge-1.pdf>.

36 Ibid., Section 3.2.2.

37 Ibid., p. 5.

Figure 4: Conceptual Model of an Integrated Climate Data Lake Ecosystem



Digital Twins of Physical Assets. Innovative approaches extend to the creation of digital twins of physical assets. Pilot studies demonstrate how virtual replicas of buildings or infrastructure integrate climate models to simulate future flood, heatwave, or other climate impacts.[38] This allows banks to assess collateral resilience dynamically, providing granular, forward-looking insights into asset vulnerability. For example, Triangle creates blockchain-based digital twins of real-world assets linked to climate data, facilitating the reporting of financed emissions.[39]

38 The International Finance Corporation (IFC). (2023). Mapping of Digital Solutions to Support Financial Services Providers in Assessing Climate Impact on Agricultural Portfolios. <https://www.ifc.org/content/dam/ifc/doc/2024/mapping-of-digital-solutions-to-support-financial-services-providers-in-assessing-climate-impact-on-agricultural-portfolios-ifc-2023.pdf>.

39 Bank for International Settlements (BIS) Innovation Hub, Central Bank of the United Arab Emirates (CBUAE), Emirates Institute of Finance (EIF). (2023). Scaling climate action: Unleashing inno-

Blockchain-Enabled Platforms for Green Energy. Blockchain technology facilitates "Green Finance" through platforms enabling fractional ownership in green energy projects and enhancing the transparency of green financial instruments. Powerledger, for instance, utilizes blockchain for peer-to-peer renewable energy trading, democratizing access to green energy markets. FeverTokens proposes on-chain monitoring for tokenized green bonds, adhering to established principles like ICMA's Green Bond Principles and the EU's Green Bond Standard.[40] This boosts transparency and trust in green investments, directly combating greenwashing by providing verifiable impact metrics, and offers a blockchain-driven platform for carbon credit trading, ensuring traceability and preventing double-counting.[41]

These emerging practices demonstrate Fintech capabilities actively optimizing climate resilience. They provide concrete examples of progress, directly addressing the "Crisis of Actionable Data" through integrated data initiatives and mitigating the potential for "Algorithmic Greenwashing" through transparent, open-source models. The continued development and adoption of these innovative approaches are crucial in building a more robust and sustainable financial future.

4.2. Uncharted Territories and Systemic Re-evaluations

The landscape of Fintech and climate risk management reveals unexplored interconnections and necessitates a critical re-evaluation of underlying assumptions. Existing literature's "white spaces" highlight nascent research areas and systemic vulnerabilities unaddressed by current approaches.

vative technologies in sustainable finance, Part 2, Finalist showcase – Triangle Solution proposed, p. 25. <https://www.bis.org/innovation_hub/projects/2023_cop28_techsprint.pdf>.

40 Ibid., p. 24.

41 Ibid., Part 2, Finalist showcase – ZERO13, p. 27.

4.3. Unexplored Interconnections and Nascent Research Areas

Novel conceptual links include direct feedback loops between climate-induced physical risks and automated portfolio adjustments. AI's real-time geospatial data processing could trigger immediate re-evaluations of mortgage-backed securities as flood risks intensify.[42] This extends financial engineering principles to novel climate data streams, offering dynamic risk management beyond traditional, lagging indicators.

Nascent research areas include the systemic risks arising from the interconnectedness of climate-aware Fintech solutions. A single climate data provider's AI model failure could precipitate cascading failures across multiple financial institutions, leading to widespread mispricing of climate risk. The concentration of climate data provision within a few specialized Fintech firms creates a "barbell" risk structure, where failure in one provider could have systemic implications; this is a concern echoed by the Bank for International Settlements (BIS) regarding critical infrastructure.[43]

Quantum computing's potential to accelerate complex climate scenario modeling draws from theoretical computer science papers outlining its capability for exponential speedup in optimization problems.[44] Bio-mimicry principles for resil-

42 The International Finance Corporation (IFC). (2023). Mapping of Digital Solutions to Support Financial Services Providers in Assessing Climate Impact on Agricultural Portfolios. <https://www.ifc.org/content/dam/ifc/doc/2024/mapping-of-digital-solutions-to-support-financial-services-providers-in-assessing-climate-impact-on-agricultural-portfolios-ifc-2023.pdf>.

43 Feyen, E., Frost, J., Gambacorta, L., Natarajan, H., Saal, M. (2021). Fintech and the digital transformation of financial services: implications for market structure and public policy. BIS Papers No 117. Bank for International Settlements and the World Bank Group. <https://www.bis.org/publ/bppdf/bispap117.pdf>.

44 Bolton, P., Despres, M., Pereira da Silva, L. A., Samama, F., Svartzman, R. (2020). The green swan: Central banking and financial stability in the age of climate change. Bank for International Settlements. Abstract, Executive Summary, Chapter 1 (pp. 1-10), Chapter 3 (pp. 23-46), Chapter 4 (pp. 47-64), Chapter 5 (pp. 65-67), Annex 2 (pp. 72-78). <https://www.bis.

ient investment strategies, supported by ecological economics literature, suggest novel financial products and portfolio constructions emulating nature's adaptive capacities.[45]

4.4. Re-evaluating Underlying Assumptions and Systemic Implications

A critical re-evaluation of underlying assumptions in climate models is necessary. The "assumption of linear climate impact models" is challenged by research highlighting non-linear tipping points and feedback loops within the climate system.[46] These non-linear dynamics render linear projections inadequate. The "sufficiency of historical data" for predicting future climate risks is challenged by palaeoclimate studies and extreme event attribution science, which demonstrate unprecedented climate shifts.[47]

Implicit biases in model training data, particularly when AI models are trained on incomplete or geographically skewed climate data, can misrepresent risks for underrepresented regions. This leads to mispriced assets and potential financial instability.[48] The "assumption of universal data availability" is challenged by the NGFS report, which quantifies significant data gaps, identifying 514 out of 1,262 raw data items as unlinked to a source.[49]

The systemic implications of Fintech adoption include a significant shift in the competitive landscape. The BIS notes a potential "barbell" market structure, where large, technologically advanced players dominate climate risk analytics, potentially marginalizing smaller banks that lack the necessary investment capacity.[50] This concentration could create new systemic vulnerabilities should these dominant providers experience disruptions, thereby impacting regulatory oversight. A critical re-evaluation of underlying assumptions in climate models is summarized in the table below. This table summarizes the essential re-evaluation of underlying assumptions in climate models, contrasting traditional views with challenges and implications for financial risk assessment.

These "Gaps in Literature" and "Unexplored Interconnections" necessitate future research, justifying a "Utility-Driven Research Agenda". Current understanding and technological application remain insufficient for navigating the complex future of climate resilience in banking (See Table 2).

The financial sector's pursuit of climate resilience, while relying heavily on Fintech innovation, navigates a landscape marked by significant data gaps, fragmented regulatory environments, and the inherent inertia of legacy systems. While Fintech solutions offer granular risk assessment and enhanced transparency in green finance, their widespread adoption encounters fundamental limitations.[51] This necessitates a radical rethinking of data governance, cross-border supervisory cooperation, and a re-evaluation of the implicit assumptions guiding current climate models. The optimal future state involves a symbiotic ecosystem where financial institutions, Fintech innovators, and regulators collaboratively establish standardized, interoperable, and ethically sound frameworks, moving beyond isolated solutions to build a robust and anticipatory climate-resilient financial architecture.

org/publ/othp31.pdf>.

45 Ibid., Chapter 4.5, p. 63.

46 Gosling, T. (2024). Universal Owners and Climate Change, Journal of Financial Regulation, Vol. 00, No. 00, pp. 1–40. <https://lbsresearch.london.edu/id/eprint/3972/1/fjae010.pdf>.

47 Ibid., p.15.

48 Basel Committee on Banking Supervision. (2021). Climate-related financial risks – measurement methodologies. Basel, Switzerland: Bank for International Settlements. Sections 2.2, 3.2, 4.1.2, 4.2.1, and Executive Summary. <https://www.bis.org/bcbs/publ/d518.pdf>.

49 Network for Greening the Financial System (NGFS). (2022). Final report on bridging data gaps. Section 3.2.1. <https://www.ngfs.net/sites/default/files/medias/documents/final_report_on_bridging_data_gaps.pdf>.

50 Feyen, E., Frost, J., Gambacorta, L., Natarajan, H., Saal, M. (2021). Fintech and the digital transformation of financial services: implications for market structure and public policy. BIS Papers No 117. Bank for International Settlements and the World Bank Group. <https://www.bis.org/publ/bppdf/bispap117.pdf>.

51 Dunbar, K., Sarkis, J., Treku, D. N. (2024). Fintech for environmental sustainability: promises and pitfalls. One Earth, 7(1), pp. 23-30. <https://doi.org/10.1016/j.oneear.2023.12.012>.

Table 2: Critical Re-evaluation of Underlying Assumptions in Climate Models

Assumption	Traditional View	Challenge and Implications
Linearity of Impact Models	Climate impacts progress predictably and linearly	Non-linear tipping points and feedback loops lead to underestimated risks.[52]
Sufficiency of Historical Data	Past climate data predicts future patterns reliably	Non-stationarity of the climate system invalidates historical extrapolation, leading to misleading forecasts.[53]
Universal Data Availability	Necessary data is accessible and complete	"Crisis of Actionable Data" persists, with gaps in granularity, standardization, and verifiability.[54]
Implicit Biases in AI Models	AI models are objective and unbiased	Training data biases lead to misallocated capital and inaccurate risk estimations for specific regions or sectors.[55]

52 *United Nations Environment Programme Finance Initiative (UNEP FI). (2024). The Climate Data Challenge: The Critical Role of Open-Source and Neutral Data Platforms. Technical Supplement to the 2024 Climate Risk Landscape Report. <https://www.unepfi.org/wordpress/wp-content/uploads/2024/05/Dataland-Final-Report-The-Climate-Data-Challenge-1.pdf>.*

53 *Office of the Comptroller of the Currency (OCC). (2023). Semiannual Risk Perspective, Part IV, E. <https://www.occ.gov/publications-and-resources/publications/semiannual-risk-perspective/files/pub-semiannual-risk-perspective-fall-2023.pdf>.*

54 *Bolton, P., Despres, M., Pereira da Silva, L. A., Samama, F., Svartzman, R. (2020). The green swan: Central banking and financial stability in the age of climate change. Bank for International Settlements. Abstract, Executive Summary, Chapter 1 (pp. 1-10), Chapter 3 (pp. 23-46), Chapter 4 (pp.47-64), Chapter 5 (pp. 65-67), Annex 2 (pp. 72-78). <https://www.bis.org/publ/othp31.pdf>.*

55 *Ibid., Chapter 4.5, p. 63.*

CONCLUSION

The escalating threat of climate-related financial risks has emerged as a pivotal concern for global financial stability. This literature review has synthesized a comprehensive body of research concerning the intersection of financial technology (Fintech) and climate risk management within the banking sector. The findings underscore the critical role that Fintech can play in enhancing the banking industry's capacity to assess, monitor, and mitigate the multifaceted risks posed by climate change. Through the deployment of advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), blockchain, big data analytics, and digital platforms for green finance, banks can navigate the complexities of climate risk more effectively.

Fintech's integration into climate risk management represents a transformative shift in how banks can operate in an increasingly volatile environment. The literature indicates that AI and ML can significantly improve risk assessment processes by enabling more accurate modeling of climate-related financial risks. These technologies facilitate the analysis of vast datasets, allowing banks to identify patterns and predict potential impacts of climate change on their portfolios. Furthermore, big data analytics can enhance monitoring capabilities, providing real-time insights into environmental changes and their potential financial implications.

Blockchain technology also offers promising solutions for transparency and traceability in green finance initiatives. By creating immutable records of transactions, blockchain can help mitigate concerns related to greenwashing—the practice of presenting an organization as more environmentally friendly than it truly is. This transparency is essential for building trust among stakeholders and ensuring that investments genuinely contribute to sustainability goals.

Despite the promising potential of fintech in addressing climate-related financial risks, several challenges and limitations persist. One of the most significant barriers is data scarcity. The availability of high-quality, granular data on climate impacts remains limited, particularly in developing regions. This scarcity complicates risk assessment and modeling efforts, hindering banks' ability to make informed decisions.

Regulatory hurdles also pose a considerable challenge to fintech adoption in climate risk management. The rapidly evolving regulatory landscape surrounding climate-related disclosures and sustainability reporting can create uncertainty for financial institutions. Banks must navigate these complexities while ensuring compliance, which can be resource-intensive and may stifle innovation.

Technological integration barriers further complicate the adoption of fintech solutions. Many banks operate on legacy systems that may not be compatible with new technologies. This mismatch can hinder the seamless implementation of advanced analytics and AI, limiting the potential benefits that these technologies can offer.

Ethical considerations, particularly concerning algorithmic bias and the risk of greenwashing, must also be addressed. The deployment of AI and ML in climate risk management necessitates a careful examination of the underlying algorithms to ensure they do not inadvertently perpetuate biases or misrepresent environmental impacts. As banks increasingly rely on these technologies, establishing robust ethical guidelines and accountability mechanisms will be essential to maintain credibility and public trust.

Considering these challenges, the literature review has illuminated several emerging best practices and innovative approaches that can guide banks in their climate risk management efforts. Collaboration between financial institutions, technology providers, and regulatory bodies is paramount. By fostering partnerships, stakeholders can share expertise, resources, and data, ultimately enhancing the efficacy of fintech solutions in addressing climate risks.

Furthermore, the establishment of industry standards for climate risk assessment and reporting can facilitate greater consistency and comparability across financial institutions. Such standards would not only aid banks in aligning their practices with regulatory expectations but also enhance transparency for investors and stakeholders.

The promotion of green finance initiatives through digital platforms represents another innovative approach. By leveraging fintech solutions, banks can facilitate access to sustainable investment opportunities, thereby driving capital towards environmentally friendly projects. This approach not only supports climate goals but also aligns with the growing demand from investors for responsible investment options.

While this review has synthesized a wealth of existing research, it has also identified several gaps that warrant further exploration. Notably, there is a need for more empirical studies that assess the real-world impact of fintech solutions on climate risk management within banks. Longitudinal studies that track the effectiveness of these technologies over time would provide valuable insights into their sustainability and scalability.

Additionally, research exploring the intersection of fintech and climate risk in emerging markets is limited. Given that many developing regions are disproportionately affected by climate change, understanding how fintech can be leveraged in these contexts is crucial. Future studies should investigate the unique challenges and opportunities that these markets present, particularly concerning data availability and regulatory frameworks.

Moreover, the ethical implications of using AI and ML in climate risk management require deeper examination. Research focused on establishing best practices for algorithmic transparency and accountability will be vital in ensuring that fintech solutions contribute positively to sustainability

goals without exacerbating existing inequalities. The integration of fintech into climate risk management represents a significant opportunity for banks to enhance their resilience in the face of growing climate-related financial risks. The literature review has established that while challenges remain, the potential benefits of leveraging advanced technologies are substantial. By adopting innovative approaches, fostering collaboration, and addressing ethical considerations, banks can navigate the complexities of climate risk more effectively.

As stakeholders in the financial ecosystem—researchers, policymakers, and institutions—continue to explore this dynamic landscape, the insights gained from this review can inform strategies that contribute to a more resilient and sustainable financial system. Moving forward, a concerted effort to bridge existing gaps in the literature and practice will be essential in ensuring that the banking sector not only survives but thrives in an era increasingly defined by climate change.

REFERENCES

Arner, D., Barberis, J., Buckley, R. P. (2020). Fintech, Bigtech, and the interoperability of digital financial infrastructure. Journal of Financial Regulation, 6(2). <https://www.bis.org/publ/bppdf/bispap117.pdf>;

Babu, R. (2024). Blockchain-Enabled Carbon Credit Trading: Revolutionizing Sustainability Efforts. International Journal of Research. Computer Applications and Information Technology (IJRCAIT), 7(2).

Bank for International Settlements (BIS) Innovation Hub, Central Bank of the United Arab Emirates (CBUAE), Emirates Institute of Finance (EIF). (2023). Scaling climate action: Unleashing innovative technologies in sustainable finance. <https://www.bis.org/innovation_hub/projects/2023_cop28_techsprint.pdf>;

Bartlett, R., Morse, A., Stanton, R., Wallace, N. (2019). Consumer-lending discrimination in the FinTech era. National Bureau of Economic Research. <https://faculty.haas.berkeley.edu/morse/research/papers/discrim.pdf>;

Basel Committee on Banking Supervision. (2021). Climate-related financial risks – measurement methodologies. Basel, Switzerland: Bank for International Settlements. <https://www.bis.org/bcbs/publ/d518.pdf>;

Bolton, P., Despres, M., Pereira da Silva, L. A., Samama, F., Svartzman, R. (2020). The green swan: Central banking and financial stability in the age of climate change. Bank for International Settlements. <https://www.bis.org/publ/othp31.pdf>.

Dunbar, K., Sarkis, J., Treku, D. N. (2024). Fintech for environmental sustainability: promises and pitfalls. One Earth, 7(1), pp. 23-30. <https://doi.org/10.1016/j.oneear.2023.12.012>;

Feyen, E., Frost, J., Gambacorta, L., Natarajan, H., Saal, M. (2021). Fintech and the digital transformation of financial services: implications for market structure and public policy. BIS Papers No 117. Bank for International Settlements and the World Bank Group. <https://www.bis.org/publ/bppdf/bispap117.pdf>;

Gomber, P., Kauffman, R. J., Parker, C., Weber, B. W. (2018). On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. Journal of Management Information Systems, 35(1), pp. 220-265. <https://doi.org/10.1080/07421222.2018.1440766>;

Gosling, T. (2024). Universal Owners and Climate Change, Journal of Financial Regulation, Vol. 00, No. 00. <https://lbsresearch.london.edu/id/eprint/3972/1/fjae010.pdf>;

International Monetary Fund. (2024, April). Navigating Climate Transitions: The Role of Financial Policies. Global Financial Stability Report. Washington, DC: International Monetary Fund;

International Monetary Fund. (2024). Fintech and Climate Risk Management in Banking. IMF Working Paper, 24/8. Washington, DC: International Monetary Fund;

King & Wood Mallesons. (2021). Blockchain and ESG: Blockchain for Sustainability and Green Finance;

Kouhizadeh, M., Sarkis, J. (2020). Blockchain Practices, Potentials, and Perspectives in Greening Supply Chains. <https://iaeme.com/MasterAdmin/Journal_uploads/IJRCAIT/VOLUME_7_ISSUE_2/IJRCAIT_07_02_017.pdf>;

Nieto, M. J. (2019). Banks, Climate Risk and Financial Stability. Journal of Financial Regulation and Compliance, 27, no. 2: 243–262. <https://doi.org/10.1108/JFRC-03-2018-0043>;

Mhlanga, D. (2022). The role of financial inclusion and FinTech in addressing climate-related challenges in the industry 4.0: Lessons for sustainable development goals. Front. Clim. 4:949178. <DOI:10.3389/fclim.2022.949178>;

Network for Greening the Financial System (NGFS). (2022). Final report on bridging data gaps. <https://www.ngfs.net/sites/default/files/medias/documents/final_report_on_bridging_data_gaps.pdf>;

Office of the Comptroller of the Currency (OCC). (2023). Semiannual Risk Perspective. <https://www.occ.gov/publications-and-resources/publications/semiannual-risk-perspective/files/pub-semiannual-risk-perspective-fall-2023.pdf>.

Perez, C. (2002). Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages. Edward Elgar Publishing

Singhvi, S., Dadhich, M. (2023). FinTech Revolution and Future of Sustainable Banking: Opportunities and Risks Analysis. International Journal of Management and Development Studies, vol. 12, no. 04. <DOI:10.53983/ijmds.v12n04.003>;

The International Finance Corporation (IFC). (2023). Mapping of Digital Solutions to Support Financial Services Providers in Assessing Climate Impact on Agricultural Portfolios. <https://www.ifc.org/content/dam/ifc/doc/2024/mapping-of-digital-solutions-to-support-financial-services-providers-in-assessing-climate-impact-on-agricultural-portfolios-ifc-2023.pdf>;

United Nations Environment Programme Finance Initiative (UNEP FI). (2024). The Climate Data Challenge: The Critical Role of Open-Source and Neutral Data Platforms. Technical Supplement to the 2024 Climate Risk Landscape Report. <https://www.unepfi.org/wordpress/wp-content/uploads/2024/05/Dataland-Final-Report-The-Climate-Data-Challenge-1.pdf>;

Wu, Q. (2024). From bits to emissions: how FinTech benefits climate resilience? Empirical Economics. <https://doi.org/10.1007/s00181-024-02609-9>;

Yang, Z., Nguyen T. T. H., Nguyen H. N., Nguyen T. T. N., Cao T. T. (2020). Greenwashing behaviours: Causes, taxonomy and consequences based on a systematic literature review. Journal of Business Economics and Management (JBEM), ISSN 2029-4433, Vilnius Gediminas Technical University, Vilnius, Vol. 21, Iss. 5, pp. 1486-1507. <https://doi.org/10.3846/jbem.2020.1322>.

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ARTICLE

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RESORT REFORM IN GEORGIA: COMPARATIVE INSIGHTS FROM EASTERN EUROPE

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Abstract. *The paper reviews the past and current resort-related regulatory framework in Georgia to identify the main obstacles that slow down resort development. The collapse of the Soviet Union had a disastrous impact on Georgia's sanatoriums and health resorts. As a result, historically valuable buildings and parks within these areas deteriorated, the number of both residents and visitors steadily declined, and many facilities lost their role in the public health system. However, recent reforms, particularly the Law on Tourism adopted in 2023, have renewed interest in the potential of resorts to attract visitors and foreign investment.*

Based on a comparative review of the legal and policy frameworks of four Eastern European countries—Bulgaria, Latvia, Lithuania, and Romania—the paper provides insights for the ongoing tourism reform in Georgia. These countries were selected because they share a similar post-Soviet background with Georgia but are also members of the European Union. The comparison revealed differences in legal definitions, recognition procedures, and criteria for resort classification, helping to identify the most effective practices that could be adapted to the Georgian context.

From these findings, the paper proposes a new regulatory framework that introduces the concept of "National Resorts" as a quality-assurance mechanism. It also recommends modernizing tourism and resort governance, improving coordination between institutions, and integrating climate-resilience and safety measures to help position Georgia's resorts as competitive and sustainable destinations within the broader European tourism landscape.

KEYWORDS: RESORTS, TOURISM POLICY, REGULATORY FRAMEWORK, SUSTAINABLE DEVELOPMENT.

JEL CLASSIFICATION: L83, Z32, R58.

INTRODUCTION

Resort development began in the early twentieth century, following the Russian Revolution of 1917. During this period, the Soviet government created a wide network of sanatoriums, health resorts, and similar facilities for the purpose of improving the health and well-being of the working population and their families. These initiatives soon spread to other Soviet republics, where resorts became part of the broader system of social welfare and labor protection. Over the following decades, this network grew into a centralized system of sanatoriums, health resorts, and children's recreation centers that served both medical and leisure purposes.[1] Because of its diverse mountain, climatic, and balneological resources, Georgia became one of the main centers of health tourism in the Soviet Union, attracting visitors from across the country.[2]

The collapse of the Soviet Union in the early 1990s created serious challenges for the resort networks across post-Soviet countries. Rapid privatization and the sudden end of government support left many resorts without funds or visitors. Many facilities lost their original public-health role and fell into disrepair, while natural and cultural assets deteriorated through neglect or unregulated use.[3] According to Tutberidze (2021), Georgian resorts today fall into four categories: (1) fully restored and operating destinations such as the Black Sea coast, Tbilisi, Borjomi, Sairme, and Tskaltubo; (2) partially restored resorts under development, including Abastumani and Bakhmaro; (3) seasonal resorts with limited infrastructure, such as Sulori and Lashichala; and (4) resorts with destroyed infrastructure, such as Menji, Tsaishi, and Nabeghlavi.[4]

The first comprehensive legal framework governing resorts was the *Law of Georgia on Tourism and Resorts* (1997), which defined "resorts", "resort areas," and "natural curative resources",[5] approving an official list of 271 resorts and resort areas.[6] This was complemented by the *Law on Protective Sanitary Zones of Health Resorts and Resort Areas* (2000), which introduced a three-tiered system of sanitary protection zones to safeguard natural healing resources and regulate economic activities.[7]

The Law on Tourism, adopted in 2023, repealed the 1997 legislation and required the preparation of a new Law on Resort Activities by 2025, later postponed to 2026. The updated law introduced three key terms: resort, resort area, and resort activity. A resort is defined as a designated location with the necessary infrastructure for resort-related activities. A resort area is a designated territory that has natural healing and therapeutic resources suitable for use, but lacks the infrastructure for resort activities. Resort activities refer to the organized use of natural healing and therapeutic resources and the related infrastructure for prevention, treatment, rehabilitation, and recovery.[8]

However, the law does not include a clear definition of natural healing resources, which was a key part of earlier resort classification. Previously, these resources included mineral waters, therapeutic muds, karst caves suitable for treatment, the sea, forests, therapeutic climates, and other natural elements used for prevention and rehabilitation. The absence of clear evaluation criteria for such resources now creates uncertainty in determining resort eligibility and weakens the credibility of official recognition.

Other than legal gaps, there is also a conceptual issue in how the term resort is defined in

1 Conterio, J. (2019). Curative nature: Medical foundations of Soviet nature protection, 1917–1941. Slavic Review, 78(1), p. 30.

2 Azmaiparashvili, M., Goderdzishvili, I. (2024). Sustainable development of Georgian resorts: modern trends and challenges. Proceedings of the 6th International Scientific and Practical Conference "Scientific Goals and Purposes in XXI Century", 6(193), p. 30.

3 Ņitavska, N., Skujāne, D. (2019). Re-branding landscapes of forgotten resorts: Case of the healing resort Kemeri in Latvia. *Landscape Architecture and Art,* 15(15), pp. 32–33.

4 Tutberidze, M. (2021). The Georgian resorts as a basis for wellness tourism development. Georgian Geographical Journal, 1(1), pp. 23–24.

5 Law of Georgia on Tourism and Resorts No. 1662-IIs. (28 November 1997). Legislative Herald of Georgia, Articles 1–7. <www.matsne.gov.ge>.

6 Decree No. 428 of the Government of Georgia On the Approval of the List of Resorts and Resort Areas of Georgia (3 July 2014).

7 Law of Georgia on Protective Sanitary Zones of Health Resorts and Resort Areas, No. 1308-IIs (7 September 2000). Legislative Herald of Georgia. <www.matsne.gov.ge>.

8 Law of Georgia on Tourism (15 December 2023). Legislative Herald of Georgia. <www.matsne.gov.ge>.

Georgia. As in other Soviet countries, a resort has mostly referred to places with officially recognized healing resources, such as mineral springs, therapeutic muds, or favorable climatic conditions, and to some basic infrastructure for using these resources, like baths or treatment facilities. This narrow, health-oriented approach does not take into consideration whether these places have functioning tourism infrastructure. As a result, some resorts exist only formally and fail to attract visitors because of the lack of tourism facilities, while active tourism destinations without certified healing resources remain outside the system. For example, Gudauri, a major mountain destination with developed infrastructure and strong demand, is still not legally recognized as a resort. The identified challenges suggest that a broader definition is needed that will capture both the curative purpose and the tourism role of resorts.

The important gap in tourism governance in Georgia should also be highlighted. There are overlapping responsibilities and weak coordination among government agencies, which remain serious obstacles for the development of the tourism industry in general and resorts in particular. According to the Law on Tourism, the Government of Georgia, the Ministry of Economy and Sustainable Development, and the Georgian National Tourism Administration (GNTA) share responsibility for tourism development, while the GNTA is the main agency for tourism policy implementation.[9] However, an analysis of the GNTA's activities shows that its main focus is on promotion, while planning and regulatory functions remain less developed. Furthermore, GNTA, local governments, Destination Management Organizations (DMOs), the Georgian Resorts Development Agency (GRDA),[10] and the Mountain Trails Agency (MTA)[11] have overlapping functions, which makes it difficult to identify which agency is accountable for specific tourism-related tasks. In October 2025, the Government officially announced the merger of two agencies, GRDA and GNTA, leading to improved coordination and reduced duplication. This reform shows that the authorities recognize long-standing institutional problems, although the process still needs to be completed. The MTA, responsible for developing ski infrastructure, still operates outside the national tourism policy framework. It is therefore of paramount importance to create a unified system that connects all tourism-related functions to ensure better planning and coordination.

The problems identified above are not unique to Georgia. After the collapse of the Soviet Union, several Eastern European countries faced the same kinds of institutional and legal difficulties. However, some of these countries improved their resort systems with more quality orientation and better management practices.

The study investigates how selected Eastern European states with a common Soviet heritage—Bulgaria, Latvia, Lithuania, and Romania—have reformed their resort regulation systems after joining the European Union. Furthermore, the paper identifies practical insights for Georgia by using a comparative legal and policy analysis of tourism and resort-related laws, focusing on the main aims, definitions, recognition procedures, and criteria that regulate resorts in the four selected countries. The main goal is to develop a clear and practical framework for the classification and management of Georgian resorts that will lead to an increase in their quality, environmental sustainability, and competitiveness for the international tourism markets.

OVERVIEW OF RESORT-RELATED REGULATIONS IN EASTERN EUROPE

This part of the paper investigates how resort regulations work in four Eastern European countries—Bulgaria, Latvia, Lithuania, and Romania. They share a Soviet past but took different paths when reforming their systems after joining the European Union, based on their own national priorities. Although no single regulation is perfect, a combination of strong sides can be very useful if adapted wisely to the Georgian context. To identify useful insights, analysis focuses on three

9 Ibid., Article 4.

10 Georgian Resorts Development Agency. (n.d.). Mission and Vision. Government of Georgia. Last access: October 31, 2025. <https://resorts.gov.ge/mission?menu_id=45&target=_self>.

11 Mountain Trails Agency. (n.d.). About the Agency. Government of Georgia. Last access: October 31, 2025. <https://mta.ski/en/about>.

main aspects: (1) the aims and legal definition of a resort, (2) the procedures for official recognition, and (3) the criteria used for that recognition.

Definition and Aim of Resort Regulation

There are different meanings of the term *resort* in different parts of the world. In the North American case, it refers to a single property offering leisure and recreation services or a type of accommodation, while in British and European contexts it describes an entire locality or destination with tourism and health-related infrastructure.[12] Eastern European countries follow this latter approach, treating resorts as complex areas that combine natural, medical, and cultural resources within a managed spatial framework.

In Bulgaria, resort regulation aims to promote the sustainable development of national resorts while protecting natural and cultural heritage. The law defines a resort as an urbanized area (either a whole or part of a settlement) with officially declared resort resources and facilities for prevention, treatment, rehabilitation, recreation, and tourism. These resources include mineral and thermal waters, therapeutic muds, seawater, coastal zones, and favorable climatic conditions. National resorts are a higher category selected by the authorities from the existing list of resorts based on their tourism potential. They are required to have developed infrastructure, good accessibility, and a balanced combination of natural and human-made assets supporting both health and leisure functions.[13]

In Latvia, resort regulation is more health-oriented and focuses on the rational use of natural healing resources for wellness, prevention, and rehabilitation in an environmentally sustainable way. A resort in Latvia is an officially designated area that has natural healing resources and at least one medical institution using them, together with basic infrastructure and proper spatial planning. This reflects Latvia's long spa and wellness tradition, where the value of local healing resources forms the main legal and economic basis for resort development.[14]

In Lithuania, resort regulation is part of broader territorial and economic planning. Its main goal is to achieve balanced social, economic, and infrastructural development, attract investment, and strengthen the country's image as a wellness destination. Lithuanian law distinguishes, on the one hand, between resorts—residential areas with scientifically proven natural healing factors and developed infrastructure—and, on the other hand, resort areas, which have potential healing resources that are not yet fully developed. This system helps Lithuania develop new resorts gradually and ensures that local planning fits with the country's tourism and health goals.[15]

Unlike other countries, Romania does not have a special law for resorts. Resorts-related matters are handled through the general tourism law that focuses mostly on recognizing natural and cultural tourism resources. A resort is defined as a locality or part of it recognized for certified natural or anthropogenic assets such as geological formations, landscapes, climate, and monuments. The presence of healing resources is not mandatory, underscoring Romania's broader recreational and cultural orientation (See Table 1).[16]

12 Varadzhakova, D., Naidenov, A., Ilieva, N., Raykova, M. (2023). The Bulgarian national Black Sea resorts in the context of domestic tourism. GeoJournal of Tourism and Geosites, 49(4), p. 1088.

13 Law of the Republic of Bulgaria on Tourism (State Gazette No. 30 of 26 March 2013; last amended State Gazette No. 20 of 12 March 2021), Chapter Four "A" – National Resorts. lex.bg – Official Legislation Database of Bulgaria. <https://lex.bg/bg/laws/ldoc/2135845281>.

14 Law of the Republic of Latvia on Tourism (19 June 1998; last amended 1 July 2022), Article 6¹ – "Resort and Granting of its Status". likumi.lv – Official Legislation Database of Latvia. <https://likumi.lv/ta/id/50026-turisma-likums>.

15 Law of the Republic of Lithuania on Tourism (18 March 1998; last amended 23 January 2023), Article 2 – "The Main Concepts of This Law". e-Seimas – Official Portal of Legal Acts of the Republic of Lithuania. <https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/3a2b7132f9f611edbc0bd16e3a4d3b97>.

16 Law of Romania on Tourism (nr. 70/2023, 30 March 2023; published in the Official Gazette of Romania, Part I, No. 256/2023), Chapter I – "General Provisions". legislatie.just.ro – Official Legislative Portal of Romania. <https://legislatie.just.ro/Public/DetaliiDocumentAfis/256247>.

Table 1. Summary of Resort Regulation Objectives and Definitions in Eastern Europe

Country	Aim of Regulation	Definition of Resort	Healing Resources Required
Bulgaria	Sustainable development of national resorts with protection of natural and cultural heritage.	Urbanized territory with declared resort resources and facilities for prevention, treatment, rehabilitation, recreation, and tourism. National resorts are resorts with essential infrastructure, good accessibility, and rich natural and cultural resources that support tourism and recreation.	Yes
Latvia	Rational use of natural healing resources for wellness, rehabilitation, and preventive healthcare within an environmentally sustainable framework.	Legally designated area containing natural healing resources and at least one medical institution using them.	Yes
Lithuania	Balanced socio-economic and infrastructural development, investment attraction, and enhancement of the wellness image.	Residential area with validated natural healing factors and resort infrastructure; "resort areas" with potential resources.	Yes
Romania	General tourism legislation without explicit strategic aims; resorts addressed through destination classification.	Locality or area with certified natural or cultural tourist resources.	No

These frameworks show two main approaches in Eastern European resort policy. The curative-medical model, used in Bulgaria, Latvia, and Lithuania, links resort status to natural healing factors and focuses on health, rehabilitation, and environmental quality. The tourism-development model, followed in Romania, defines resorts more broadly based on their recreational, cultural, and natural features.

Procedures for Resort Recognition

The existing formal recognition procedures in the selected countries ensure that nominated areas meet agreed standards. Although the level of complexity differs from country to country, all the systems reviewed include expert evaluation, coordination between ministries, and regular monitoring.

In Bulgaria, the recognition process is based on a clear legal framework that focuses on the proper use and protection of healing resources. The Minister of Health pilots the process by preparing a proposal for resort recognition based on expert reviews. The final approval is given by the Council of Ministers together with the Ministries of Health, Regional Development, Environment, and Tourism. An important step is the balneological assessment of mineral waters, which confirms their healing qualities for a period of ten years and can later be renewed. The results are published on the Ministry of Health's website to keep the process transparent.[17] After a locality is officially recognized as a resort, it can later be given the status of a national resort. This second step is regulated by an ordinance adopted by the Council of Ministers based on a joint proposal from the Ministers of Health and Tourism. Businesses operating in national resorts benefit from simpler administrative procedures and special incentives that support investment and sustainable growth (See Fig.1).[18]

17 Law of the Republic of Bulgaria on Health (SG No. 70/2004; last amended SG No. 98/2018), Section VIII – "Resort Resources and Resorts", Articles 75–76. Republic of Bulgaria. lex.bg – Official Legislation Database of Bulgaria. <https://lex.bg/bg/laws/ldoc/2135489147>.

18 Law of the Republic of Bulgaria on Tourism (SG No. 30/2013; last amended SG No. 20/2021), Chapter Four "A" – National Resorts. lex.bg – Official Leg-

Figure 1. Sequence of resort and national resort recognition procedures in Bulgaria (author's elaboration)

Figure 2. Sequence of resort-recognition procedures in Latvia (author's elaboration)

Figure 3. Sequence of resort-recognition procedures in Lithuania (author's elaboration)

In Latvia, the process is initiated by municipalities and regulated through the Cabinet of Ministers' decisions. Local councils submit applications including development plans, spatial documentation, and compliance evidence. The Ministry of Economy conducts the preliminary review and forwards qualified cases to an inter-ministerial commission, which evaluates conformity with the *Tourism Law* within two months. Based on its findings, the Ministry drafts an order for the Cabinet, which issues the final designation. Municipalities must submit biennial progress reports; non-compliance can result in revocation of status (See Fig.2).[19]

In Lithuania, the municipal council submits a proposal to the Ministry of Economy and Innovation, together with planning and explanatory documents. The Ministry forms a working group to review the submission within sixty days and prepares a recommendation for the Government, which makes the final decision. This clear and transparent process allows the gradual recognition of new destinations through the resort-area category (See Fig.3).[20]

In Romania, resort recognition is regulated by the general tourism law through ministerial certification of natural or cultural resources. The process is officially defined, but less transparent than in the other three countries.[21]

Overall, these procedures show different levels of institutional development. Bulgaria focuses on medical evaluation; Latvia and Lithuania combine local initiative with national oversight; and Romania follows a simpler, resource-based system.

Criteria for Resort Recognition

The four selected countries differ widely in the specificity, transparency, and formality of their

islation Database of Bulgaria. <https://lex.bg/bg/laws/ldoc/2135845281>.

19 Regulations of the Cabinet of Ministers of the Republic of Latvia No. 451, "Regulations on Resorts" (2 August 2016; last amended 8 June 2021). likumi.lv – Official Legislation Database of Latvia. <https://likumi.lv/ta/en/en/id/253701>.

20 Resolution No. 1459 of the Government of the Republic of Lithuania On the Approval of the Procedure for Granting and Revoking the Status of Resorts and Resort Areas (23 December 2008; last amended 2 December 2020). e-TAR – Official Register of Legal Acts of Lithuania. <https://www.e-tar.lt/portal/lt/legalAct/f94027a07d0111e7827cd63159af616c/asr>.

21 Order No. 630/2022 of the Ministry of Economy, Entrepreneurship and Tourism of Romania On the Certification of Tourist Resorts of National or Local Interest. Official Gazette of Romania, Part I, No. 330/04.04.2022. <https://legislatie.just.ro/Public/DetaliiDocumentAfis/256247>.

resort-recognition criteria. In Lithuania, the criteria are written into law and clearly connected to spatial planning and environmental policy. In Bulgaria and Romania, by contrast, the criteria are not published or are set mainly through administrative practice. Latvia lies in between, providing general rules for compliance and development planning but without detailed technical standards.

Compared with other countries, Lithuania has much more detailed criteria available in regulations for resort recognition. There are two types of requirements for areas seeking resort or resort-area status—general and specific. The general criteria focus on several key areas, including environmental protection, public health and safety, land-use planning, and tourism infrastructure. Furthermore, they follow sustainable principles by including measures such as limiting pollution, improving accessibility, and keeping high standards of cleanliness and safety. In contrast, the specific criteria address the practical side of the development by focusing on the quality of infrastructure, like pedestrian and bicycle paths, parking and storage facilities, and well-maintained public spaces that create a comfortable and attractive resort environment. In addition, areas aiming for full resort status must also provide bypass routes for transit traffic, developed tourism infrastructure, and a mix of public and private services. Key elements include healthcare and wellness centers, accommodation, and cultural, leisure, and dining facilities. Resort areas, on the other hand—seen as developing or transitional destinations—have fewer requirements and mainly focus on basic recreation facilities and public services for visitors. This two-level system helps Lithuania develop new resorts gradually while supporting national goals for sustainability and spatial planning.[22]

Latvia's criteria for resort designation are defined in the Regulations on Resorts issued by the Cabinet of Ministers. While the regulations do not set precise quantitative or qualitative benchmarks, they require municipalities to submit comprehensive documentation—such as spatial-development plans, evidence of resource protection, and medium-term resort strategies—demonstrating the feasibility and long-term vision of the proposed resort. The focus on planning and environmental management helps keep resort policy consistent, even without detailed technical standards.[23]

In Bulgaria and Romania, there is no complete or publicly available list of resort-recognition criteria. In fact, the process in Bulgaria focuses mainly on the balneological evaluation of natural healing resources, while Romania regulates resorts through the general tourism law, without clearly defined standards for eligibility, sustainability, or quality. Due to the fact that these rules are not published, decisions often depend on administrative judgment, making the process less consistent than in Lithuania.

In summary, these differences that that resort related regulations in Eastern Europe have developed at different speeds and in different ways. Lithuania's model is the most complete because it brings together health, environmental, and infrastructure aspects. Latvia's approach is more focused on local planning and management, while Bulgaria and Romania still struggle with unclear procedures and a lack of detailed legal guidance.

DEVELOPING A RESORT REGULATION FRAMEWORK FOR GEORGIA

Reforming resort regulations in Georgia requires more than just updating legal terms or setting new recognition criteria. For real impact, the entire tourism governance system needs bigger, more comprehensive change and optimization. The conceptual framework below is based on the analysis of resort-related regulations of Eastern European countries and is adapted to Georgia's recent institutional and economic context.

22 Resolution No. 350 of the Government of the Republic of Lithuania On the Approval of the Description of the Procedure for Granting the Status of a Resort and a Resort Territory (12 April 2006; last amended 15 December 2021). e-TAR – Official Register of Legal Acts of Lithuania. <https://www.e-tar.lt/portal/en/legalAct/TAR.B4B629EF1E3E/WHPJjFiPBK>.

23 Regulations of the Cabinet of Ministers of the Republic of Latvia No. 451, "Regulations on Resorts" (2 August 2016; last amended 8 June 2021). likumi.lv – Official Legislation Database of Latvia. <https://likumi.lv/ta/en/en/id/253701>;

Aim and Definition of Resorts

As mentioned earlier, the Law of Georgia on Tourism (2023) keeps the old definitions of resorts and resort areas but contains several important flaws. To solve this problem, the law should clearly list what counts as curative resources. Another important step would be the introduction of the term National Resort, allowing the government to distinguish resorts by their tourism potential without changing the current list of resorts. A proposed legal formulation could read as follows:

> **"***A resort is an urbanized area initially declared as a resort and subsequently recognized as a National Resort based on a proposal by the Georgian National Tourism Administration and a decision of the Cabinet of Ministers. National resorts are important for the sustainable development of tourism in Georgia. They are characterized by essential tourism infrastructure, accessibility, and valuable tourism resources. These resources include components of the natural and anthropogenic environment (geological formations, climate, flora and fauna, landscapes, and cultural or historical sites) used for tourism unless subject to full protection regimes. In special cases, areas with high-value tourism resources may be nominated for national resort status without prior resort designation*".

The concept of "National Resorts" is similar to Bulgaria's approach, where they are considered as an important drivers for sustainable tourism and economic growth. It is also partly in line with Romania's system, which defines resorts based on their tourism resources. However, the paper suggests going a step further by allowing exceptional destinations without curative resources to be nominated directly for national status. For example, destinations without resort status but with high tourism potential, like Gudauri, would also have the opportunity to be declared as national resorts.

Procedures for Resort Recognition

The paper proposes a national resort recognition system using practices observed in Bulgaria, Latvia, and Lithuania, while taking into consideration the local governance system:

- **Nomination –** The Georgian National Tourism Administration (GNTA), together with the local municipality, submits a nomination for national resort status. As a result, both expert knowledge and local perspectives are reflected in the proposal;
- **Formation of a Working Group** – A multidisciplinary team composed of ministry representatives, technical experts, and local authorities evaluates the proposal;
- **Evaluation of Compliance** – The working group evaluates accessibility, sustainability, infrastructure quality, and distinctive tourism resources and prepares a formal opinion for the Ministry of Economy and Sustainable Development;
- **Drafting of the Decision** – Based on the group's findings, the Ministry prepares a draft decision to either approve or reject the nomination and adds recommendations if needed;
- **Final Approval** – The Cabinet of Ministers makes the final decision, ensuring that it aligns with national tourism policy and broader development goals.

The suggested framework provides a simple and transparent process that is designed to help agencies work together more effectively. Furthermore, it makes responsibilities clearer and brings Georgia closer to international tourism management standards.

Criteria for Resort Recognition, Including Ski Resorts

The recognition criteria should reflect the main purpose of each resort while still keeping a single, unified national framework. All *National Resorts* must satisfy general quality and sustainability standards, supplemented by type-specific indicators.

General Criteria (applicable to all resorts) are the following:

1. Accessibility and connectivity;
2. Quality of infrastructure (roads, parking, public spaces);
3. Availability of tourism services and facilities;
4. Environmental protection and sustainable management practices;

5. Existence and quality of tourism resources;
6. Availability of healthcare and emergency services;
7. Compliance with spatial and territorial planning standards;
8. Existence of a medium-term strategy for resort growth.

Specific Criteria are the following:

- **National Ski Resorts** – quality, safety, and reliability of ski slopes; maintenance of lifts and snow-making systems; proximity of emergency services; variety of winter sports and après-ski facilities; and environmental safeguards in mountain ecosystems;
- **National Seaside Resorts** – beach quality, water safety, coastal protection, and waste-management systems ensuring sustainable use;
- **National Wellness Resorts** – quality and diversity of spa and therapeutic services based on natural healing resources such as mineral waters or therapeutic muds;
- **National Tourism Resorts** – distinctiveness and attractiveness of natural or cultural resources, quality of supporting infrastructure, and capacity to offer recreation, learning, and leisure experiences.

The working group should apply these criteria fairly, taking into account the size, type, and potential of each destination. A clear but flexible system will make the process more balanced and help create a variety of good-quality Georgian resorts that meet international standards.

It is also important to note that simply following Lithuania's example and adopting stricter criteria to existing resorts without bringing new terms could improve quality control of the resorts, but it would likely remove the status of about 95% of existing resorts, resulting in a long, costly, and politically sensitive process.

Institutional Roles after National Resort Recognition

It's important to note that National Resort is a real tool, not a formal label for developing and improving resort competitiveness. In practice, it is a brand giving high-quality information to visitors travelling to destinations for tourism purposes. In order to make this idea work, effective cooperation between agencies is of paramount importance.

Firstly, the GNTA and local DMOs should support these resorts with marketing and promotion and include them in training programs. The two agencies should also assess and control indicators of infrastructure and service quality, environmental conditions, and visitor satisfaction. In case standards drop, the GNTA should have the authority to suspend or withdraw resort status in order to maintain high quality.

Secondly, the regulations should focus on safety and climate resilience activities. With the increasing number of winter and adventure visitors, the improvement of safety management becomes essential.[24] Furthermore, as a result of Climate change, warmer winters and less snow threaten ski destinations such as Bakuriani and Gudauri, while erosion affects Black Sea resorts. For these reasons, monitoring climate risks and improving disaster preparedness should become a national goal.[25]

Finally, Enterprise Georgia can also play an important role. It can support national resorts through funding, infrastructure upgrades, and workforce training activities. At the same time, the government can help through tax incentives, public infrastructure improvement, and better access to finance. These steps would encourage both public and private investment in the sustainable growth of resorts.

To summarize, effective coordination between the GNTA, DMOs, Enterprise Georgia, and other agencies is essential to keep everyone working toward the same goal. Through the clearer roles, stronger management, and the inclusion of climate planning and safety measures, the National Resort title can be turned into a sign of quality that helps attract investment and improves Georgia's long-term competitiveness. Utilizing this approach, the country can move from its old Soviet-style resort system toward a modern, European model that supports sustainable tourism growth.

24 Azmaiparashvili, M., Davituliani, T. (2023). Ecological Safety of Georgian Tourism. Globalization and Business, 8(16), p. 69.

25 Bregadze, G. (2023). Climate Change Impacts on the Tourism Industry in Georgia, Globalization and Business, Vol. 8, No. 16, pp. 57–59. <https://doi.org/10.35945/gb.2023.16.005>.

REFERENCES:

Scientific Articles:

Azmaiparashvili, M., Davituliani, T. (2023). *Ecological Safety of Georgian Tourism. Globalization and Business, 8*(16);

Azmaiparashvili, M., Goderdzishvili, I. (2024). Sustainable development of Georgian resorts: modern trends and challenges. Proceedings of the 6th International Scientific and Practical Conference "Scientific Goals and Purposes in XXI Century", 6(193);

Bregadze, G. (2023). *Climate Change Impacts on the Tourism Industry in Georgia*, Globalization and Business, Vol. 8, No. 16. <https://doi.org/10.35945/gb.2023.16.005>;

Conterio, J. (2019). Curative nature: Medical foundations of Soviet nature protection, 1917–1941. *Slavic Review*, 78(1);

Ņitavska, N., Skujāne, D. (2019). Re-branding landscapes of forgotten resorts: Case of the healing resort Kemeri in Latvia. *Landscape Architecture and Art,* 15(15);

Tutberidze, M. (2021). The Georgian resorts as a basis for wellness tourism development. *Georgian Geographical Journal,* 1(1);

Varadzhakova, D., Naidenov, A., Ilieva, N., Raykova, M. (2023). The Bulgarian national Black Sea resorts in the context of domestic tourism. GeoJournal of Tourism and Geosites, 49(4).

Normative Acts:

Decree No. 428 of the Government of Georgia On the Approval of the List of Resorts and Resort Areas of Georgia (3 July 2014);

Law of Georgia on Protective Sanitary Zones of Health Resorts and Resort Areas No. 1308-IIs (7 September 2000). Legislative Herald of Georgia. <www.matsne.gov.ge>;

Law of Georgia on Tourism (15 December 2023). *Legislative Herald of Georgia.* <www.matsne.gov.ge>;

Law of Georgia on Tourism and Resorts No. 1662-IIs. (28 November 1997). *Legislative Herald of Georgia.* <www.matsne.gov.ge>;

Law of Romania on Tourism (*nr. 70/2023*, 30 March 2023; published in the *Official Gazette of Romania,* Part I, No. 256/2023), *legislatie.just.ro – Official Legislative Portal of Romania.* <https://legislatie.just.ro/Public/DetaliiDocumentAfis/256247>;

Law of the Republic of Bulgaria on Health (*SG* No. 70/2004; last amended *SG* No. 98/2018), Republic of Bulgaria. *lex.bg – Official Legislation Database of Bulgaria.* <https://lex.bg/bg/laws/ldoc/2135489147>;

Law of the Republic of Bulgaria on Tourism (*State Gazette* No. 30 of 26 March 2013; last amended *State Gazette* No. 20 of 12 March 2021), *lex.bg – Official Legislation Database of Bulgaria.* <https://lex.bg/bg/laws/ldoc/2135845281>;

Law of the Republic of Latvia on Tourism (19 June 1998; last amended 1 July 2022). l*ikumi.lv – Official Legislation Database of Latvia.* <https://likumi.lv/ta/id/50026-turisma-likums>;

Law of the Republic of Lithuania on Tourism (18 March 1998; last amended 23 January 2023). *e-Seimas – Official Portal of Legal Acts of the Republic of Lithuania.* <https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/3a2b7132f9f611edbc0bd16e3a4d3b97>;

Order No. 630/2022 of the Ministry of Economy, Entrepreneurship and Tourism of Romania *On the Certification of Tourist Resorts of National or Local Interest*. Official Gazette of Romania, No. 330/04.04.2022. <https://legislatie.just.ro/Public/DetaliiDocumentAfis/256247>;

Regulations of the Cabinet of Ministers of the Republic of Latvia No. 451, "Regulations on Resorts" (2 August 2016; last amended 8 June 2021). likumi.lv – Official Legislation Database of Latvia. <https://likumi.lv/ta/en/en/id/253701>;

Resolution No. 1459 of the Government of the Republic of Lithuania On the Approval of the Procedure for Granting and Revoking the Status of Resorts and Resort Areas (23 December 2008; last amended 2 December 2020). *e-TAR – Official Register of Legal Acts of Lithuania.* <https://www.e-tar.lt/portal/lt/legalAct/f94027a07d0111e7827cd63159af616c/asr>;

Resolution No. 350 of the Government of the Republic of Lithuania On the Approval of the Description of the Procedure for Granting the Status of a Resort and a Resort Territory (12 April 2006; last amended 15 December 2021). *e-TAR – Official Register of Legal Acts of Lithuania.* <https://www.e-tar.lt/portal/en/legalAct/TAR.B4B629EF1E3E/WHPJjFiPBK>.

Web Resources:

Georgian Resorts Development Agency. (n.d.). *Mission and Vision.* Government of Georgia. Last access: October 31, 2025. <https://resorts.gov.ge/mission?menu_id=45&target=_self>;

Mountain Trails Agency. (n.d.). *About the Agency.* Government of Georgia. Last access: October 31, 2025. <https://mta.ski/en/about>.

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ARTICLE

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SPATIAL-TERRITORIAL ASPECTS OF REGIONAL DEVELOPMENT PLANNING: THE CASE OF BORJOMI MUNICIPALITY

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Abstract. *This article analyzes the spatial-territorial structure of Borjomi Municipality through the lens of polycentric regional development, functional specialization, and seasonal economic dynamics. Drawing on qualitative field observations, semi-structured interviews, and the examination of municipal planning documents, the study evaluates how the municipality's three dominant nodes—Borjomi–Likani, Bakuriani, and the seasonal corridor villages—shape local development patterns and influence the distribution of economic activity, mobility flows, and service accessibility. Findings show that tourism-driven functions are heavily concentrated within the two major nodes, while peripheral settlements remain dependent on short seasonal cycles and underdeveloped infrastructure. The research also identifies significant gaps in rural–urban value-chain integration, particularly the limited participation of local agricultural producers in the tourism supply system. These spatial and functional disparities underscore the challenges of achieving balanced and resilient development in mountainous regions. By situating the Borjomi case within broader theoretical discussions on polycentricity and place-based development, the study demonstrates how spatial coordination and targeted policy interventions can enhance territorial cohesion and support sustainable development in structurally diverse municipalities.*

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KEYWORDS: REGIONAL DEVELOPMENT; SPATIAL PLANNING; TOURISM ECONOMY.

INTRODUCTION

Efficient regional development planning in mountainous countries requires a clear understanding of spatial-territorial structures, functional linkages, and the internal logic of settlement systems. In contemporary economic geography, spatial development is increasingly conceptualized through the lens of polycentricity, agglomeration effects, and spatial cohesion.[1] These ideas have been broadly discussed in economic and regional development literature, including works by Georgian scholars who emphasize the role of territorial organization, functional specialization, and spatial efficiency in shaping development trajectories.[2] Although their approaches vary, the literature converges on the notion that spatial structure fundamentally conditions the distribution of population, economic activity, and investment potential.

In Georgia's mountainous municipalities, spatial-territorial planning is linked not only to economic growth prospects but also to demographic sustainability, access to services, and the rational allocation of public resources.[3] Research on post-transition regional development shows that fragmented territorial policies and "one-size-fits-all" approaches often exacerbate disparities between central and peripheral settlements.[4] Likewise, studies on functional specialization and regional competitiveness argue that the concentration of infrastructure and economic functions in selected nodes can generate spillover benefits if the system is well connected but may deepen inequalities under weak institutional or infrastructural conditions.[5] Regional planning literature also underlines the importance of recognizing territorial heterogeneity and designing policies suited to specific functional zones, especially in tourism-led regions.[6]

1 Fujita, M., Krugman, P., Venables, A. J. (1999). *The spatial economy: Cities, regions, and international trade.* MIT Press. Meijers, E. (2008). Measuring polycentricity and its promises. European Planning Studies, 16(9), 1313–1323. <https://doi.org/10.1080/09654310802401805>.

2 Bedianashvili, G. (2018). Culture as a factor of knowledge economics with paradigmatic changes in systemic institutional context. *Globalization and Business,* 4(6), 59–66. <https://doi.org/10.35945/gb.2018.06.007>; Keshelashvili, G. (2018). Value chain management in agribusiness. *International Journal of Business and Management, 6*(2), 59–77. <https://doi.org/10.20472/BM.2018.6.2.004>; Kharaishvili, E. (2020). Methodological features of determining the level of competitiveness in the agri-food sector of Georgia. *Globalization and Business, 5*(10), 43–49. <https://doi.org/10.35945/gb.2020.10.004>; Papava, V. (2014). The catch-up effect and regional comparisons of growth indicators: With the Eastern Partnership countries as an example. *Problems of Economic Transition, 57*(3), 3–12. <https://doi.org/10.2753/PET1061-1991570301>; Silagadze, A. (2013). Priorities for the economy of postcommunist Georgia in the context of the world financial crisis. *Problems of Economic Transition, 56*(8), 3–16. <https://doi.org/10.2753/PET1061-1991560801>;

3 Jibuti, M. (2019). Administrative division, regions of Georgia and their characteristics. *Globalization and Business,* 4(8), 126–129. <https://doi.org/10.35945/gb.2019.08.016>; Mekvabishvili, E. (2019). The economic role of the state in conditions of globalization. *Globalization and Business,* 4(8), 22–33. <https://doi.org/10.35945/gb.2019.08.002>; Jibuti, M. (2025). Enhancing regional development in Georgia: Integrating functional spatial planning and land use modeling for sustainable economic growth. International Journal of Social Sciences, 14(1), 23–34. <https://doi.org/10.52950/SS.2025.14.1.002>; Jibuti, M. (2021). On the usage of old and modern technologies for economic sustainability. Globalization and Business, 6(11), 97-100. <https://doi.org/10.35945/gb.2021.11.013>; Keshelashvili, G. (2016). General strategies of Georgian winemaking companies' management in the conditions of integrated development. In Proceedings of the 23rd International Academic Conference, Venice (pp. 242-251), IISES. <https://doi.org/10.20472/IAC.2016.023.049>; Keshelashvili, G. (2017). Characteristics of management of agricultural cooperatives in Georgia. In Proceedings of the 32nd International Academic Conference, Geneva (pp. 207–218). IISES. <https://doi.org/10.20472/IAC.2017.032.020>.

4 Papava, V. (2014). The catch-up effect and regional comparisons of growth indicators: With the Eastern Partnership countries as an example. *Problems of Economic Transition, 57*(3), 3–12. <https://doi.org/10.2753/PET1061-1991570301>.

5 Silagadze, A. (2013). Priorities for the economy of postcommunist Georgia in the context of the world financial crisis. Problems of Economic Transition, 56(8), 3–16. <https://doi.org/10.2753/PET1061-1991560801>; Silagadze, A. (2022). Contemporary global economic trends: Transitional economies during Covid Depression. Bulletin of the Georgian National Academy of Sciences, 16(3), pp.130–135.

6 Kharaishvili, E., Suknishvili, M. (2021). Agribusiness development trends in Georgia: Modern challenges

Against this theoretical background, Borjomi Municipality represents a particularly informative case. Located in the Samtskhe–Javakheti region, Borjomi is one of Georgia's most significant tourism destinations, distinguished by mineral springs, national parks, mountainous landscapes, and year-round recreational resources. Yet despite the municipality's strategic importance, its spatial-territorial structure is uneven and highly seasonal, with substantial economic concentration in a limited number of settlements. For this study, Borjomi is conceptualized as a polycentric municipality composed of three dominant nodes: Borjomi–Likani as the administrative and service center, Bakuriani as a winter-specialized ski resort, and the seasonal villages along the Borjomi–Bakuriani corridor (e.g., Tsemi, Kimotesubani, Tsagveri), where economic activity fluctuates significantly between summer and winter tourism seasons.[7]

These nodes differ substantially in function, infrastructure, and economic potential. Spatial disparities between them shape the municipality's overall development trajectory, influencing labor mobility, business activity, property markets, and the availability of services. Field observations and qualitative interviews conducted in Borjomi reveal that many peripheral settlements remain deeply dependent on seasonal flows and on the economic vitality generated within the main nodes.

The relevance of this research is strengthened by Georgia's ongoing regional policy reforms, which aim to enhance territorial cohesion and support decentralized development. However, policy implementation often remains fragmented, with limited integration between spatial planning, economic strategies, and tourism development.[8] By examining Borjomi's polycentric spatial structure, this study contributes to a more informed understanding of how functional nodes operate within mountainous municipalities and how targeted spatial interventions can generate more balanced and resilient development.

International literature offers extensive conceptual foundations for understanding spatial-territorial development in complex geographies such as mountainous regions. European spatial planning research widely emphasizes the role of polycentric development[9] as a mechanism for reducing regional disparities and supporting balanced territorial growth.[10] Theories of agglomeration and spatial clustering, grounded in the works of Fujita et al.,[11] highlight how economic activities gravitate toward nodes with superior accessibility and infrastructure, reinforcing both opportunities and inequalities within regional systems. At the same time, New Regionalism frameworks stress the importance of relational connectivity, local institutional capacity, and place-based policy approaches.[12] Tour-

and solutions. *Economic. Ecology. Socium*, *5*(4), 29–38. <https://doi.org/10.31520/2616-7107/2021.5.4-4>.

7 Nepal, S. K., Saarinen, J. (2016). *Political ecology and tourism*. Routledge.

8 Barca, F. (2009). *An agenda for a reformed cohesion policy: A place-based approach to meeting European Union challenges and expectations*. European Commission.

9 Bedianashvili, G. (2022). The problem of assessing the expected consequences of economic policy. Globalization and Business, 7(13), 17–24. <https://doi.org/10.35945/gb.2022.13.002> (in Georgian); Bedianashvili, G., Ivanov, Y. B., Paientko, T. V. (2019). Tax reforms in Ukraine and Georgia: Changing priorities. Journal of Tax Reform, 5(2), 107–128. <https://doi.org/10.15826/jtr.2019.5.2.063>; Mekvabishvili, E. (2020). The anti-crisis role of the state (Based on the experience of the global financial and corona-economic crisis). Globalization and Business, 7(10), 35–41. <https://doi.org/10.35945/gb.2020.10.003>; Papava, V. (2014). Georgia's economy: The search for a development model. Problems of Economic Transition, 57(3), 13–24. <https://doi.org/10.2753/PET1061-1991570304>; Papava, V. (2017). A Eurasian or a European future for post-Soviet Georgia's economic development: Which is better? Archives of Business Research, 5(1), 159–170. <https://doi.org/10.14738/abr.51.2651>.

10 ESPON. (2019). *ESPON Policy Brief: The territorial dimension of future EU policies*. European Spatial Planning Observatory Network. Meijers, E. (2008). Measuring polycentricity and its promises. *European Planning Studies, 16*(9), 1313–1323. <https://doi.org/10.1080/09654310802401805>.

11 Fujita, M., Krugman, P., Venables, A. J. (1999). *The spatial economy: Cities, regions, and international trade*. MIT Press.

12 Amin, A. (2004). Regions unbound: Towards a new politics of place. *Geografiska Annaler: Series B, Human Geography, 86*(1), 33–44. <https://doi.org/10.1111/j.0435-3684.2004.00152.x>; Barca, F. (2009). *An agenda for a reformed cohesion policy: A place-*

ism-dependent regions, particularly in mountainous settings, have been shown to experience structural seasonality, fragmented value chains, and uneven development trajectories when governance and spatial planning fail to integrate peripheral settlements effectively.[13] These international perspectives complement the Georgian context by underscoring that polycentricity, functional linkages, and spatially coordinated territorial policy are essential for building resilience and ensuring inclusive development across differentiated settlement systems.

METHODOLOGY

This study aims to analyze Borjomi Municipality's spatial-territorial structure through the lens of polycentric development and to assess how functional nodes, seasonal patterns, and value-chain dynamics shape local economic outcomes. The research objectives include: (1) identifying the dominant spatial-functional centers within the municipality; (2) assessing their linkages and disparities; (3) examining seasonal fluctuations and settlement-level dependencies; and (4) evaluating the extent to which local producers participate in tourism-driven value chains. The methodology applies qualitative fieldwork conducted in Borjomi Municipality, including semi-structured interviews with residents and local business representatives, direct observations, and the interpretation of municipal planning documents and secondary statistical data. A comparative, place-based analytical framework is used to understand how spatial concentration and functional specialization generate uneven development patterns in mountainous regions.

Spatial–Territorial Structure and Functional Dynamics of Borjomi Municipality

The spatial–territorial configuration of Borjomi Municipality reflects the interaction between mountainous geomorphology, transportation corridors, and a tourism-driven local economy. Field observations and qualitative interviews conducted during the research reveal that Borjomi operates as a polycentric settlement system, within which three dominant nodes—Borjomi–Likani, Bakuriani, and the corridor villages—perform distinct but interconnected functions. These nodes exhibit asymmetrical economic weight, divergent seasonal profiles, and varying degrees of infrastructural maturity, shaping the municipality's internal spatial logic and development opportunities.

Borjomi–Likani as the Administrative, Service, and Health-Tourism Core: The Borjomi–Likani cluster constitutes the municipality's most consolidated urban center, serving simultaneously as its administrative hub and its primary year-round tourism destination. The research indicates several defining characteristics:

- Concentration of administrative institutions, public services, and social infrastructure, which anchors stable employment opportunities and public-sector mobility;
- Developed hospitality and wellness sectors, supported by mineral springs, health resorts, and access to Borjomi–Kharagauli National Park;
- High density of commercial services, including hotels, guesthouses, retail, and dining establishments that attract both domestic and international visitors;
- Strong nodal influence, as residents from surrounding villages rely on Borjomi–Likani for education, healthcare, administrative procedures, and market access.

These attributes position Borjomi–Likani as the municipality's primary functional center, generating regular commuter flows and acting as the infrastructural and economic "anchor" of the broader spatial system.

Bakuriani as a Rapidly Transforming Winter Resort Node: Bakuriani represents the munici-

based approach to meeting European Union challenges and expectations. European Commission.

13 Briedenhann, J., Wickens, E. (2004). Tourism routes as a tool for the economic development of rural areas—Vibrant hope or impossible dream? *Tourism Management, 25*(1), 71–79. <https://doi.org/10.1016/S0261-5177(03)00063-3>; Nepal, S. K., & Saarinen, J. (2016). *Political ecology and tourism*. Routledge.

pality's second major node, distinguished by its dynamic transformation into a winter-sport and recreational destination. The analysis reveals that:

- Winter tourism specialization—particularly ski infrastructure—remains Bakuriani's dominant economic driver;
- Rapid urbanization and large-scale real-estate development have reshaped the built environment, often outpacing municipal planning capacity;
- Expanding but uneven year-round tourism potential is emerging due to new service offerings, although seasonality remains pronounced;
- High concentration of hotels, rental apartments, and tourism services, primarily catering to winter visitors.

These dynamics illustrate a tourism-intensive node heavily influenced by private investment and national-level infrastructural initiatives, yet still challenged by spatial seasonality and the need for diversified functional capacity.

Seasonal Villages along the Borjomi–Bakuriani Corridor: A third set of nodes—Tsemi, Kimotesubani, Tsagveri, and other settlements along the Borjomi–Bakuriani road—constitute the municipality's most seasonally sensitive area. The research identifies several shared characteristics:

- Pronounced seasonal fluctuations, with peak economic activity during the summer season and significantly reduced demand during winter;
- Economic dependence on transit flows, with livelihoods tied to passing tourists and the tourism cycles of Borjomi–Likani and Bakuriani;
- Limited permanent employment opportunities and a reliance on small-scale hospitality, roadside commerce, or temporary migration;
- Underdeveloped physical and service infrastructure constrains their potential to function as autonomous development nodes.

These corridor villages operate as intermediary spaces within the municipality's spatial system but lack sufficient functional specialization or investment to generate sustained economic activity.

Seasonal Dynamics and Implications for Local Livelihoods – Seasonality emerged as a central theme in the research, shaping household strategies, business operations, and spatial interactions:

- Summer constitutes the primary peak season in Borjomi–Likani, while winter dominates in Bakuriani, creating dual but unaligned seasonal cycles;
- Corridor villages rely heavily on short periods of tourism-driven demand, making income highly volatile;
- Mixed livelihood strategies, including temporary out-migration to Tbilisi or other urban centers, are widespread among working-age residents;
- Local agricultural producers face systemic barriers—including small production volumes, certification requirements, and logistical challenges—preventing them from entering tourism-related supply chains.

Consequently, a significant share of goods consumed in Borjomi and Bakuriani is imported from major cities, resulting in weak local value-chain integration and missed economic opportunities for rural households (See Table).

Functional Linkages, Mobility Patterns, and Spatial Interactions – The research highlights substantial disparities in the strength and direction of functional linkages among the nodes:

- Borjomi–Bakuriani mobility flows are strong but highly seasonal, reflecting the tourism calendar and road accessibility;
- Corridor villages benefit from transit flows, but their economic engagement remains marginal due to limited-service diversification;
- Backward linkages between tourism enterprises and rural producers are weak, diminishing potential multiplier effects within the municipality;
- Infrastructure quality and winter road conditions significantly influence the fluidity of spatial interactions, particularly between Bakuriani and smaller villages.

These patterns underline that spatial proximi-

Table. Functional characteristics of the three dominant nodes (author's own)

Node / Area	Main Functions	Dominant Economic Activities	Seasonality Level	Infrastructure Condition	Role in Municipal System
Borjomi–Likani	Administrative, health-tourism, services	Hospitality, public services, wellness tourism	Moderate	High	Core urban and service hub
Bakuriani	Mountain resort, sports tourism	Hotels, rentals, winter sports industry	Very high (winter peak)	Developed but overloaded in peak periods	Secondary center with growing investment demand
Seasonal Villages	Rural tourism, summer recreation	Guesthouses, small-scale services	High (summer peak, winter drop)	Low to medium	Peripheral settlements dependent on core nodes

ty does not automatically translate into functional integration—connectivity, economic incentives, and institutional support play decisive roles.

Structural Challenges to Balanced Spatial Development – The analysis identifies several structural barriers that hinder balanced development across the municipality:

- Strong dependence on tourism and narrow functional specialization create vulnerability to seasonal and external shocks;
- Insufficient year-round employment opportunities outside Borjomi–Likani, contributing to labor out-migration;
- Demographic pressures, including seasonal depopulation and long-term population decline in smaller settlements;
- Fragmented territorial planning processes often lack strategic coordination between economic, tourism, and spatial development policies;
- Weak integration of rural production systems into urban tourism markets is limiting the emergence of local value chains.

These challenges collectively constrain the municipality's ability to strengthen its polycentric structure and develop resilient functional zones.

CONCLUSION

The research demonstrates that Borjomi Municipality's development trajectory is fundamentally shaped by its polycentric but asymmetrical spatial structure, where three dominant nodes—Borjomi–Likani, Bakuriani, and the seasonal corridor villages—perform distinct and unequally developed functions. Field observations, interviews, and comparative spatial analysis reveal that while the municipality possesses strong tourism assets and significant economic potential, these benefits are distributed unevenly across the territory. Borjomi–Likani functions as a consolidated year-round administrative and service center, while Bakuriani has evolved into a rapidly transforming, investment-driven mountain resort with strong winter specialization. In contrast, the corridor villages remain structurally peripheral, with livelihoods tied to highly seasonal demand and insufficient integration into municipal development processes.

Seasonality emerged as the most influential factor shaping economic activity, mobility patterns, and household strategies. Divergent seasonal cycles between Borjomi–Likani (summer peak) and Bakuriani (winter peak) create temporal fragmentation within the municipality, limiting opportunities for stable year-round employ-

ment and reinforcing dependency on short peak periods. This, in turn, contributes to temporary migration, income volatility, and uneven service provision. Furthermore, the research highlights a major structural challenge: the weak integration of local agricultural producers into tourism-sector value chains. Despite strong theoretical potential for rural–urban economic synergies, empirical evidence shows persistent logistical, quality-standard, and institutional gaps that prevent local producers from supplying hotels and restaurants in either main node.

The findings also reveal that functional linkages between nodes—although geographically proximate—are insufficiently coordinated. Transport connectivity, road quality, and winter accessibility affect mobility patterns, while fragmented planning processes and limited inter-sectoral coordination weaken opportunities for integrated spatial development. Together, these dynamics underscore that Borjomi's current spatial configuration is neither fully cohesive nor economically optimized. Strengthening polycentricity therefore requires more than the existence of multiple nodes—it requires policy instruments that enhance their complementarities, reduce disparities, and support functional diversification across the municipality.

Overall, the study contributes to regional development literature by empirically illustrating how spatial organization, functional specialization, and seasonality jointly produce uneven development outcomes in mountainous municipalities. A place-based, polycentric planning approach presents a viable path forward, but only if supported by targeted interventions that address structural constraints and promote more balanced territorial development.

RECOMMENDATIONS

Based on the research findings, several policy and planning recommendations emerge that could support more equitable and resilient spatial development in Borjomi Municipality. These recommendations emphasize the need for integrated territorial strategies, diversified economic functions, and strengthened local value chains[14].

Strengthen Functional Polycentricity through Coordinated Spatial Planning – The municipality should adopt a more explicit polycentric development framework, recognizing the differentiated roles of Borjomi–Likani, Bakuriani, and the corridor villages. Strategic spatial planning should ensure:

- coordinated investments across nodes rather than isolated, project-based interventions;
- development of complementary functions rather than duplication of services;
- balanced allocation of infrastructure and public services to reduce peripheral disadvantage.

Reduce Seasonal Vulnerability through Economic Diversification – Given the dual and unaligned seasonal cycles, the municipality should promote activities capable of providing year-round income. This includes:

- expanding wellness, eco-tourism, and cultural tourism in Borjomi–Likani beyond peak periods;
- supporting off-season tourism offerings in Bakuriani to extend its economic calendar;
- incentivizing small-scale, experience-based tourism (e.g., agro-tourism, homestays) in corridor villages to stabilize local incomes.

Improve Rural–Urban Value Chain Integration – To address weak backward linkages between tourism enterprises and local producers, the following measures are recommended:

- establishing aggregation, storage, or logis-

14 Keshelashvili, G. (2024). The role of business in achieving sustainable development and need of changes in managerial attitude: The case of Georgia. Proceedings of the International Conference on Economics, Finance & Business, Vienna, 2024, pp. 37–49. International Institute of Social and Economic Sciences. <https://doi.org/10.20472/EFC.2024.020.003>; Keshelashvili, G. (2025). Sustainable business practices in Georgian SMEs: Assessment, needs, and strategic perspectives. International Journal of Social Sciences, 14(1), 35–51. <https://doi.org/10.52950/SS.2025.14.1.003>; Kharaishvili, E., Talikadze, N. (2022). Competitiveness characteristics of agri-food products – What does the consumer choose? (Case of Georgia). Innovative Marketing, 18(1), 195–207. <https://doi.org/10.21511/im.18(1).2022.16>.

tics centers to consolidate small farm outputs;
- supporting producers in meeting certification and quality standards required by hotels and restaurants;
- creating municipal partnership programs that connect farmers directly with tourism businesses (e.g., "Buy Local Borjomi" initiatives);
- introducing training programs on processing, packaging, and supply-chain management.

Enhance Transport and Mobility Infrastructure – Reliable connectivity is essential for spatial cohesion. Investments should prioritize:

1. improved winter road maintenance between Borjomi and Bakuriani;
2. upgraded public transport options to strengthen functional mobility between villages and main centers;
3. accessibility enhancements in corridor villages, enabling them to participate more actively in tourism flows.

Address Demographic Pressures and Support Peripheral Settlements – Smaller settlements require targeted interventions to mitigate depopulation and ensure long-term resilience. Recommended actions include:

- decentralizing select administrative or social services into larger villages;
- improving digital infrastructure to support remote work and small service businesses;
- providing incentives for young households and entrepreneurs to remain in or relocate to peripheral areas.

Strengthen Institutional Coordination and Strategic Governance – The research identifies fragmented planning as a major constraint. To overcome this:

- municipal authorities should integrate spatial, tourism, agricultural, and economic strategies into a unified development framework;
- inter-agency and public–private cooperation should be enhanced to ensure coherent policy implementation;
- Data collection and monitoring systems should be improved to enable evidence-based decision-making.

REFERENCES:

Amin, A. (2004). Regions unbound: Towards a new politics of place. *Geografiska Annaler: Series B, Human Geography, 86*(1). <https://doi.org/10.1111/j.0435-3684.2004.00152.x>;

Barca, F. (2009). *An agenda for a reformed cohesion policy: A place-based approach to meeting European Union challenges and expectations.* European Commission;

Bedianashvili, G. (2018). Culture as a factor of knowledge economics with paradigmatic changes in systemic institutional context. Globalization and Business, 4(6). <https://doi.org/10.35945/gb.2018.06.007>. (in Georgian);

Bedianashvili, G. (2022). The problem of assessing the expected consequences of economic policy. Globalization and Business, 7(13), 17–24. <https://doi.org/10.35945/gb.2022.13.002>. (in Georgian);

Bedianashvili, G., Ivanov, Y. B., Paientko, T. V. (2019). Tax reforms in Ukraine and Georgia: Changing priorities. Journal of Tax Reform, 5(2), 107–128. <https://doi.org/10.15826/jtr.2019.5.2.063>;

Briedenhann, J., Wickens, E. (2004). Tourism routes as a tool for the economic development of rural areas—Vibrant hope or impossible dream? *Tourism Management, 25*(1). <https://doi.org/10.1016/S0261-5177(03)00063-3>;

ESPON. (2019). *ESPON Policy Brief: The territorial dimension of future EU policies.* European Spatial Planning Observatory Network;

Fujita, M., Krugman, P., Venables, A. J. (1999). *The spatial economy: Cities, regions, and international trade.* MIT Press;

Jibuti, M. (2025). Enhancing regional development in Georgia: Integrating functional spatial planning and land use modeling for sustainable economic growth. *International Journal of Social Sciences, 14*(1), 23–34. <https://doi.org/10.52950/SS.2025.14.1.002>;

Jibuti, M. (2021). *On the usage of old and modern technologies for economic sustainability. Globalization and Business*, 6(11), 97-100. <https://doi.org/10.35945/gb.2021.11.013>;

Jibuti, M. (2019). Administrative division, regions of Georgia and their characteristics. *Globalization and Business, 4*(8). <https://doi.org/10.35945/gb.2019.08.016>;

Keshelashvili, G. (2016). *General strategies of Georgian winemaking companies' management in the conditions of integrated development*. In *Proceedings of the 23rd International Academic Conference, Venice (pp. 242-251).* IISES. <https://doi.org/10.20472/IAC.2016.023.049>;

Keshelashvili, G. (2017). *Characteristics of management of agricultural cooperatives in Georgia.* In *Proceedings of the 32nd International Academic Conference, Geneva* (pp. 207–218). IISES. <https://doi.org/10.20472/IAC.2017.032.020>;

Keshelashvili, G. (2018). Value chain management in agribusiness. *International Journal of Business and Management, 6*(2). <https://doi.org/10.20472/BM.2018.6.2.004>;

Keshelashvili, G. (2024*). The role of business in achieving sustainable development and need of changes in managerial attitude: The case of Georgia*. Proceedings of the International Conference on Economics, Finance & Business, Vienna, 2024, pp. 37–49. International Institute of Social and Economic Sciences. <https://doi.org/10.20472/EFC.2024.020.003>;

Keshelashvili, G. (2025*). Sustainable business practices in Georgian SMEs: Assessment, needs, and strategic perspectives.* International Journal of Social Sciences, 14(1), 35–51. <https://doi.org/10.52950/SS.2025.14.1.003>;

Kharaishvili, E. (2020). Methodological features of determining the level of competitiveness in the agri-food sector of Georgia. *Globalization and Business, 5*(10). <https://doi.org/10.35945/gb.2020.10.004>. *(in Georgian);*

Kharaishvili, E., Suknishvili, M. (2021). Agribusiness development trends in Georgia: Modern challenges and solutions. *Economic. Ecology. Socium, 5*(4). <https://doi.org/10.31520/2616-7107/2021.5.4-4>;

Kharaishvili, E., & Talikadze, N. (2022). Competitiveness characteristics of agri-food products – What does the consumer choose? (Case of Georgia). Innovative Marketing, 18(1), 195–207. <https://doi.org/10.21511/im.18(1).2022.16>;

Meijers, E. (2008). Measuring polycentricity and its promises. European Planning Studies, 16(9). <https://doi.org/10.1080/09654310802401805>;

Mekvabishvili, E. (2019). The economic role of the state in conditions of globalization. Globalization and Business, 4(8). <https://doi.org/10.35945/gb.2019.08.002>;

Mekvabishvili, E. (2020). The anti-crisis role of the state (Based on the experience of the global financial and corona-economic crisis). Globalization and Business, 7(10), 35–41. <https://doi.org/10.35945/gb.2020.10.003>;

Nepal, S. K., Saarinen, J. (2016). Political ecology and tourism. Routledge;

Papava, V. (2014). The catch-up effect and regional comparisons of growth indicators: With the East-

ern Partnership countries as an example. Problems of Economic Transition, 57(3). <https://doi.org/10.2753/PET1061-1991570301>;

Papava, V. (2014). Georgia's economy: The search for a development model. Problems of Economic Transition, 57(3), 13–24. <https://doi.org/10.2753/PET1061-1991570304>;

Papava, V. (2017). A Eurasian or a European future for post-Soviet Georgia's economic development: Which is better? Archives of Business Research, 5(1), 159–170. <https://doi.org/10.14738/abr.51.2651>;

Silagadze, A. (2013). Priorities for the economy of postcommunist Georgia in the context of the world financial crisis. Problems of Economic Transition, 56(8). <https://doi.org/10.2753/PET1061-1991560801>;

Silagadze, A. (2022). Contemporary global economic trends: Transitional economies during Covid Depression. Bulletin of the Georgian National Academy of Sciences, 16(3).

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ARTICLE

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FROM INDIVIDUAL TO COLLECTIVE: A CRITICAL REVIEW OF TECHNOLOGY ACCEPTANCE AND ORGANIZATIONAL KNOWLEDGE

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Abstract. *The Technology Acceptance Model is one of the most employed frameworks applied by academics worldwide to explain why individuals accept or do not use technology. Since then, several studies have confirmed the influence of Internal Beliefs on Attitude and Behavioral Intention toward technology, preceded by a wide range of external factors. Domain-relevant knowledge is a crucial external factor in determining users' behavioral intention to use enterprise resource technology systems, corroborating findings from the technology acceptance model. From a literature scope review, we explore a different and complementary approach regarding knowledge, not only as an external factor, but as a component of the organizational cycle of knowledge creation. The consideration of organizational knowledge creation processes and the nature of the technology used by individuals may bring new light to behavioral intention studies, tying together different study fields, and allowing further academic research work to provide constructive insights and contributions in the quest to determine where the individual's technology acceptance fits in dynamic organizational knowledge creation.*

KEYWORDS: TECHNOLOGY ACCEPTANCE MODEL, ORGANIZATIONAL KNOWLEDGE, INFORMATION TECHNOLOGY.

INTRODUCTION

The proliferation of knowledge and information technologies has profoundly reshaped work and economic structures,[1] transforming practices across industries and professions.[2] The main reason behind the development and adoption of technologies in organizations is the increase in human efficiency and effectiveness in the practice of routines.[3] The advancement of information system technologies enables organizations to enhance efficiency, reduce costs, and improve information management, strengthening decision-making and enabling novel operational capabilities,[4] making research on the adoption and use of systems relevant in academic and working realms.

Research on individual information system adoption is mature, providing established theories that explain adoption determinants and emphasizing the significance of technology acceptance behavior for successful system implementation.[5] The Technology Acceptance Model (TAM) is a widely recognized and highly predictive framework for understanding technology adoption and use,[6] characterized by its parsimony, specific constructs, robust theoretical foundation, applied across various technologies, expertise levels, and countries.[7]

While individual system use is often considered voluntary, organizational contexts frequently dictate adoption, driven by organizational needs rather than solely individual beliefs.[8] Consequently, organizational technology acceptance reflects both individual preferences and organizational dynamics that foster knowledge development.[9] The use of information systems can involve individuals in organizational knowledge creation, where systems process and disseminate information, thereby amplifying knowledge scope.[10] Outside organizational contexts, understanding adoption at an individual level has limited practical value.[11] Recognizing these organizational and individual factors within firms, this paper investigates the influence of organizational dynamics and information system characteristics on individual technology acceptance.

This research integrates literature conceptualization findings from the TAM with the Organizational Dynamic Knowledge Creation theory to understand the evolution of beliefs and intentions toward information systems as a process shaped by organizational dynamics driving knowledge creation. This study highlights findings in the literature of the potential influence of organizational group-thinking on individual adoption, a recognized limitation in TAM research.[12]

The present manuscript is divided as follows: We first work on finding organizational knowledge creation factors explored and considered in technology acceptance theory literature. By applying a scope analysis, we aim to provide an organizational explanation to technology acceptance factors, such as behavioral intention, beliefs, and attitude, followed by a conceptualization of organizational knowledge from a technology individual use perspective. Finally, we close by elaborating on discussion points regarding organizational dy-

1 Powell, W. W., Snellman, K. (2004). The Knowledge Economy. Annual Review of Sociology, (30), 199-220.

2 Swanson, E. B. (2019). Technology as a Routine Capability. MIS Quarterly, 43(3), 1007-1024.

3 Murray, A., Rhymer, J., Sirmon, D.G. (2021). Humans and Technology: Forms of Cojoined Agency in Organizations. Academy of Management Review, 46(3), 552-571.

4 Anthony, C. (2018). To Question or Accept? How Status Differences Influence Responses to New Epistemic Technologies in Knowledge Work. Academy of Management Review, 43(4), 661-679.

5 Jen, W., Lu, T., Liu, P. T. (2009). An Integrated Analysis of Technology Acceptance Behavior Models: Comparison of Three Major Models. MIS Review, 15(1), 89-121.

6 Venkatesh, V., Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. Decision Sciences, 39(2), 273-315.

7 Gefen, D., Kaharanna, E., Straub, D. W. (2003). Trust and TAM in Online Shopping: An Integrated Model. MIS Quarterly, 27 (1), 51-90.

8 Davis, F., Bagozzi, R., Warshaw, P. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science, 35(8), 982-1003.

9 Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. Organization Science, 5(1), 14-37.

10 Ibid.

11 Venkatesh, V., Bala, H. (2008). Ibid.

12 Mullins, J. K., Cronan, T. P. (2021). Enterprise Systems Knowledge, Beliefs, and Attitude: A Model of Informed Technology Acceptance. International Journal of Information Management, 59 (2021), 102348.

namics and technology acceptance and providing theoretical and practical implications.

1. LITERATURE REVIEW

1.1. Technology Acceptance Model

The TAM aims to capture critical aspects of information technology through a set of quantitative surrogates – beliefs, attitudes, and intention – to understand what motivates users to accept and use new technology.[13] The judgments regarding the usefulness and ease of use of a technology generate behavioral intentions that affect the individual's willingness to use and the actual use behavior.[14] The TAM is deemed capable of explaining user behavior across a broad range of research contexts[15] while at the same time being both parsimonious and theoretically justified[16] thanks to its core variables – perceived usefulness and perceived ease of use,[17] with substantial empirical support.[18]

1.2. Behavioral intention

Behavioral Intention (BI) is a function of salient information or beliefs set to measure the strength of an individual's intention to perform a specified behavior.[19] The TAM postulates that BI is the major determinant of usage behavior; that behavior should be predictable from measures of BI, and any other factors influencing use behavior do so indirectly by influencing BI.[20] Technology use intention is based on the rational intention that captures the motivational factors that influence users' behavior, indicating how much effort an individual could exert to perform a behavior[21] and to initiate and formalize knowledge.[22] Technology use, action, and practice[23] are the factors that give shape to the flow of information acquired by individuals, organizing and creating knowledge, anchored on the commitment and beliefs of the holder.[24]

An undesirable outcome of the application of the TAM has been the intensive focus on the prediction or explanation of system use, defined and operationalized as an amount or frequency.[25] In fact, most system acceptance studies do not measure system use, but rather measure variance in self-reported use, hence the construct Intention becomes a non-precise measure of actual system use.[26] The relationship between intention and usage appears to be dependent on the measurement method: when usage is measured as self-report, intentions do predict usage, but when actual usage is measured, intentions do not predict usage.[27] In theory, the construct Intention must work as a precise measure of future, or even present use; however, it rather shows different results in the

13 Orlikowski, W., Iacono, C. S. (2001). Research Commentary: Desperately Seeking the "IT" in IT Research – A Call to Theorizing the IT Artifact. Information Systems Research, 12(2), 121-134.

14 Yang, L., Sheng, X., Lin, J., Wang, W., Wu, W., Lin, R., Liu, A., Liu, L. (2025). Acceptance Scale for Traditional Chinese Medicine Techniques in Cancer Patients: Development and Validation. Patients: Preference and Adherence, 2025(19), 305-3225. <DOI:10.2147/PPA.S550541>.

15 Muller, S., von Kramer, A., Tonnies, J., Wildenauer, A., Wensing, M., Friederich, H. C., Haun, M. K. (2025). Engaging Underrepresented Patient Groups in Specialized Treatment – Qualitative Results from the PROVIDE-C Randomized Trial on Integral Mental Health Video Consultations for Depression and Anxiety. BMC Public Health (2025) 25:3817. <DOI:10.1186/s12889-025-25235-1>.

16 Davis et al. (1989). Ibid.

17 Alsharida, R. A., Hammood, M. M., Al-Emran, M. (2021). Mobile Learning Adoption: A Systematic Review of the Technology Acceptance Model from 2017 to 2020. International Journal of Emerging Technologies in Learning, 16(5), 147-162.

18 Venkatesh, V., Bala, H. (2008). Ibid.

19 Davis et al. (1989). Ibid.

20 Ibid.

21 Ajzen, I. (1991). The Theory of Planned Behavior. Organizational Behavior and Human Decision Processes, 50(2), 179-211.

22 Nonaka, I. (1994). Ibid.

23 Monteiro, E., Parmiggiani, E. (2019). Synthetic Knowledge: The Politics of the Internet of Things. MIS Quarterly, 43(1), 167-184.

24 Nonaka, I. (1994). Ibid.

25 Benbasat, I., Barki, H. (2007). Quo Vadis, TAM? Journal of the Association for Information Systems, 8(4), 211-218.

26 Legris, P., Ingham, J., Collerette, P. (2003). Why do People use Information Technology? A Critical Review of the Technology Acceptance Model. Information & Management, 40 (2003), 191-204.

27 Szajna, B. (1996). Empirical Evaluation of the Revised Technology Acceptance Model. Management Science, 42(1), 85-92.

literature.[28] TAM measures of behavioral intention are not focused on an overall behavioral measure; hence, the interpretation of the TAM must keep in mind a "narrower conceptualization of intended behavior".[29] Literature explains that time is the basis of the difference between intentions and action;[30] in this way, when intentions measure system's pre-implementation usage, they cannot include the additional information that the subjects may acquire by the time of the post-implementation intention measures, information accumulated by experiencing system use.[31] By treating BI as a terminal goal for human action, researchers fail to consider the fact that several actions are taken not as ends in and of themselves, rather as means of more fundamental ends or goals.[32]

1.3. Beliefs

In TAM, beliefs are defined as the individual's subjective probability that performing a target behavior will result in a certain consequence,[33] suggesting two main determinants: Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). PEOU indicates the cognitive effort needed to learn and to utilize the new system, while PU measures the individual subjective assessment of the utility offered by the new system,[34] with PEOU being an antecedent of PU.[35]

As users' beliefs about their ability to successfully complete tasks by using a system increase, they will perceive the system as being easier to use.[36] Similarly, as users' beliefs about the positive relationship between system's use and performance increase, they will perceive that using a system provides benefits within organizational contexts.[37] TAM literature conceptualizes a hierarchy between the two belief variables, where PU is a major determinant of people's intentions to use a system, while PEOU works on a secondary level.[38] The implication of this hierarchy of beliefs is that, unless users perceive a system as being useful at first, its ease of use has no effect on the formation of intentions; however, ease of use does have some effect on how useful an individual perceives a system,[39] it doesn't matter for them how easy it could be to operate the system if it does not perform a useful function within their organizational context.[40] Likewise, the more experience regarding system use over time, the less relevant the system's ease of use will be, while, at the same time, it will increase the beliefs of the system's usefulness,[41] leading to knowledge from a process of creation and manipulation of beliefs that conveys to users with perspectives that help them with their context's perceptions and definitions.[42]

1.4. Attitude

Attitude is defined as an individual's positive or negative feelings about performing a target behavior.[43] Attitude as a predictor of human behavior is determined by the product of the user's salient beliefs about the consequences of performing the behavior multiplied by the evaluation of those consequences.[44] Both intention and behavior are motivated by attitude as an overall affective evaluation toward a system, based on a set of cognitive beliefs about the system in question.[45] Individuals with higher levels of knowledge about a system will manifest enhanced beliefs about the system's perceived ease of use and perceived usefulness, subsequently influencing a stronger attitude toward it.[46]

28 Legris et al. (2003). Ibid.
29 Gefen et al. (2003). Ibid.
30 Bandura, A. (2001). Social Cognitive Theory: An Agentic Perspective. Annual Review of Psychology, 52, 1-26.
31 Szajna, B. (1996). Ibid.
32 Bagozzi, R. P. (2007). The Legacy of the Technology Acceptance Model and a Proposal for Paradigm Shift. Journal of the Association for Information Systems, 8(4), 244-254.
33 Davis et al. (1989). Ibid.
34 Gefen et al. (2003). Ibid.
35 Venkatesh, V., Bala, H. (2008). Ibid.
36 Mullins, J. K., Cronan, T. P. (2021). Ibid.
37 Davis et al. (1989). Ibid.
38 Ibid.
39 Szajna, B. (1996). Ibid.
40 Davis et al. (1989). Ibid.
41 Venkatesh, V., Bala, H. (2008). Ibid.
42 Nonaka, I. (1994). Ibid.
43 Davis et al. (1989). Ibid.
44 Ibid.
45 Mullins, J. K., Cronan, T. P. (2021). Ibid.
46 Ibid.

Revised versions of the TAM make no consideration of attitude as a predictor of behavioral intention.[47] Within organizational settings, system users form intentions toward behaviors they believe will increase their job performance, over and above whatever positive or negative feeling may be evoked toward the very behavior.[48] Hence, the attitude formed by personal beliefs about a system is of secondary relevance regarding the intention of using a system to perform job-related operations.[49] Direct belief-intention relationships have been observed, contrary to the fact that attitudes fully mediate the effects of beliefs on intention.[50]

1.5. Organizational knowledge

From an organizational perspective, knowledge refers to the relatively formal and facts, rules, policies, and procedures within the organization,[51] as an emergent product of a situated context of individuals' lives and work.[52] Every activity performed by people working in an organization creates and gives shape to the organization's knowledge. The creation, transfer, and integration of knowledge is an important reason firms exist,[53] being embedded in the skills of employees, as well as in processes, policies, and information repositories.[54]

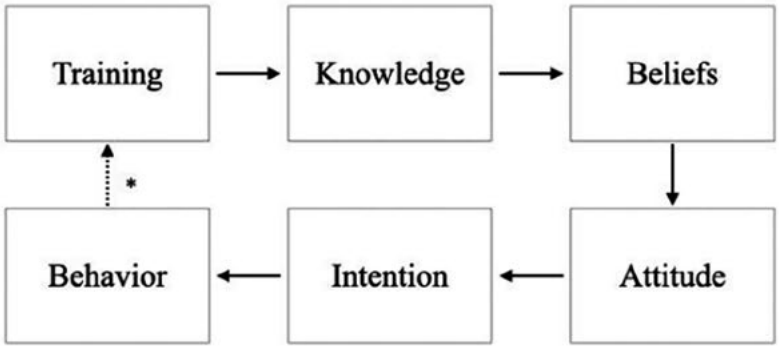
Organizations exist because they reduce the cost of using the "price mechanism" to organize production and the cost of negotiating and concluding transactions individually.[55] To solve economic problems by constructing "a rational economic order", individuals within an organization "must make use of the knowledge of circumstances" that exists dispersed, incomplete, and frequently contradictory by individuals.[56] Securing the best use of knowledge implies communication between individuals aimed at building mutual understanding; thus, the communication factor of knowledge consequently builds, amplifies, and develops new knowledge from individuals within the organization.[57] Communication among individuals leads to organizational alignment of mission, objectives, and plans,[58] creating knowledge readily available that enhances individuals' information-processing capabilities in a great way.[59]

By establishing communities with shared identity, norms, sequences, and patterns, organizations lower the cost of communication and coordination of knowledge, creating a shared knowledge context that enables the development of new knowledge and capabilities through the recombination of existing knowledge,[60] fostering regular and predictable patterns of activity – organizational routines – that govern coordinated activities within organizations.[61] Thus, decision making in group contexts refers to acting out of congruence between one's own and group's shared values or goals, in a process of internalization that is developed through processes of socialization, psychological development, education, training, and indoctrination in organizations, developing a combination of compliance and internalization within the reference group, operating when a person sees oneself as an individual but in a relationship to a group.[62]

Collective intentions related to technology acceptance are rooted in everyone's self-conception as a member of an organization, where the individual's actions are conceived as either the group

47 Venkatesh, V., Bala, H. (2008). Ibid.
48 Davis et al. (1989). Ibid.
49 Szajna, B. (1996). Ibid.
50 Venkatesh, V., Bala, H. (2008). Ibid.
51 Nass, C. (1994). Knowledge or Skills: Which do Administrators Learn from Experience? Organization Science, 5(1), 38-50.
52 Monteiro, E., Parmiggiani, E. (2019). Ibid.
53 Karim, S., Kaul, A. (2015). Structural Recombination and Innovation: Unlocking Intraorganizational Knowledge Synergy Through Structural Change. Organization Science, 26(2), 439-455.
54 Bharadwaj, A. S. (2000). A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation. MIS Quarterly, 24(1), 169-196.
55 Coase, R. H. (1937). The Nature of the Firm. Economica. Blackwell Publishing, 4(16), 386-405.
56 Hayek, F. A. (1945). The Use of Knowledge in Society. American Economic Review, 35(4), 519-520.
57 Nonaka, I. (1994). Ibid.
58 Reich, B. H., Benbasat, I. (2000). Factors that Influence the Social Dimension of Alignment Between Business and Information Technology Objectives. MIS Quarterly, 24(1), 81-113.
59 Nass, C. (1994). Ibid.
60 Karim, S., Kaul, A. (2015). Ibid.
61 Bharadwaj, A. S. (2000). Ibid.
62 Bagozzi, R. P. (2007). Ibid.

Figure 1. Diagram of the effects of Knowledge on Intention and Behavior (from authors)



* The work from Mullins & Cronan (2021) addresses the importance of domain-relevant knowledge in the formation of beliefs and attitudes toward a system, developing a model of informed technology acceptance. The hypothesized path form Behavior to Training responds to the process of amplification of knowledge created by individuals, crystallizing it as part of the knowledge network of the organization (Nonaka, 1994)

acting as a unit or the person acting as an agent of the group.[63] Such collective behavior can be understood thanks to the concept of organizational commitment, which represents a psychological bond that individuals form with an organization that stabilizes their behaviors toward the organization. Thus, regarding organizational knowledge and acceptance of technology, the limitation of TAM, as a technology proxy study, deals with technologies through surrogates – factors that conceptualize internal beliefs, attitudes, and intentions toward technologies-, it tends not to conceive of historical or cultural variations in information technology artifacts, given that those variations may not be evident in the surrogates' measures.[64]

2. DISCUSSIONS

2.1. The sufficiency of the Technology Acceptance Model

Much of human behavior is not best characterized by an individual action in isolation, where decisions regarding technology acceptance and actual usage are often made collaboratively or with an aim to how they fit in with, or affect other people or group requisites.[65] A limitation of the TAM is the fact that the model considers information system acceptance to be an independent individual issue rather than part of organizational dynamics.[66] Therefore, *while measuring individual intentions, how to ensure the consideration of organizational knowledge effects?* Figure 1 illustrates the proposed path within the theorized influence of knowledge on behavior: knowledge gain system and training affect users' beliefs about their own ability to successfully use a system, the amount of effort required to use a system, and the direct benefits of using a system, beliefs that in turn shape the overall attitude toward the system, and ultimately influence their intentions and behaviors (See Fig.1).

Over the years, the individual construct additions made to the TAM have been justified by researchers; however, in the final analysis, this construct-addition approach has basically provided explanations or antecedents for the core TAM belief perceptions – PU and PEU – via another set of belief perceptions, without increasing the knowledge of what makes an information technology useful,[67] lacking the means to account for temporal and contextual variations in socio-psychological and socio-economical patterns.[68]

63 Ibid.
64 Orlikowski, W., Iacono, C. S. (2001). Ibid.
65 Bagozzi, R. P. (2007). Ibid.
66 Legris et al. (2003). Ibid.
67 Benbasat, I., Barki, H. (2007). Ibid.
68 Orlikowski, W., Iacono, C. S. (2001). Ibid.

To continue using the life-long TAM constructs in a changing technology context threatens our capability to understand present and future phenomena.[69] Some other limitations present in most of the TAM research works are related to self-reported use as a measurement of actual use, for it does not accurately reflect actual behavior and actual usage.[70] The constructs employed in technology acceptance research are inferred indirectly from behavioral proxies rather than measured explicitly, creating a sense of speculation about their conclusions.[71]

2.2. The relevance of organizational knowledge in technology acceptance

Based on the resource-based view of the firm, organizational knowledge creates competitive advantage and organizational capability, comprising the training, experience, relationships, and insights of organizational human resources.[72] Information technologies do not influence organizations' performance directly, but the relationships existing between these technologies and other resources and organizational capabilities mediate the value creation process.[73] The knowledge derived from individual use of technology may not only contribute to organizational performance, but also the organization's workflow may depend more heavily on the individual's knowledge.[74] The account for the impact of organizational dynamics that create knowledge within the organization is yet to be addressed by employing quantitative methods in academic literature. Hence, we propose the continuation of research work on this field, furthermore needed due to the new holistic capabilities from modern information systems employed in organizations.

2.3. The relevance of the information technology instrument in technology acceptance

The core premise of information system studies is based on the centrality of emerging technologies reshaping management practices and changing the nature of work in an organization.[75] However, the economic analysis of technological innovation includes several factors that might be expected to influence innovation, except for any discussion of the technology itself.[76]

The implementation and effective application of information systems must follow a correct analysis of how the technological instrument fits within the dynamics of the organization and how this implementation process is going to affect such dynamics, following a pattern where the management proceeds with disjoint periods of intensive implementation, rather than with continuous improvement.[77] The fact that information systems are becoming increasingly complex has implications for IT adoption decision processes and managerial implementation decisions,[78] where organizational institutions and processes support the sharing of knowledge within institutions and facilitate collaboration in linking available knowledge into practice.[79] Therefore, it is important to

69 Compeau, D., Correia, J., Thatcher, J.B. (2022). When Constructs Become Obsolete: A Systematic Approach to Evaluating and Updating Constructs for Information Systems Research. MIS Quarterly, 46(2), 679-711.

70 Szajna, B. (1996). Ibid.

71 Figueiredo, D., Schonewille, M. (2025). Instructor-centered Case Generation with GenAI: A Design-based Exploration. Journal of Ethics in Entrepreneurship and Technology. <DOI:10.1108/JEET-06-2025-0038>.

72 Bharadwaj, A. S. (2000). Ibid.

73 Felipe, C. M., Leidner, D. E., Roldan, J. L., Leal-Rodriguez, A. L. (2020). Impact of IS Capabilities on Firm Performance: The Roles of Organizational Agility and Industry Technology Intensity. Decision Sciences, 51(3), 575-619.

74 Stadler, C., Helfat, C., Verona, G. (2022). Transferring Knowledge by Transferring Individuals: Innovative Technology Usage and Organizational Performance in Multi-Unit Firms. Organizational Science, 33(1), 253-274.

75 Philip, J. (2022). A Perspective of Embracing Emerging Technologies Research for Organizational Behavior. Organization Management Journal, 19(3), 88-98.

76 Orlikowski, W., Iacono, C.S. (2001). Ibid.

77 Legris et al. (2003). Ibid.

78 Venkatesh, V., Bala, H. (2008). Ibid.

79 Kork, A-A., Martinnen, M., Laihonen, H., Ruusuvuori, J., Ahonen, J. E., and Kankaanpää, E. (2025). Implementing Clinical Practice Guidelines into Action: A Qualitative Study of Managing Knowledge Translation in Primary Care Organizations. Health Research

mention that the proper application of technological change in an organization requires important leadership skills, such as awareness, acceleration, and harmonization of digital transformation.[80]

3. LIMITATIONS

While this review provides a comprehensive analysis of existing literature, we acknowledge certain limitations.

Firstly, despite the theoretical proposition of a link between "Behavior" and "Training" within our framework (as depicted in Figure 1), the current review is constrained by the absence of quantitative data to empirically validate this hypothesized relationship. While literature provides conceptual support for this connection, the lack of quantitative evidence requires further investigation. A mixed-methods approach, combining qualitative literature insights with quantitative empirical evidence, would offer a more comprehensive understanding of the organizational nature of technology acceptance.

Secondly, this research has focused on examining the constructs within the TAM and their relevance to organizational knowledge creation dynamics. While this analysis provides valuable insights, it does not include a comparative analysis of other important technology acceptance models and their applicability to understanding organizational knowledge creation. Future academic work could explore alternative models, such as the Unified Theory of Acceptance and Use of Technology (UTAUT) or the Innovation Diffusion Theory, in the context of organizational knowledge dynamics, offering a more comprehensive understanding of different perspectives on technological adoption within organizations and its impact on knowledge creation processes.

Thirdly, the well-established nature of technology acceptance theories presents both advantages and limitations. TAM literature provides a robust theoretical foundation, but it also raises the potential for findings to appear repetitive, diminishing the perceived novelty of current research. This review focuses on analyzing influential publications within the TAM domain to explore evidence of the organizational character of individual technology adoption in renowned academic papers. By re-evaluating these established contributions through the lens of organizational knowledge creation, this research aims to offer a fresh perspective on the insights provided by these foundational works, acknowledging the evolutionary nature of academic inquiry, where established theories are continually re-examined and re-interpreted, considering evolving organizational contexts.

CONCLUSION

From a thorough scoping review of academic literature, we conclude that individual information system acceptance is shaped by organizational dynamics that create and amplify organizational knowledge. There is sufficient evidence in the literature to affirm that the acceptance and use of information systems in organizational contexts respond to organizational goals and commitments rather than individual beliefs and attitudes alone. Likewise, users adapt their behavior and use practices to the complex characteristics of modern information systems, which not only serve a single determined task, but combine several levels of action to collect, process, analyze, share, visualize, and recommend improvement at once.

Technology acceptance is a vibrant field of academic research, much needed to bring understanding of the fast-paced development of technologies that become more complex and autonomous. Investigating current trends in technology adoption by applying older methods, such as TAM, could impact the credibility of the studies by resulting in reporting significant results that may not happen when applying novel methods. Thus, the need to perform analysis with different models and methodologies and comparing the results of the mentioned could bring a clear understanding of current technology acceptance that shows change over time.

Policy and Systems (2025) 23:130. <DOI:10.1186/s12961-025-01402-z>.

80 Hanelt, A., Bohnsack, R., Marz, D., Antunes Marante, C. (2021). A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change. Journal of Management Studies, 58(5), 1159-1197.

REFERENCES:

Ajzen, I. (1991). The Theory of Planned Behavior. Organizational Behavior and Human Decision Processes, 50(2);

Alsharida, R. A., Hammood, M. M., Al-Emran, M. (2021). Mobile Learning Adoption: A Systematic Review of the Technology Acceptance Model from 2017 to 2020. International Journal of Emerging Technologies in Learning, 16(5);

Anthony, C. (2018). To Question or Accept? How Status Differences Influence Responses to New Epistemic Technologies in Knowledge Work. Academy of Management Review, 43(4);

Bagozzi, R. P. (2007). The Legacy of the Technology Acceptance Model and a Proposal for Paradigm Shift. Journal of the Association for Information Systems, 8(4);

Bandura, A. (2001). Social Cognitive Theory: An Agentic Perspective. Annual Review of Psychology, 52;

Benbasat, I., Barki, H. (2007). Quo Vadis, TAM? Journal of the Association for Information Systems, 8(4);

Bharadwaj, A. S. (2000). A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation. MIS Quarterly, 24(1);

Coase, R. H. (1937). The Nature of the Firm. Economica. Blackwell Publishing, 4(16);

Compeau, D., Correia, J., Thatcher, J.B. (2022). When Constructs Become Obsolete: A Systematic Approach to Evaluating and Updating Constructs for Information Systems Research. MIS Quarterly, 46(2);

Davis, F., Bagozzi, R., Warshaw, P. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science, 35(8);

Felipe, C. M., Leidner, D. E., Roldan, J. L., Leal-Rodriguez, A. L. (2020). Impact of IS Capabilities on Firm Performance: The Roles of Organizational Agility and Industry Technology Intensity. Decision Sciences, 51(3);

Figueiredo, D., Schonewille, M. (2025). Instructor-centered Case Generation with GenAI: A Design-based Exploration. Journal of Ethics in Entrepreneurship and Technology. <DOI:10.1108/JEET-06-2025-0038>;

Gefen, D., Kaharanna, E., Straub, D. W. (2003). Trust and TAM in Online Shopping: An Integrated Model. MIS Quarterly, 27 (1);

Hanelt, A., Bohnsack, R., Marz, D., Antunes Marante, C. (2021). A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change. Journal of Management Studies, 58(5);

Hayek, F. A. (1945). The Use of Knowledge in Society. American Economic Review, 35(4);

Jen, W., Lu, T., Liu, P. T. (2009). An Integrated Analysis of Technology Acceptance Behavior Models: Comparison of Three Major Models. MIS Review, 15(1);

Karim, S., Kaul, A. (2015). Structural Recombination and Innovation: Unlocking Intraorganizational Knowledge Synergy Through Structural Change. Organization Science, 26(2);

Kork, A-A., Martinnen, M., Laihonen, H., Ruusuvuori, J., Ahonen, J. E., and Kankaanpää, E. (2025). Implementing Clinical Practice Guidelines into Action: A Qualitative Study of Managing Knowledge Translation in Primary Care Organizations. Health Research Policy and Systems (2025) 23:130. <DOI:10.1186/s12961-025-01402-z>;

Legris, P., Ingham, J., Collerette, P. (2003). Why do People use Information Technology? A Critical Review of the Technology Acceptance Model. Information & Management, 40 (2003);

Monteiro, E., Parmiggiani, E. (2019). Synthetic Knowledge: The Politics of the Internet of Things. MIS Quarterly, 43(1);

Muller, S., von Kramer, A., Tonnies, J., Wildenauer, A., Wensing, M., Friederich, H. C., Haun, M. K. (2025). Engaging Underrepresented Patient Groups in Specialized Treatment – Qualitative

Results from the PROVIDE-C Randomized Trial on Integral Mental Health Video Consultations for Depression and Anxiety. BMC Public Health (2025) 25:3817. <DOI:10.1186/s12889-025-25235-1>;

Mullins, J. K., Cronan, T. P. (2021). Enterprise Systems Knowledge, Beliefs, and Attitude: A Model of Informed Technology Acceptance. International Journal of Information Management, 59 (2021), 102348;

Murray, A., Rhymer, J., Sirmon, D.G. (2021). Humans and Technology: Forms of Cojoined Agency in Organizations. Academy of Management Review, 46(3);

Nass, C. (1994). Knowledge or Skills: Which do Administrators Learn from Experience? Organization Science, 5(1);

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. Organization Science, 5(1).

Orlikowski, W., Iacono, C. S. (2001). Research Commentary: Desperately Seeking the "IT" in IT Research – A Call to Theorizing the IT Artifact. Information Systems Research, 12(2);

Philip, J. (2022). A Perspective of Embracing Emerging Technologies Research for Organizational Behavior. Organization Management Journal, 19(3);

Powell, W. W., Snellman, K. (2004). The Knowledge Economy. Annual Review of Sociology, (30);

Reich, B. H., Benbasat, I. (2000). Factors that Influence the Social Dimension of Alignment Between Business and Information Technology Objectives. MIS Quarterly, 24(1);

Stadler, C., Helfat, C., Verona, G. (2022). Transferring Knowledge by Transferring Individuals: Innovative Technology Usage and Organizational Performance in Multi-Unit Firms. Organizational Science, 33(1);

Swanson, E. B. (2019). Technology as a Routine Capability. MIS Quarterly, 43(3);

Szajna, B. (1996). Empirical Evaluation of the Revised Technology Acceptance Model. Management Science, 42(1);

Venkatesh, V., Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. Decision Sciences, 39(2);

Yang, L., Sheng, X., Lin, J., Wang, W., Wu, W., Lin, R., Liu, A., Liu, L. (2025). Acceptance Scale for Traditional Chinese Medicine Techniques in Cancer Patients: Development and Validation. Patients: Preference and Adherence, 2025(19). <DOI:10.2147/PPA.S550541>.

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ARTICLE

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INFLATION DYNAMICS IN ALGERIA: EVIDENCE FROM A TIME–FREQUENCY WAVELET ANALYSIS OF MONETARY, FISCAL, AND INVESTMENT FACTORS (1970–2024)

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Abstract. *This paper analyzes the dynamics of inflation in Algeria by examining its relationship with money supply, government expenditure, and capital formation over the period 1970–2024. The study adopts a time–frequency framework based on wavelet power spectrum and wavelet coherence analysis to capture the evolving and non-linear interactions between inflation and its key macroeconomic determinants across short-, medium-, and long-term horizons.*

The empirical results provide strong evidence in support of the monetary hypothesis, revealing persistent and statistically significant coherence between money supply growth and inflation, particularly at short – and medium-term frequencies, with monetary expansion generally leading price increases. Government expenditure also exhibits a positive and significant association with inflation during specific periods, reflecting demand-driven inflationary pressures, especially in the context of fiscal expansions linked to oil revenue windfalls. In contrast, the relationship between inflation and capital formation appears asymmetric, as inflation tends to lead investment at medium-term horizons, suggesting that price volatility discourages capital accumulation rather than stimulating productive capacity.

Overall, the findings highlight inflation in Algeria as a time-varying and structurally driven phenomenon shaped by the interaction of monetary, fiscal, and investment dynamics. The wavelet-based approach offers policy-relevant insights by identifying the time horizons at which inflationary pressures are most pronounced.

KEYWORDS: INFLATION DYNAMICS, MONEY SUPPLY, GOVERNMENT EXPENDITURE, CAPITAL FORMATION, WAVELET ANALYSIS, EMERGING MARKET ECONOMY, ALGERIA.

INTRODUCTION

In Algeria, as a result of its impact on price stability, economic growth, and social welfare, inflation is still seen as the central concern in macroeconomic policy! Indeed, in spite of the country's substantial oil wealth, inflation remains a central concern affecting every sector of society. Repeated bursts of inflation in recent decades, which can be attributed to money-borne inflation, intervention in fiscal policies, investment cycles, and structural changes, give the affected system a chaotic look. There are many papers on the empirical knowledge of inflation. However, we still have never reached a consensus about which factors are the main driver of inflation in Algeria, especially considering their changes over time and the different opinions held at varying frequencies. Most existing studies use traditional time-domain econometric techniques, which in practice suppose that relationships between inflation and its determinants remain stable over the entire sample period. But such an approach may still be missing important structural breaks, discontinuities in system operations, or dynamics at different time scales. Thus, the hard empirical evidence of monetary versus fiscal factors in producing inflation remains confused and inconclusive.

Under these circumstances, the central research problem of this paper is: How do money supply, government expenditure, and gross capital formation interact in Algerian inflation dynamics across different time horizons and over a span of years? This broad question then leads to three specific research questions: Do inflation and its major determinants in macroeconomics have highs in the short, medium, or long term? Do relationships between inflation and monetary, fiscal, or investment variables stay the same throughout time, or do they switch for different periods and frequencies? Which of these variables is causing the inflation, and when in time scales is this effect significant?

The paper combines the testing of these queries with a projected analysis. H1 (Monetary Hypothesis): Inflation shows significant and persistent time–frequency coherence with the money supply, and at medium – and long-term horizons, coherent movement in turn leads inflation upwards. H2(Fiscal Hypothesis): Government expenditures will generate positive impulses to inflation at a given time scale, indicating demand-pull inflation pressures during periods of expansionary fiscal policy. H3 (Investment Hypothesis): Capital formation differs over time in its relationship with inflation: medium-term extremes on the inflation side tend to precede high investment levels, reflecting the negative impact of unstable prices on capital accumulation.

By applying a time–frequency method based on wavelet analysis, this study breaks new ground in terms of these hypotheses. It allows us to observe the ever-changing nature of Algerian inflation and provides empirical evidence that cannot be obtained from conventional econometric methods.

1. LITERATURE REVIEW

Inflation modeling is a multi-faceted subject, with numerous economic influences and a great variety of advanced econometric modeling methods applied to various national circumstances. Not only do they come from different theoretical perspectives, but they differ widely in empirical methodology.

Earlier studies largely attribute inflationary pressures to the growth of demand and the presence of macroeconomic imbalances. Hendry,[1] for instance, analyzes inflation in relation to demand pressures arising from goods and services markets, productive inputs, monetary expansion by authorities (governments or central banks), and asset prices such as equities. Similarly, the study of Stock et al.[2] emphasizes real economic slack as a key determinant of inflation dynamics. Building on this line of research, Marku[3] employs Bayesian nonparametric methods to identify persistent

1 Hendry, D.-F. (2001). Modelling UK inflation, 1875–1991. Journal of Applied Econometrics, 16(3), pp. 255–275. <https://doi.org/10.1002/jae.615>.

2 Stock, J.-H., Watson, M.-W. (2010). Modeling Inflation After the Crisis. National Bureau of Economic Research, Cambridge, pp. 1-61. <doi:10.3386/w16488>.

3 Markus, J. (2015). Modeling U.S. Inflation Dynamics: A Bayesian Nonparametric Approach. Econometric Reviews, 34(5), pp. 537-558. <doi:10.1080/07474938.2013.806199>.

structural breaks in inflation data while accounting for its time-dependent behavior and stochastic volatility characteristics.

To date, a variety of econometric techniques have been used in the study of inflation. In addition, De Brouwer et al.[4] use error-correction models to provide both short-run dynamics and long-term equilibrium relationships. The time-series approach, ARMA, for example, with GARCH models as well, has been used by the study of Nyoni[5] in modeling volatility of inflation, while Chan[6] gives us stochastic volatility models to fit the varying time uncertainty in how inflation behaves. Despite these methodological improvements, the article of Rudd et al.[7] pinpoint a scenario in which many rational expectations-based inflation models fall off the cliff, not to describe actual inflation with any empirical integrity at all.

In more recent literature, some authors have, however, documented basic changes taking place in inflation dynamics. Mishkin[8] identifies three regularities that typify modern inflation: its reduced persistence, a flatter Phillips curve, and diminished sensitivity to external shocks. The study of Ball et al.[9] confirms these findings. They argue that inflation expectations have, since the 1980s, tended to become increasingly shock-anchored, i.e., gradually anchored to long-run inflation targets. However, Feldkircher et al.[10] find that inflation expectations tend to rise when inflation accelerates. This occurs although domestic demand and supply shocks often only exert short-lived effects. Parker[11] finds that the global inflation factor explains a substantial share of consumer price variation in high-income countries relative to others, with its impact differing across components of the consumption basket, being stronger for energy and food prices than for non-tradable goods.

A major strand of the literature uses wavelet analysis to capture the time-varying and frequency-dependent relation between money supply and inflation. Rua[12] and Ryczkowski[13] are the latest to show that the money–inflation relationship evolves at different time scales. Mandler et al.[14] find strong co-movements between money growth and inflation at low frequencies, while the study of Tursoy et al.[15] provides evidence of a bi-directional causality between money supply and inflation in Turkey at both short and long run. More recently, Chekouri et al.[16] find similar dynamics. Also, at different horizons, they provide evidence of significant causality from money growth to inflation. However, these studies tend to ignore fiscal variables, suggesting a need to integrate government consumption and investment into frequency-domain analysis of inflation.

4 De Brouwer, G., Ericsson, N.-R. (1998). Modeling Inflation in Australia. Journal of Business & Economic Statistics, 16(4), pp. 433-449.

5 Nyoni, T. (2018). Modeling and forecasting inflation in Kenya: Recent insights from ARIMA and GARCH analysis. Dimorian Review, 5(6), pp. 16-40.

6 Chan, J. (2017). The Stochastic Volatility in Mean Model with Time-Varying Parameters: An Application to Inflation Modeling. Journal of business & economic statistics, 35(1), pp. 17-28. <doi:10.1080/07350015.2015.1052459>.

7 Rudd, J., Whelan, K. (2007). Modeling Inflation Dynamics: A Critical Review of Recent Research. Journal of Money, Credit and Banking, 39(s1), pp. 155-170. <doi:doi.org/10.1111/j.1538-4616.2007.00019.x>.

8 Mishkin, F. (2007). Inflation Dynamics. International Finance, 10(3), pp. 317-334. <doi:doi.org/10.1111/j.1468-2362.2007.00205.x>.

9 Ball, L., Mazumder, S. (2011). Inflation Dynamics and the Great Recession. Brookings Papers on Economic Activity, 42(1), pp. 337-405.

10 Feldkircher, M., Siklos, P. (2019). Global inflation dynamics and inflation expectations. International Review of Economics & Finance, 64, pp. 217-241. <doi:https://doi.org/10.1016/j.iref.2019.06.004>.

11 Parker, M. (2018). How global is global inflation? Journal of Macroeconomics, 58(C), pp. 174-197. <doi:DOI: 10.1016/j.jmacro.2018.09.003>.

12 Rua, A. (2012). Money Growth and Inflation in the Euro Area: A Time-Frequency View. Oxford Bulletin of Economics and Statistics, 74(6), pp. 875-885. <doi:j.1468-0084.2011.00680.x>.

13 Ryczkowski, M. (2021). Money and inflation in inflation-targeting regimes – new evidence from time–frequency analysis. Journal of Applied Economics, 24(1), pp. 17-44. <doi:10.1080/15140326.2020.183046>.

14 Mandler, M., Scharnagl, M. (2014). Money growth and consumer price inflation in the euro area: A wavelet analysis. Deutsche Bundesbank Discussion, Frankfurt, pp. 1-14.

15 Tursoy, T., Mar'i, M. (2020). Lead-lag and relationship between money growth and inflation in Turkey: New evidence from wavelet analysis. MPRA Paper No. 99595. Munich Personal RePEc Archive, Munich, pp. 1-23.

16 Chekouri, S., Kahoui, H., Chibi, A. (2024). Money Supply and Inflation in Algeria: A Wavelet Based Analysis. 39(3), Les Cahiers du CREAD, 39(3), pp. 27-51. <doi:10.4314/cread.v39i3.2>.

The literature on Algerian inflation reveals a complex, multi-dimensional interaction between monetary, fiscal, and external variables. Early evidence by the study of Beltas et al.[17] shows a strong one-way causal relationship from money supply to inflation in Algeria for the period 1970-1988, supporting early monetarist views in a financially repressed economy.

The study of Ayad has made this analysis using cointegration detection methods, which allow for breaks in the constant over the period 1970-2018. Our findings confirm that there is now a long-run relationship among money supply, inflation, and real output, following multiple changes to the structure during this process. Although money supply and inflation do not have a direct influence on output growth, the results strongly support the monetary view of inflation's evolution in Algeria.[18]

The article by Si Mohammed et al. employed an ARDL method to analyze the main determinants of inflation in Algeria from 1980 to 2012, and identified import prices, oil prices, money stock, government expenditure, and the nominal exchange rate.[19] Their findings are supported and extended by the study of Hamadouche, who found that a 1% increase in current government expenditure results in 2.14% higher inflation, while a 1% rise in capital expenditures lowers it by 1.08%. This highlights the asymmetrical effects of different components under fiscal policy.[20]

Recent studies point out that transmission channels are crucial. Taking an SVAR-X approach, Mehibel et al. considered the means by which oil price shocks pass on to inflation in Algeria. Their results suggest that in the short term, fiscal spending is the dominant channel, while in the long term, money supply becomes most influential, and this is followed by exchange rates. This development reflects Algeria's oil-dependent fiscal structure.[21]

Synthesis The literature makes it clear that in Algeria, modelling price inflation is complex, structurally changes with time, and interacts in three ways between money supply, government spending levels, oil price fluctuations, import prices, and turning points in foreign exchange rates. A wide range of empirical findings and methodological diversity serves to emphasize the need for economists to take full account of the unique conditions in their own region that may differ significantly from prevailing conditions elsewhere when studying how inflation emerges in detail.

2. INFLATION IN ALGERIA: THEORETICAL AND INSTITUTIONAL BACKGROUND

Inflation is one of the major macroeconomic phenomena because of its direct link to stability in both the economy and society, besides its immediate impacts on purchasing power, income distribution, and eventually economic policy itself. The issue of inflation in Algeria assumes special significance given the structural features of an economy still largely dependent on the hydrocarbon sector – an economy vulnerable to external shocks as well as fluctuations in public revenues. This paper attempts a theoretical analysis of inflation while bringing out its actual evolution within the Algerian economy based on such economic and statistical information that happens to be available.

Inflation is a sustained and general increase in the overall price level of goods and services over a certain period, resulting in a decline in the purchasing power of money, whereby a monetary unit cannot purchase the same quantity of goods and

17 Beltas, A., Jones, T. (1993). Money, inflation and causality in a financially repressed economy: Algeria, 1970–1988. Applied Economics, 25(4), pp. 473-480. <doi:doi.org/10.1080/00036849300000055>.

18 Ayad, H. (2020). Money Supply, Inflation and Economic Growth: Co-Integration and Causality Analysis. Studia Universitatis Babeș-Bolyai Oeconomica, Sciendo, 65(2), pp. 29-45. <doi:10.2478/subboec-2020-0008>.

19 Si Mohammed, K., Benyamina, K., Benhabib, A. (2015). The Main Determinants of Inflation in Algeria. An ARDL Model. International Journal of Management, 5, pp. 71-82.

20 Hamadouche, F. (2024). The impact of public expenditure on inflation: An ARDL approach. Financial Markets, Institutions and Risks (FMIR) journal, 8(2), pp. 70-85. <doi:doi.org/10.61093/fmir.8(2).70-85.2024>.

21 Mehibel, S., Oughlissi, M., Boudjana, R., Menna, K., Haffar, A. (2024). Oil price shocks pass-through into inflation in Algeria: Assessing the relative importance of the transmission channels using structural VAR-X. Les Cahiers du CREAD, 39(3), pp. 235-273.

services as it could previously.[22] Therefore, inflation develops when most prices are rising rapidly; it is not simply an upsurge or upward movement in some prices. It is normally expressed through the consumer price index or CPI-the change in household consumption expenditure items on goods and services.

Economic theories have come to analyze inflation from different analytical angles. The Quantity Theory of Money articulates the relationship between money supply and general price level and states that an increase in the money supply, with constant velocity of money and real output assumed, will eventually lead to higher prices. Friedman[23] emphasized a monetary phenomenon of inflation, particularly a long-run monetary phenomenon.

On the other hand, the Keynesian approach highlights and explains the role played by aggregate demand in inflation. Therefore, according to this school of thought, expansionary fiscal policies increase government spending or consumption and investment; then we say that aggregate demand has exceeded aggregate supply when close to full employment within an economy, hence pressures on inflation.[24] Also found widely discussed within economic literature is a relationship between inflation and unemployment, where it's theorized through the Phillips Curve as being inversely related, short run, long term; however breaks down.[25]

There are different types or forms of inflation depending on what causes it. Demand-pull inflation occurs when aggregate demand is more than productive capacity. Cost-push inflation happens because the costs of production (such as wages, price of raw materials, energy) are transmitted to consumers in higher prices, becoming upward rigid. Monetary inflation is very relevant in developing economies where an excessive expansion of the money supply exists without a corresponding increase in real output that brings about a general rise in the level of prices.[26]

Historically, there were large differences in the rate of inflation at different times in the Algerian economy. In the early 1990s, high rates of structural inflation accompanied reforms toward a market-oriented economy. It is only later years to be found that since about a decade ago until now, cautious monetary policy accompanied by government intervention through price controls and subsidies on essential goods has left aggregate demand satisfied within existing supply, hence low and stable rates of inflation[27] (see Figure.1).

The most recent economic data in Algeria show inflation mainly driven by internal and external factors, among them changes in money supply, exchange rate fluctuations, volatility of food and energy prices, and the effects of expansionary fiscal policies. Oil prices play a central role in shaping inflation dynamics due to Algeria's reliance on hydrocarbon revenues to finance public spending, which indirectly affects aggregate demand and price levels.[28]

Many empirical works undertaken on the Algerian economy confirm significant relationships between inflation and major macroeconomic variables – money supply, exchange rate, government spending, and GDP.

The economic and social impacts of inflation comprise, predominantly, the weakening of the real purchasing power of households, more particularly among the fixed-income group, thus negative effects on living standards and social inequality, apart from distorting saving and investment decisions due to greater economic uncertainty, which eventually hampers the process of economic growth in the medium term if not addressed through coherent, well-coordinated policy measures (See Fig.1).

22 Blanchard, O. (2021). Macroeconomics (éd. 8e). Pearson.

23 Friedman, M. (1968). The role of monetary policy. American Economic Review, 58(1), pp. 1-17. <http://www.jstor.org/stable/1831652>.

24 Keynes, J. (1936). The general theory of employment, interest and money. London: England: Macmillan.

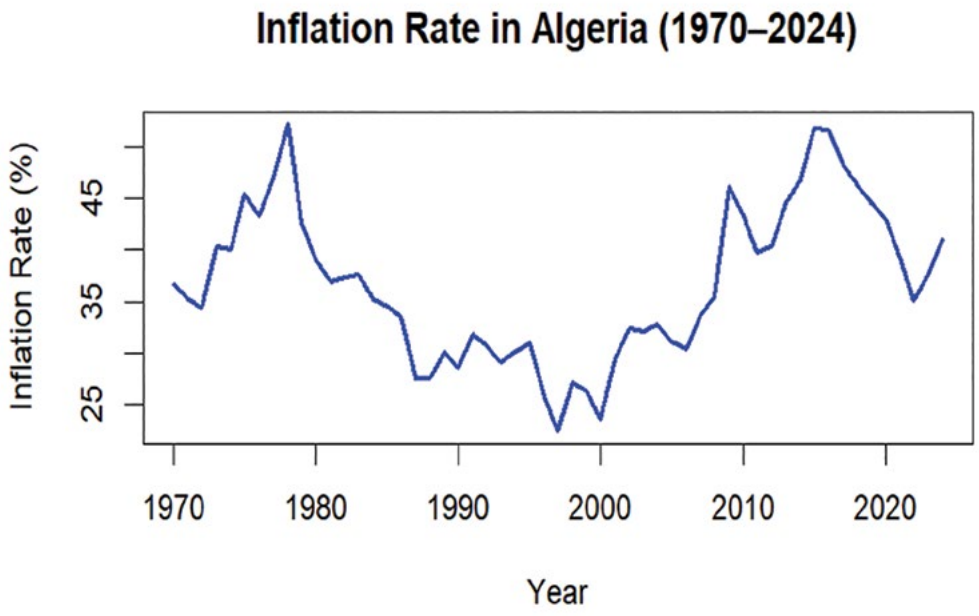
25 Samuelson, P., Solow, R. (1960). Analytical aspects of anti-inflation policy. American Economic Review, 50(2), pp. 177-194.

26 Mankiw, N. (2019). Macroeconomics (éd. 10e). Worth Publishers.

27 Banque d'Algérie. (Various years). Annual reports. Algiers. <https://www.bank-of-algeria.dz/politique-monetaire/>.

28 International Monetary Fund. (2024). Algeria: Country report (No. 24/088). IMF. <doi.org/10.5089/9798400271878.002>.

Figure1. Inflation rate in Algeria (1970-2024).



3. DATA AND METHODOLOGY

3.1. Data

In this paper, results are presented from an experiment employing the wavelet coherence technique to examine how inflation and its determinants – i.e., money supply, government expenditure, and the volume of investment – evolve in Algeria through 1970-2024. This research method allows one not only to see the lengths and frequencies at which these variables most intensively affect inflation, but also whether, in any or all periods, all three lead or trail inflation in the time dimension.

Inflation is measured by the annual growth rate of the Consumer Price Index (CPI), while money supply is proxied by the broad monetary aggregate (M2). Government expenditure is represented by total public spending, while capital formation refers to gross fixed capital formation.

The data are extracted from official and trustworthy sources, the annual reports of the Bank of Algeria and the International Monetary Fund (IMF) data base World Bank database, to ensure consistency and accuracy. All variables are converted into constant 1990 United States dollars (adjusted for inflation) and expressed in natural logarithms, except for the inflation rate, so as to increase the homogeneity of the series and level up their statistical properties.

3.2. Methodology

There are multiple reasons why wavelet analysis is an appropriate choice for this study. The Algerian economy is subject to repeated structural shocks (oil price fluctuations, economic reforms, monetary and fiscal policies changes), which result in a long-term instability of the economic relationship. Second, wavelet analysis provides a means to assess non-stationary time series without strong assumptions of stationarity. Third, this method allows us to learn more about how the relationships are functioning at different time scales, further helping policymakers craft better policies depending on the temporal scale of interest.

Wavelet-based methods are particularly suitable for emerging market economies characterized by structural breaks and time-varying dynamics. Thus, examining inflation in Algeria between the period 1970–2024 can be more accurately and closely analysed through the use of wavelet analysis. As we will see, wavelet analysis provides a comprehensive and dynamic understanding of inflation in Algeria.

3.2.1. Continuous Wavelet Transform (CWT):

The wavelet technique is a relatively recent and highly efficient tool for addressing non-linearity and non-stationarity in economic and financial data. Although it is based on Fourier analysis, it overcomes its limitations by extracting information simultaneously from both the time and frequency domains.

The Continuous Wavelet Transform (CWT) is one of the most widely used wavelet analysis methods and is recognized as a powerful mathematical tool for analyzing the time–frequency characteristics of non-stationary time series. For a time series X(t), the Continuous Wavelet Transform (CWT) for a wavelet ψ(t) is defined as follows:

$$W_{X,\psi}(\tau,s) = \int_{-\infty}^{+\infty} X(t)\frac{1}{\sqrt{|s|}}\psi^*\left(\frac{t-\tau}{s}\right)dt \dots\dots\dots\dots\dots\dots eq1$$

Where indicates the time and the frequency domain of the wavelet, respectively.

is the Morlet wavelet function, consisting of a plane wave modulated by a Gaussian:

$$\psi_0(\mu) = \pi^{-\frac{1}{4}} e^{i\omega_0\mu}\ e^{-\mu^2/2}$$

The Wavelet Power Spectrum (WPS) of the continuous wavelet transform is defined as:

$$WPS_x(\tau,s) = |W_x(\tau,s)|^2$$

The WPS depicts and measures the local variance of a time series at different times and scales.[29]

3.2.2. Wavelet squared coherence (WSC)

The wavelet squared coherence technique is a valuable tool for analyzing the co-movements between two time series across different time scales and frequency bands.

The wavelet coherence between two time series u and v is defined as:

$$R_t^2(\tau_s) = \frac{|\varepsilon(\tau_s^{-1}W_t^{uv}(\tau_s))|^2}{\varepsilon|(\tau_s^{-1}W_t^{uv}(\tau_s))|.\,\varepsilon|(\tau_s^{-1}W_t^{uv}(\tau_s))|}$$

Where $R_t^2(\tau_s)$ is the squared wavelet coherence, its value ranges between 0 and 1, and measures the local linear correlation between two time series at a particular scale. Where:

S: is a smoothing operator defined as:

$$S(W) = S_{scale}(S_{time}(W_n(s))$$

Where S_{scale} represents smoothing along the wavelet scale axis, and S_{time} smoothing in time.

W_t^{uv}: the cross wavelet power, it is viewed as the local covariance of u and v, where $W_n^{uv}(s) = W_n^u W_n^v$

W_n^u, W_n^v are continuous wavelet transforms of two time series u(t) and v(t), respectively.[30]

The wavelet coherence phase difference is given by:

$$\emptyset_{u,v} = tan^{-1}\frac{I\,W_n^{uv}}{R\,W_n^{uv}}\ \emptyset_{u,v} \in [-\pi;\ \pi]$$

Where: I and R are the imaginary and real parts, respectively, of the smoothed cross wavelet power spectrum. Phase differences are indicated by arrows on the wavelet coherence plots. Right-pointing arrows indicate that the time series are in phase, while left-pointing arrows indicate they are in anti-phase. When the arrows point vertically upward, the first time series leads the second. Conversely, downward-pointing arrows indicate that the second time series is leading.[31]

In addition, the phase difference derived from the wavelet coherence analysis provides information on the direction of the relationship and potential lead–lag structures. Phase arrows pointing to the right indicate positive correlations, while arrows pointing to the left indicate negative correlations. Arrows pointing upward (downward) suggest that the second (first) variable leads the first (second) variable.

29 Tastan, H., Sahin, S. (2020). Low-frequency relationship between money growth and inflation in Turkey. Quantitative Finance and Economics, 4(1), pp. 91-120. <doi:10.3934/QFE.2020005>.

30 Torrence, C., Webster, P.-J. (1999). Interdecadal Changes in the ENSO-Monsoon System. Journal of Climate, 12, pp. 2679-2690. <doi.org/10.1175/1520-0442(1999)012<2679:ICITEM>2.0.CO;2>.

31 Torrence, C., Compo, G.-P. (1998). A Practical Guide to Wavelet Analysis. Bulletin of the American Meteorological Society, 79(1), pp. 61–78. <doi.org/10.1175/1520-0477(1998)079<0061:APGTWA>2.0.CO;2>.

4. EMPIRICAL RESULTS

4.1. Wavelet power spectrum results

This is accomplished using the wavelet power spectrum to analyze dynamic features of some important economic variables in Algeria for the period (1970–2024) in a joint time–frequency domain. Such a technique enables to detect the process dominant cycles and to quantify fluctuations intensity of inflation, money supply, government expenditure, and capital formation, while including the shocks of the economy and the changes of monetary and fiscal stimuli. Thus, as the wavelet power spectrum provides more informative dynamic intuition of the drivers of inflation at short-, medium – and long-run horizons, it renders the analysis more valid and robust in the context of the Algerian economy (See Fig.2).

Figure 2 illustrates the inflation wavelet power spectrum in Algeria over the period 1970–2024. These show that inflation fluctuations are spelt printed out in the worldwide price index mainly at short and medium horizons with reference to years from 1970 to 1980, approximately 2–5 years. The statistically significant high-power regions imply that inflation dynamics in Algeria are governed primarily by cyclical shocks and policy-making rather than slowly evolving long-term trends. However, the weak power at longer periods means there is restricted (long-term) inflation persistence: temporary but lasting pressures account for virtually all of an episode of high price levels (See Fig.3).

Figure 3 shows the wavelet power spectrum of gross capital formation in Algeria from 1970 to 2024. Power concentrations are strongly evident at medium and long horizons (approximately 4-16 years), reflecting the great long building cycles in which this capital is formed. These are largely driven by public investment programs and broad-gauge structural projects. The statistically significant areas of high power suggest that investment dynamics in Algeria are cyclical and irregular, and influenced predominantly by general macroeconomic fluctuations as well as changes in world oil prices. This may limit their ability--in the long run--to ensure economic stability (See Fig.4).

Figure 4 shows the wavelet power spectrum for government spending in Algeria in the 1970-2024 period. The pattern indicates significant power concentrations at medium-and long-term targets (about 4-16 years), reflecting fiscal policy cycles in Algeria. Significantly high-power areas show that government spending follows regular economic cycles. These largely result from varying inflows of oil revenue and the adoption of expansionary fiscal policies. Inflationary pressures are heightened by these variations in public spending, especially when real growth of output does not keep up pace with increases in public spending (See Fig.5).

The wavelet power spectrum of money supply in Algeria reveals strong and time-varying fluctuations, particularly over the short – and medium-term horizons. Statistically significant periods indicate the presence of monetary cycles ranging between two and eight years, reflecting the sensitivity of money supply to economic shocks and changes in monetary policy. In contrast, long-term fluctuations appear less pronounced, suggesting a relatively stable long-run trend in money supply (See Figure 5).

4.2. Wavelet coherence results

Wavelet coherence is employed here to analyze the dynamic interaction between inflation and its fundables (money supply, government expenditure, and capital formation) in Algeria for the period 1970–2024. This allows us to pinpoint the time periods and frequency bands where these variables are most closely linked to inflation, and whether monetary, fiscal, or investment variables lead or lag inflation at different horizons (See Fig.6).

Figure 6 depicts wavelet coherence between government spending and inflation, based on a 1970-2024 interval in Algeria. Using the criterion suggested by Song et al., the actual results show both important coherence in terms (which is relevant in the shorter run) and statistically significant coherence at medium horizons of 2-5 years (about four-fifths). This very strong coherence between government expenditure and inflation means that there is an active, well-established relationship at work over time. It suggests that, when public spending increases are larger than required for public production to function smoothly and efficiently, wages will start to rise. This, in turn, pushes up prices on an economy-wide scale – po-

Figure 2. WPS of Inflation in Algeria.
Source: Authors' calculations using R.

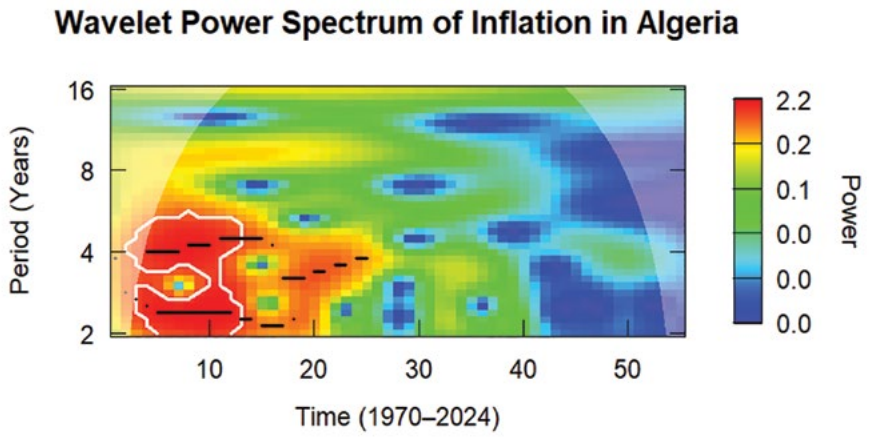


Figure 3. WPS of Gross capital formation in Algeria.
Source: Authors' calculations using R.

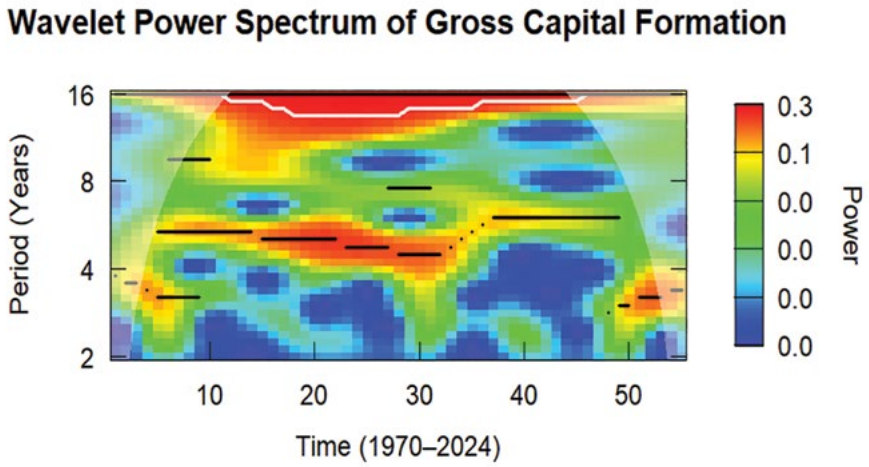


Figure 4. WPS of Government expenditure in Algeria.
Source: Authors' calculations using R.

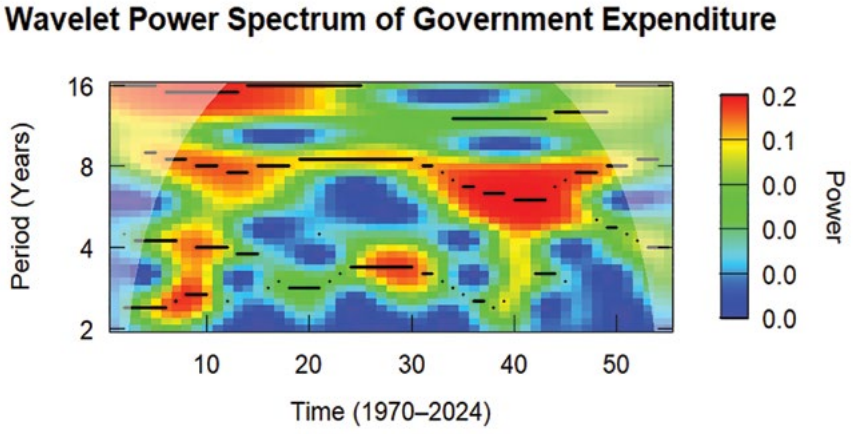


Figure 5. WPS of Money supply in Algeria.
Source: Authors' calculations using R.

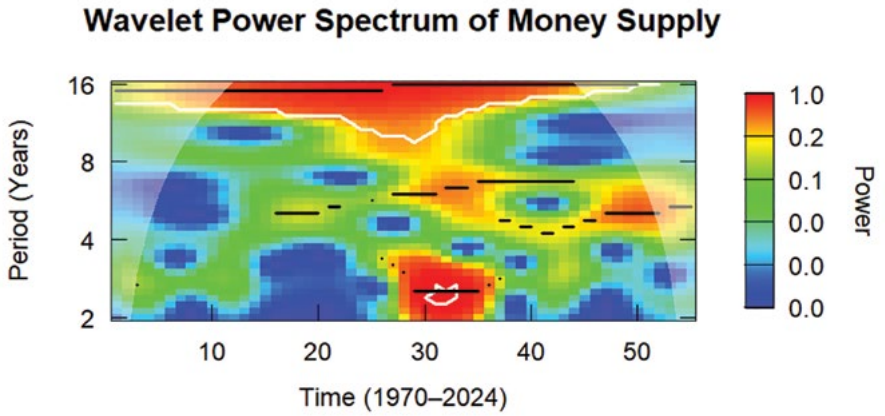


Figure 6. Wavelet Coherence Inflation INF – Government expenditure G in Algeria.
Source: Authors' calculations using R.

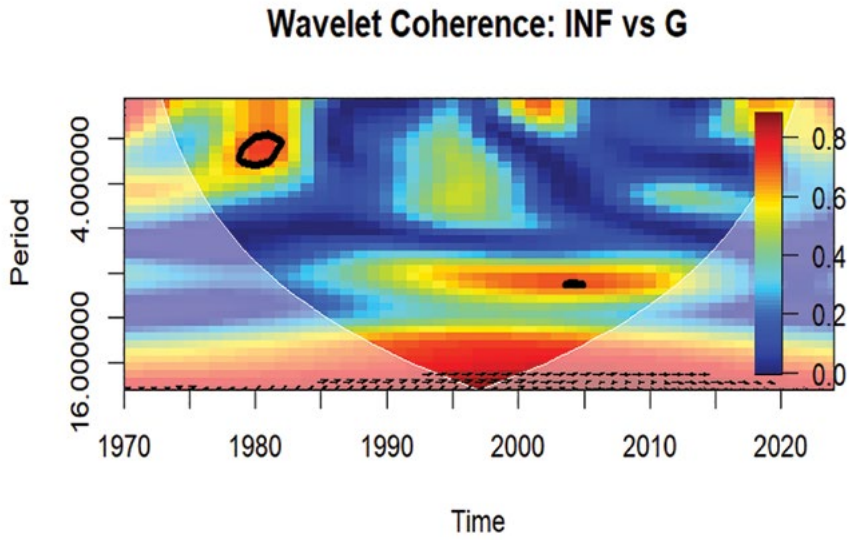


Figure 7. Wavelet Coherence Inflation INF – Gross capital formation GCF in Algeria.
Source: Authors' calculations using R.

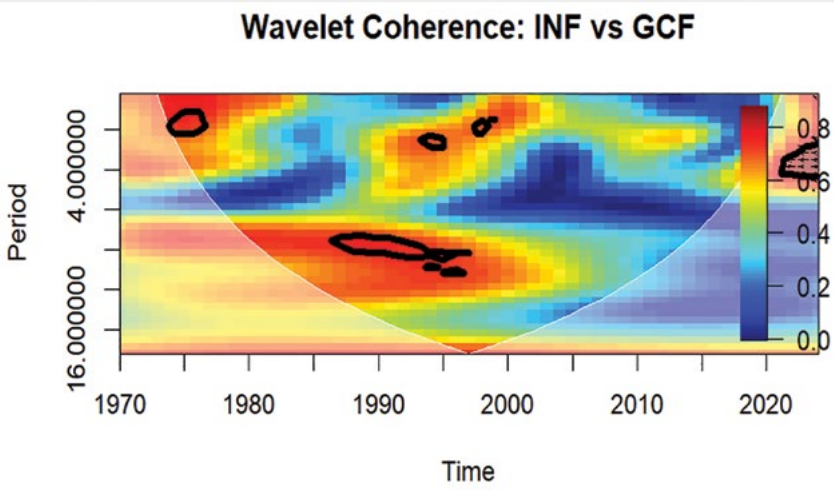
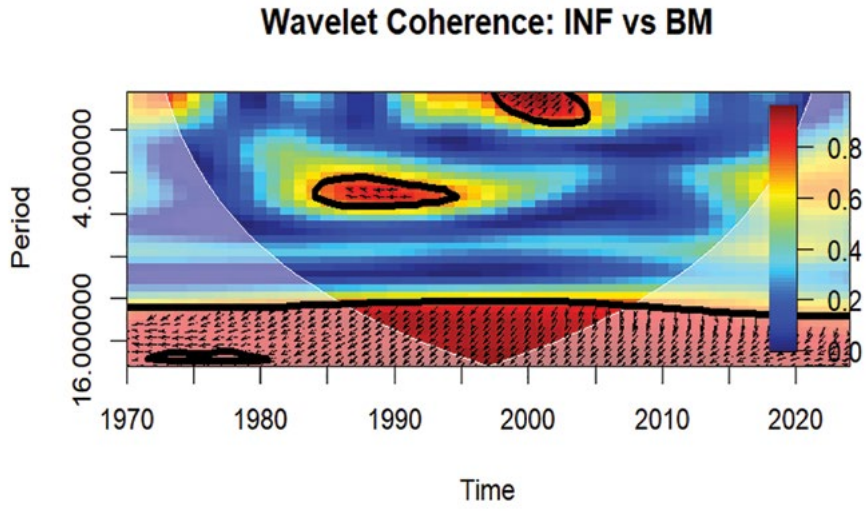


Figure 8. Wavelet Coherence Inflation INF – Money supply BM in Algeria.
Source: Authors' calculations using R.



tentially increasing short-term demand for goods because of producer price pressures. These findings are a testament to the inflationary character of fiscal policy in Algeria, where increases in government spending are often made without any corresponding increase in the means of production. With demand-oriented inflation (See Fig.7).

Figure 7 shows the wavelet coherence between inflation and gross capital formation in Algeria over the period 1970–2024. When you look at the diagram below, coherence for inflation with net capital formation is statistically significant both on a short and medium term (say about 2–5 years). This coherence indicates a close relationship between investment dynamics and inflation, whereby increases in investment—especially public investment—generate short-term inflationary pressures before their potential positive effects on productive capacity materialize. Efficiency in the transmission of investment into so many effective products is still so low that in the short run, it becomes inflation rather than being consumed by society. This pattern reflects inefficiencies in the transmission of investment into effective productive growth in the short run, thereby contributing to inflation rather than mitigating it (See Fig.8).

In Figure 8, we have the wavelet coherence of Inflation and Money Supply. The period is 1970 to 2024. These results show considerable and statistically significant coherence at short and medium-term horizons (roughly 2 – 5 years), particularly during the early part of the sample. Such high coherence shows how money supply expansion is generally the main factor in the movement of inflation. The further supply is increased, so will inflation rise along in both the short and medium term. These findings suggest that limitations on printing banknotes have failed to soften economic blows. Moreover, reliance upon monetary financing has grown heavy and so reinforces the monetary nature of inflation.

5. DISCUSSION OF RESULTS

The wavelet power spectrum and coherence findings present inflation in Algeria from 1970 to 2024 as an ever-changing dynamic phenomenon, influenced by various economic channels. The nature of these effects changes from short – to long – term, and thus cannot simply be pinned down as a question of money supply growth. First, wavelet coherence between inflation and money supply strongly confirms that the nature of inflation in Algeria is monetary, especially in the short and medium term. Coherence occurring within the 2–5 year period shows that prices are highly sensitive to cash injections resulting from deficit financing of government deficits, and lack an independent

monetary authority. Injecting more money into a system where there is already excessive liquidity unrelated to real production only causes higher inflation rates, not basic production, in support of Friedman's monetary inflation hypothesis.

Second, coherence between inflation and government expenditure reveals that expansionist fiscal policies also have a role in driving up consumer prices. In an economy whose revenue depends heavily on oil rents, higher public spending acts to increase total demand and output at a time when such advances are not followed by any corresponding increases in actual goods production. Consequently, fiscal influences push through into inflation pressures – especially if such public spending is borne by printing money or the country is relatively weak in terms of the productive sector.

Third, the relationship between inflation and gross capital formation exposes investment anomalies. While in the long run investment is believed to alleviate inflationary pressures by expanding capacity, in the short term, its results show it is a cause of inflation. This may be due to state investment inefficiencies, lengthy implementation delays, and highly import-oriented project investment, whose completion not only raises demand but also fails to raise actual domestic productive capacity.

These findings indicate that inflation in Algeria takes on many different forms: it is a product of monetary policy interacting with fiscal policy and structural investment dynamics. These results have significant policy implications for inflation targeting in the context of Algeria. At first, the tight time–frequency connection between the money supply and inflation highlights that there should be a more rigorous discipline in monetary policy, in addition to the higher independence degree of the central bank to minimize excess liquidity. The large inflationary effects of government expenditure underscore the need for fiscal sustainability, especially in an oil-exporting economy where revenue bonanzas tend to materialize in the form of pro-cyclical spending. Taking into consideration the above, the countercyclical response of capital formation to inflation suggests the need for structural reforms that could enhance investment efficiency, lower implementation lags, and reduce the import dependence of investment projects. Thus, an integrated policy framework for monetary discipline, sustainable fiscal policy, and structural reforms is needed to enable the emergence of stable price conditions and sustainable growth in Algeria.

With the evolution of the global economy, inflation dynamics are more contingent on external shocks, especially in open and resource-dependent economies. Important external determinants include exchange rate movements and imported inflation; volatility of international prices of commodities and energy; and international financial shocks generated by world crises and the broad liquidity conditions tightening or easing globally. Moreover, the behavior of monetary and fiscal authorities is influenced by policy frameworks that are being promoted by international institutions, as well as by constraints from external financing and from exposure to developments in the foreign sector, which, in turn, determine domestic inflation outcomes.

Against this backdrop, Algeria represents an especially salient empirical case. Given its reliance on oil-exporting income, its high dependence on hydrocarbon revenues as well as its heavy reliance on imports, inflationary pressures in Algeria are crucially linked to real shocks transmitted through oil price cycles, exchange rate fluctuations, and, on the fiscal side, reactions to global conditions. Algeria stands as a microcosm of the inflation dynamics of oil-reliant economies, shaped by the interplay of such external factors with domestic monetary and fiscal dynamics.

The study adds to the worldwide body of knowledge by envisaging the inflation in such nations mainly as not solely a domestic event, but as a time-varying process established by the interplay between exterior shocks and interior response performance. As the analysis implements a time-frequency wavelet approach, it offers an international perspective of how inflationary pressures adjust across time horizons amongst oil-exporting economies subject to global business cycles.

CONCLUSION

Wavelet power spectrum and wavelet coherence methods are used to examine the dynamic connections between inflation and its main macroeconomic determinants in Algeria through the period 1970-2024. By employing a time-frequency framework, this analysis affords a comprehensive view of how changes in monetary and fiscal policy, as well as investment-related factors, interact with inflation over different growth horizons. For this reason, the authors' hypotheses can be reliably assessed.

Empirical evidence strongly supports the monetary hypothesis. Over short – and intermediate frequencies, the money supply has significant and persistent coherence with inflation. The results suggest that monetary expansion frequently leads to inflation, confirming the idea that excess liquidity has a major impact on inflation dynamics in Algeria. This finding provides solid evidence for the belief that inflationary pressures come from monetary factors- – especially in an economic environment characterized by laissez-faire Wall Street policies and limited monetary independence.

The evidence also provides robust support for the fiscal hypothesis. At specific time scales, government expenditure is positively and statistically significantly related to inflation, especially over short to medium-term horizons. These results reflect demand-pull inflation, which generally results from the time it takes to adopt expansionary fiscal measures in the wake of changes in oil revenues. This variable relationship underscores the pro-cyclical nature of fiscal policy in Algeria and its tendency to amplify inflation when the public sector is expanding.

The investment narrative is more complex and asymmetric. The results suggest that capital formation follows inflation rather than leading it. At medium time horizons, price volatility exerts a strongly negative effect on investment (capital expenditure) decisions. The findings point to structural and efficiency constraints, long implementation lags, and a high import content of investment projects. In this context, and alongside the easing of foreign exchange constraints, persistently high money growth and a strong reliance on monetary base–oriented policies have become central issues on the monetary authority's agenda.

Episodes of government expenditure driven by temporary fiscal revenue windfalls resulting from buoyant global crude oil prices—often described as golden periods in petroleum-dependent economies—demonstrate that a countercyclical fiscal stance aimed at containing demand-pull inflation tends to be ineffective in practice, despite its theoretical appeal. There are a few realistic policy options capable of altering the nature of demand surges so that they do not generate inflation; indeed, such attempts may prove even more counterproductive over time. Without structural reforms to improve investment efficiency, address persistent implementation bottlenecks, and significantly reduce time-to-market, a substantial share of potential annual economic growth will remain unrealized, requiring corrective measures to close existing gaps and align the economy with its intended development trajectory.

To sum up, inflation in Algeria is seen as a phenomenon that varies by time and is structurally conscious, influenced by combinations of both monetary expansion, fiscal policy, and investment dynamics. This wavelet approach is particularly handy in capturing these changing relationships and should benefit both practical policymakers and academic researchers. An integrated approach to controlling inflation sustainably in Algeria requires disciplined monetary policy, fiscal sustainability, and structural change to promote long-term economic stability.

To sum up, inflation in Algeria emerges as a time-varying and structurally driven phenomenon, shaped by the interaction of monetary expansion, fiscal policy, and investment dynamics. The wavelet approach proves particularly effective in capturing these evolving relationships across different time horizons, offering valuable insights for both policymakers and academic researchers. Achieving sustainable inflation control in Algeria, therefore, requires an integrated policy framework that combines disciplined monetary policy, fiscal sustainability, and structural reforms aimed at strengthening investment efficiency and long-term economic stability.

REFERENCES:

Ayad, H. (2020). Money Supply, Inflation and Economic Growth: Co-Integration and Causality Analysis. Studia Universitatis Babeș-Bolyai Oeconomica, Sciendo, 65(2). <doi:10.2478/subboec-2020-0008>;

Ball, L., Mazumder, S. (2011). Inflation Dynamics and the Great Recession. Brookings Papers on Economic Activity, 42(1);

Banque d'Algérie. (Various years). Annual reports. Algiers. <https://www.bank-of-algeria.dz/politique-monetaire/>;

Beltas, A., Jones, T. (1993). Money, inflation and causality in a financially repressed economy: Algeria, 1970–1988. Applied Economics, 25(4). <doi:doi.org/10.1080/00036849300000055>;

Blanchard, O. (2021). Macroeconomics (éd. 8e). Pearson;

Chan, J. (2017). The Stochastic Volatility in Mean Model with Time-Varying Parameters: An Application to Inflation Modeling. Journal of business & economic statistics, 35(1). <doi:10.1080/07350015.2015.1052459>;

Chekouri, S., Kahoui, H., Chibi, A. (2024). Money Supply and Inflation in Algeria: A Wavelet Based Analysis. 39(3), Les Cahiers du CREAD, 39(3). <doi:10.4314/cread.v39i3.2>;

De Brouwer, G., Ericsson, N.-R. (1998). Modeling Inflation in Australia. Journal of Business & Economic Statistics, 16(4);

Feldkircher, M., Siklos, P. (2019). Global inflation dynamics and inflation expectations. International Review of Economics & Finance, 64. <doi:https://doi.org/10.1016/j.iref.2019.06.004>;

Friedman, M. (1968). The role of monetary policy. American Economic Review, 58(1). <http://www.jstor.org/stable/1831652>;

Hamadouche, F. (2024). The impact of public expenditure on inflation: An ARDL approach. Financial Markets, Institutions and Risks (FMIR) journal, 8(2). <doi:doi.org/10.61093/fmir.8(2).70-85.2024>;

Hendry, D.-F. (2001). Modelling UK inflation, 1875–1991. Journal of Applied Econometrics, 16(3). <https://doi.org/10.1002/jae.615>;

International Monetary Fund. (2024). Algeria: Country report (No. 24/088). IMF. <doi.org/10.5089/9798400271878.002>;

Keynes, J. (1936). The general theory of employment, interest and money. London: England: Macmillan;

Mandler, M., Scharnagl, M. (2014). Money growth and consumer price inflation in the euro area: A wavelet analysis. Deutsche Bundesbank Discussion, Frankfurt;

Mankiw, N. (2019). Macroeconomics (éd. 10e). Worth Publishers;

Markus, J. (2015). Modeling U.S. Inflation Dynamics: A Bayesian Nonparametric Approach. Econometric Reviews, 34(5). <doi:10.1080/07474938.2013.806199>;

Mehibel, S., Oughlissi, M., Boudjana, R., Menna, K., Haffar, A. (2024). Oil price shocks pass-through into inflation in Algeria: Assessing the relative importance of the transmission channels using structural VAR-X. Les Cahiers du CREAD, 39(3);

Mishkin, F. (2007). Inflation Dynamics. International Finance, 10(3). <doi:doi.org/10.1111/j.1468-2362.2007.00205.x>;

Nyoni, T. (2018). Modeling and forecasting inflation in Kenya: Recent insights from ARIMA and GARCH analysis. Dimorian Review, 5(6);

Parker, M. (2018). How global is global inflation? Journal of Macroeconomics, 58(C). <doi:DOI: 10.1016/j.jmacro.2018.09.003>;

Rua, A. (2012). Money Growth and Inflation in the Euro Area: A Time-Frequency View. Oxford Bulletin of Economics and Statistics, 74(6). <doi:j.1468-0084.2011.00680.x>;

Rudd, J., Whelan, K. (2007). Modeling Inflation Dynamics: A Critical Review of Recent Research. Journal of Money, Credit and Banking, 39(s1). <doi:doi.org/10.1111/j.1538-4616.2007.00019.x>;

Ryczkowski, M. (2021). Money and inflation in inflation-targeting regimes – new evidence from time–frequency analysis. Journal of Applied Economics, 24(1). <doi:10.1080/15140326.2020.1830461>;

Samuelson, P., Solow, R. (1960). Analytical aspects of anti-inflation policy. American Economic Review, 50(2);

Si Mohammed, K., Benyamina, K., Benhabib, A. (2015). The Main Determinants of Inflation in Algeria. An ARDL Model. International Journal of Management, 5;

Stock, J.-H., Watson, M.-W. (2010). Modeling Inflation After the Crisis. National Bureau of Economic Research, Cambridge. <doi:10.3386/w16488>;

Tastan, H., Sahin, S. (2020). Low-frequency relationship between money growth and inflation in Turkey. Quantitative Finance and Economics, 4(1). <doi:10.3934/QFE.2020005>;

Torrence, C., Compo, G.-P. (1998). A Practical Guide to Wavelet Analysis. Bulletin of the American Meteorological Society, 79(1). <doi.org/10.1175/1520-0477(1998)079<0061:APGTWA>2.0.CO;2>;

Torrence, C., Webster, P.-J. (1999). Interdecadal Changes in the ENSO-Monsoon System. Journal of Climate, 12. <doi.org/10.1175/1520-0442(1999)012<2679:ICITEM>2.0.CO;2>;

Tursoy, T., Mar'i, M. (2020). Lead-lag and relationship between money growth and inflation in Turkey: New evidence from wavelet analysis. MPRA Paper No. 99595. Munich Personal RePEc Archive, Munich.

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ARTICLE

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THE IMPACT OF BIG DATA USE ON SMART TOURISM: ECONOMIC ANALYSIS AND PERSPECTIVE (ALGERIA)

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Abstract. *This paper explores the role of Big Data in advancing smart tourism, focusing on experiences from leading countries such as South Korea, Spain, China, Singapore, and the United Arab Emirates. These nations have successfully integrated Big Data analytics into tourism management to improve decision-making, sustainability, and visitor experiences. By analyzing real-time information from multiple sources including IoT devices, mobile data, and social media they have developed intelligent systems that enhance competitiveness and innovation in the tourism sector. The study highlights how these global leaders use data-driven strategies to optimize resource management, personalize services, and promote sustainable tourism. It also draws lessons for developing countries, particularly Algeria, emphasizing the importance of digital infrastructure, open data governance, and collaboration between public and private sectors to achieve smart and sustainable tourism development. Advances in information and communication technologies have provided tourism researchers with a golden opportunity to access big data, which plays a pivotal role in smart tourism. Building on this reality, this paper discusses the evolution of studies related to big data in the tourism sector, with a focus on the conceptual understanding of its types and the insights derived from its analysis.*

KEYWORDS: BIG DATA, SMART TOURISM, INNOVATION, ALGERIA.

INTRODUCTION AND DEFINITIONS

Data it can be defined as a set of letters, words, numbers, symbols, or images related to a specific subject. Data by itself has no meaning or value; it represents the raw form of information. Information, on the other hand, consists of data that has been analyzed and processed in such a way that it carries meaning and value and can be used for decision-making, for example, obtaining the total number of employees, their average age, and average years of experience, etc.

Knowledge is the process of analyzing different pieces of information, linking them together, having a clear understanding of them, and combining them with experience as illustrated in the following figure 1.

- For Data it's mean individual facts, figures, signals, measurements.
- For Information, we transform Data to Information (organized, structrured, categorized, calculated).
- Knowledge that means notion, concept, idea.
- Vision (accumulated, applied, integration...).

In the context of smart tourism, the transformation of raw data into information, then into knowledge, plays a critical role in supporting evidence-based and intelligent decision-making. Data refers to raw, unprocessed facts collected from various digital sources such as sensors, mobile devices, social media platforms, and Internet of Things (IoT) systems. When these data are analyzed and organized, they become information that provides meaningful insights into tourism patterns and behaviors[1]. By interpreting and integrating this information with contextual understanding and expertise, it evolves into knowledge, which enables tourism stakeholders to make informed strategic and operational decisions[2].

In smart tourism ecosystems, this flow from data to knowledge supports decisions such as optimizing resource allocation, personalizing tourist experiences, and improving destination management[3]. Consequently, data-driven knowledge becomes a key enabler of innovation, sustainability, and competitiveness in modern tourism development[4].

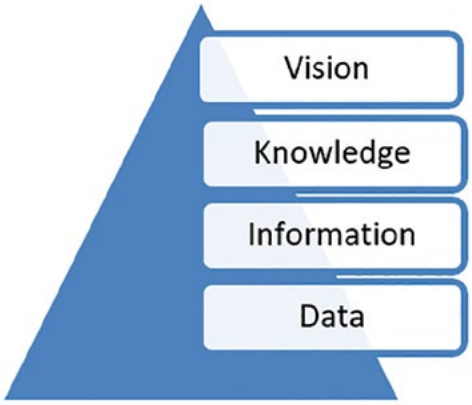
1 Gretzel, U., Sigala, M., Xiang, Z., Koo, C. (2015). Smart tourism: Foundations and developments. Electronic Markets, 25(3), 179–188. <https://doi.org/10.1007/s12525-015-0196-8>.

2 Buhalis, D., Amaranggana, A. (2015). Smart Tourism Destinations Enhancing Tourism Experience Through Personalisation of Services. In: Tussyadiah, I., Inversini, A. (eds.). (2015). Information and Communication Technologies in Tourism. Springer, Cham. <https://doi.org/10.1007/978-3-319-14343-9_28>.

3 Li, Y., Hu, C., Huang, C., Duan, L. (2017). The concept of smart tourism in the context of tourism information services. Tourism Management, 58, 293–300. <https://doi.org/10.1016/j.tourman.2016.03.014>.

4 Del Vecchio, P., Mele, G., Ndou, V., Secundo, G. (2018). Creating value from open data: The role of smart tourism ecosystems. Information Processing & Management, 54(5), 847-860. <https://doi.

Figure 1: Differences between data, information and knowledge



In the era of digital transformation, the tourism sector increasingly relies on the intelligent use of data to enhance innovation, efficiency, and sustainability. Within the framework of smart tourism, the process of converting raw data into meaningful knowledge plays a vital role in supporting strategic decision-making.

In smart tourism ecosystems, this transformation from data to knowledge directly influences decision-making by enabling real-time, data-driven decisions. For example, analyzing big data from social media and mobile applications can allow local authorities in destinations such as Algiers, Oran, or Constantine to monitor tourist satisfaction, predict demand fluctuations, and adapt marketing strategies accordingly. This process enhances both economic efficiency and visitor experience, ensuring that decisions are not based on intuition but on empirical evidence[5]. Furthermore, in the context of developing countries such as Algeria, the integration of data analytics into tourism management can contribute to overcoming challenges related to information asymmetry, resource allocation, and sustainable development[6].

Ultimately, the data–information–knowledge–decision chain forms the backbone of smart tourism governance. It empowers public and private stakeholders to design innovative policies, promote smart destination management, and foster economic growth while ensuring the sustainability of natural and cultural resources. As such, effective use of data analytics and knowledge management systems represents not only a technological evolution but also a strategic imperative for the modernization of the tourism sector in Algeria and beyond.

1. BIG DATA AND SMART TOURISM: FAST VIEW ON LEADER COUNTRIES

Globally, big data analytics has become a cornerstone of smart tourism development, driving evidence-based decision-making and sustainable destination management. Several countries have emerged as leaders in integrating big data into tourism governance, innovation, and policy design.

South Korea

South Korea is considered one of the pioneers in smart tourism ecosystems, where data-driven services are central to enhancing tourist experiences and operational efficiency. The Korean government, through the Korea Tourism Organization (KTO), uses big data from mobile devices, credit card transactions, and online platforms to monitor visitor behavior and predict tourism demand in real time[7]. Seoul's "Smart Tourism City Project" integrates IoT, AI, and big data to provide tourists with personalized recommendations and digital wayfinding services. Such initiatives enable efficient crowd management and targeted marketing, illustrating how big data transforms tourism governance[8].

Spain

Spain has positioned itself as a European leader in smart destinations, largely through the SEGITTUR program (Sociedad Estatal para la Gestión de la Innovación y las Tecnologías Turísticas). Big data analytics are used to manage visitor flows, optimize resources, and enhance sustainability in destinations such as Benidorm and Barcelona. Data from booking systems, sensors, and social media are integrated into decision-support systems that inform infrastructure planning and environmental management[9]. Spain's model emphasizes collaboration between public institutions, private firms, and research centers, showcasing how data governance and innovation can align to strengthen competitiveness.

org/10.1016/j.ipm.2017.10.006>.

5 Gretzel, U., Sigala, M., Xiang, Z., Koo, C. (2015), Op. cit.

6 Li, Y., Hu, C., Huang, C., Duan, L. (2017). The concept of smart tourism in the context of tourism information services. Tourism Management, 58, 293–300. <https://doi.org/10.1016/j.tourman.2016.03.014>.

7 Gretzel, U., Sigala, M., Xiang, Z., Koo, C. (2015). Smart tourism: Foundations and developments. Electronic Markets, 25(3), 179–188. <https://doi.org/10.1007/s12525-015-0196-8>.

8 Koo, C., Gretzel, U., Hunter, W. C., Chung, N. (2015). The role of IT in tourism: A dynamic capabilities perspective. Tourism Management, 25 (1), 99-104. <DOI:10.14329/apjis.2015.25.1.099>.

9 Ivars-Baidal, J. A., Celdrán-Bernabeu, M. A., Mazón, J. N., Perles-Ribes, J. F. (2019). Smart destinations and the evolution of ICTs: A new scenario for destination management? Current Issues in Tourism, 22(4), 1-20. <DOI:10.1080/13683500.2017.1388771>.

China

China has also become a global powerhouse in smart tourism, leveraging big data, AI, and IoT technologies to modernize the sector. The Chinese government's "Smart Tourism Cities" initiative collects and analyzes massive data from online travel agencies (e.g., Ctrip, Fliggy), social media, and payment platforms to understand travel behavior and preferences[10]. Destinations like Hangzhou and Shanghai use predictive analytics to manage tourist flows and provide personalized digital experiences. Moreover, China's integration of blockchain in tourism information systems enhances data security and trust among users, positioning the country as a global innovator in tourism intelligence[11].

Singapore

Singapore represents another leading example of data-driven tourism planning, combining advanced analytics, open data, and AI to support policy and operational decisions. The Singapore Tourism Analytics Network (STAN) consolidates data from multiple agencies and private sources, providing real-time insights on visitor demographics, spending, and mobility[12]. This centralized big data platform enables destination managers and businesses to co-create tourism products and adjust marketing strategies dynamically. Singapore's model demonstrates how an integrated data ecosystem can sustain long-term competitiveness and resilience in tourism.

United Arab Emirates

The United Arab Emirates, particularly Dubai, illustrates how big data supports luxury and sustainable tourism. Dubai's Department of Economy and Tourism employs big data analytics to optimize marketing campaigns, monitor visitor satisfaction, and predict global travel trends[13]. The emirate's "Smart Dubai" strategy integrates data from tourism, transport, and hospitality systems to enhance service delivery and improve visitors' digital experience. These innovations have positioned Dubai as one of the world's most connected and data-driven tourism hubs.

The United Arab Emirates stands out as one of the leading Arab examples in successfully embedding innovation and artificial intelligence into its tourism policies to advance environmental sustainability. From an early stage, the country adopted a forward-looking vision centered on the

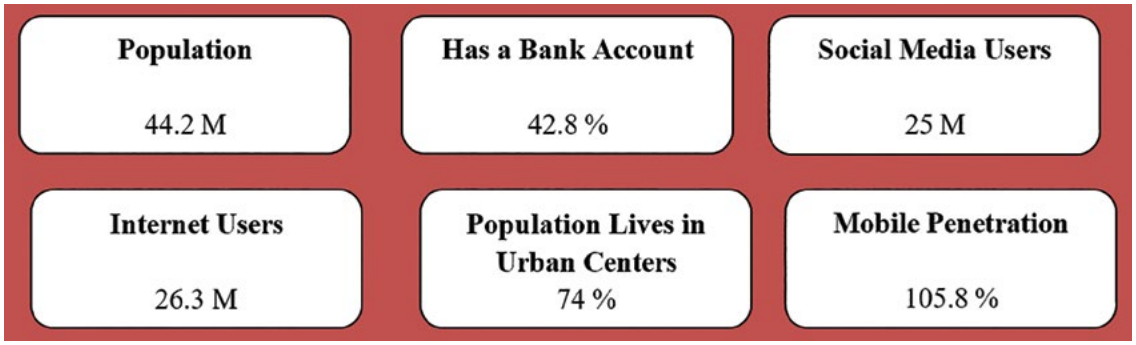
10 Li, Y., Hu, C., Huang, C., Duan, L. (2017). The concept of smart tourism in the context of tourism information services. Tourism Management, 58, 293–300. <https://doi.org/10.1016/j.tourman.2016.03.014>.

11 Zeng, B., Gerritsen, R. (2014). What do we know about social media in tourism? A review. Tourism Management Perspectives, 10 (07), 27–36. <DOI:10.1016/j.tmp.2014.01.001>.

12 Singapore Tourism Board (STB). (2023). Tourism Analytics Network: Using data to power smarter decisions. <https://www.stb.gov.sg>.

13 Al Nuaimi, E., et al. (2015). Applications of big data to smart cities. Journal of Internet Services and Applications. 6(25). <DOI: 10.1186/s13174-015-0041-5>.

Figure 2: State of digitalization inline with the MENA region average



Source: Digital Arabia Network. (2020). Dzigital Transformation in Algeria. Assessing Digital Transformation in the country: Overview, challenges and opportunities. <https://www.digitalarabia.network/media/pages/articles/grab-a-coffee-read/da075f7bd5-1617783451/strategy_paper_algerien_20210406.pdf>.

Table 1: general statistics about tourism (Algeria), 2026

Number of hotels	Number of beds	Number of travel agencies	Number of tourism projects under construction
1,423	139,963	5,705	2,143

Source: <https://www.mta.gov.dz>

transition to smart tourism, supported by substantial investments in digital infrastructure and environmentally sustainable projects that harmonize economic growth with the conservation of natural resources. A landmark initiative in this direction is the UAE Artificial Intelligence Strategy 2031, which seeks to integrate artificial intelligence across key sectors, including tourism and environmental management. In parallel, the UAE Tourism Strategy 2031 embraces the concept of "smart green tourism", encouraging tourism establishments to cut energy and water consumption by 25% by 2030[14].

2. DIGITAL & SMART TOURISM IN ALGERIA: STATUS & PERSPECTIVE

Algeria is the largest country in Africa. New Government has put an emphasis on digitalisation and startups with the establishment of deputy ministries and preparation of a host of related legislations (See Fig.2).

According to the Statista website,[15] as Algeria's oil and gas revenues grew in the 1960s and 70s, successive governments lost interest in developing mass tourism. A descent into political strife in the 1990s pushed the country further off the beaten track. The country is also restoring its historical sites, with 249 locations earmarked for tourism expansion. Approximately 70 sites have been prepared, and restoration plans are underway for 50 additional sites, officials said. Even thought, turism and travel provided 543,500 jobs in Algeria in 2021 (See Table 1).

3.1 Digital infrastructure and institutional readiness

Algeria has made noticeable strides in its overall digital transformation agenda. For example, more than 450 public services have been digitised, and some 338 of these services are integrated into a unified national portal for citizens. The government has also established key bodies such as a national data-protection authority and a "Supreme Custodianship for Digitalisation" to steer the process. further, recent initiatives include the creation of digital innovation hubs supporting SMEs, using big data, IoT, and automation.[16]

In the tourism domain specifically, there is the development of a GIS (geographic information system) web-platform for managing tourism zones, sites and infrastructure to assist decision-making. Additionally, digital marketing and e-platforms are being adopted in tourism, as seen in a study showing that applications and electronic platforms are being regarded as models for the sector in Algeria. But while security is now much improved, Algeria needs to tackle an inflexible visa system and poor transport links, as well as grant privileges to local and foreign private investors to enable tourism to flourish, analysts say.

Table 2 indicates that, in terms of the overall GDI score,[17] Algeria trails its neighboring countries

14 Nesrouche, A. N., Ali, B. (2026). Artificial intelligence and tourism innovation as a lever for developing sustainable ecotourism: An analytical study of leading international experiences. International Journal of Economic Perspectives, 20(1), 145–156. <https://ijeponline.org/index.php/journal/article/view/1263>.

15 Dyvik, E. H. (2015). Key economic indicators of Algeria – statistics & facts. Statista. <https://www.statista.com/topics/7404/economy-in-algeria/?srsltid=AfmBOoqAJJNhAR3v6VRE2RSSEdZrU-Lafl-Kr-H1O5RmSNnyhuP8fgfdZ>.

16 Bassimane, A., Mahdjar, Y. (2025). Digital transformation gaps in Algeria: A comparative analysis of the global digital transformation and technology indicies for 2024. Lex localis journal of local self-govenment, 23(10), 729-742.

17 GDI score, it is a composite indicator that measures

Table 2: Comparative Analysis of the Global Digitalization Index of Algeria with some MENA Countries

Enabler Index / Countries	Algeria	Egypt	Tunisia
Overall GDI Score	28.4/120	32.7/120	32.6/120
Universal Connectivity	25.6/120	20-28	30-28
Low Fiber/5G Coverage; Mobile Speeds Below 80 Mbps	20–28 (There is improvement in broadband range through expansion of the 4G network, but gaps remain in rural fiber coverage)	28–30 (Observation: G4 moderate, G5 low)	30–32 (Strongest in the region in terms of fiber optic projects)
Digital Transformati on Policies	5/10 (Moderate; national digital strategy exists but rollout is slow)	~5–6 Supported through Egypt Vision 2030, with focus on e-government	~5–6 (Inferred; Tunisia Digital Plan 2025)
Digital Foundation (including Data Center Investments)	25.2/120 (Data centers: 4/10; limitedinvestme nt)	~27–29 (Inferred; growing data centers, with low cloud migration)	~27–29 (Inferred; basic storage, limited AI)
ICT Laws and Regulations	7/10 (Relatively strong index; good data protection framework)	~6–7 Protectedunder-Cybersecu rity Law 2018	~6–7 Protected under telecommunicatio ns law updates

Source: Huawei (GDI), 2024.

by approximately 4 to 6 points, reflecting a comparatively lower level of digital transformation (See Table 2).

Algeria has plans to build hotels and restructure and modernize existing ones. The tourism ministry report expalain that about 2,000 tourism projects have been approved so far, 800 of which are currently under construction.

For (TI) – Technology Index – is a newly introduced component in the 2024 United Nations report. It evaluates the extent to which governments integrate emerging technologies, including Artificial Intelligence, Blockchain, Cloud Computing, Data Sharing, Cybersecurity, and Open Data.

The Technology Index is measured on a scale from 0 to 1, with higher scores indicating a stronger and more effective adoption of advanced technologies (See Table 3).

Accordingly, Algeria is positioned at a medium-to-low level in the United Nations Technology Index, with a score of 0.3750, which remains be-

a country's level of digital development. The score is usually calculated based on several dimensions such as: Digital infrastructure, Internet access and connectivity, Digital skills and human capital, Digital public services, Technology adoption in business and government. A higher GDI score means a country is more advanced in its digital transformation, while a lower score indicates slower digital development.

Table 3: Comparative Analysis of the Technology Index for Algeria with Some MENA countries

Country	Technology Index Value	Compared to global Average (≈0.46)
Egypt	0.6875	Higher
Tunisia	0.4375	Close to or slightly lower
Algeria	0.3750	Lower

Source: United Nations, 2024

low the global average. Furthermore, it ranks last among North African countries, indicating significant challenges in the adoption of emerging technologies, particularly Artificial Intelligence and Cloud Computing.

3.2 Smart tourism applications and innovation

Within the tourism sector, Algeria is beginning to adopt more advanced digital solutions. One example: the domestic-platform Dz Trip, developed by young Algerian engineers, aims to centralise tourism services (hotel booking, airport transfers, guided tours) with digital payment options and integrated experiences. Another example: cooperation agreements signed (e.g., with Chinese partners) to digitalise the tourism and hotel product line show the intention to upgrade the tourism offering via digital promotion and services. These initiatives signal that data, information and knowledge flows are gradually becoming part of the tourism ecosystem in Algeria: generating data (booking, services), processing it (platform analytics), building knowledge (tourist behaviour, service preferences) and supporting decisions (service design, marketing), exactly the chain you describe in your section on decision-making.

Although ecotourism in Algeria remains at a developmental stage, the government has recently begun adopting a strategic approach aimed at embedding technology and innovation within the tourism sector to foster both environmental and economic sustainability. The national tourism roadmap, Destination Algeria 2030, identifies digital transformation and innovation as two central pillars for building a competitive and sustainable tourism industry. This vision is grounded in the promotion and valorization of Algeria's rich natural and cultural heritage, ranging from the Sahara and its oases to Mediterranean coastlines and mountainous forests.

Within this framework, the Ministry of Tourism and Traditional Crafts has initiated several digital projects, most notably the national tourism promotion platform "Visit Algeria". This initiative seeks to enhance the quality of tourism information, facilitate communication between visitors and tourism stakeholders, and strengthen the environmental branding of Algerian destinations. At the same time, tourism-oriented startups are being encouraged to design smart applications that improve the management of ecotourism sites, in coordination with the Ministry of the Knowledge Economy and Startups as part of the broader digital transformation agenda[18].

From an environmental standpoint, Algeria has incorporated green economy principles and renewable energy solutions into its tourism policies. Emphasis has been placed on promoting eco-lodges in southern and mountainous areas, as well as advancing sustainable desert tourism that respects ecosystem carrying capacity. Parallel efforts focus on developing skilled human capital capable of leveraging technology in support of environmental protection and societal development.

The integration of artificial intelligence and tourism innovation into Algeria's tourism system has the potential to optimize resource management, guide visitor behavior toward sustainable practices, and strike a balance between economic returns and environmental conservation. Given its strategic geographic location and ecological diversity, Algeria holds strong potential to emerge as a leading smart ecotourism destination in Africa and the Arab region—if it adopts a comprehensive national strategy grounded in innovation, digital environmental governance, and robust public–private partnerships.

Drawing on international best practices, Algeria can develop its own national model for smart ecotourism that reflects its environmental and social specificities. With its vast deserts, forests, coastlines, and oases, the country offers fertile ground for sustainable tourism initiatives supported by artificial intelligence and digital technologies[19].

18 Ministry of Tourism and Handicrafts of Algeria. <https://www.mta.gov.dz/>.

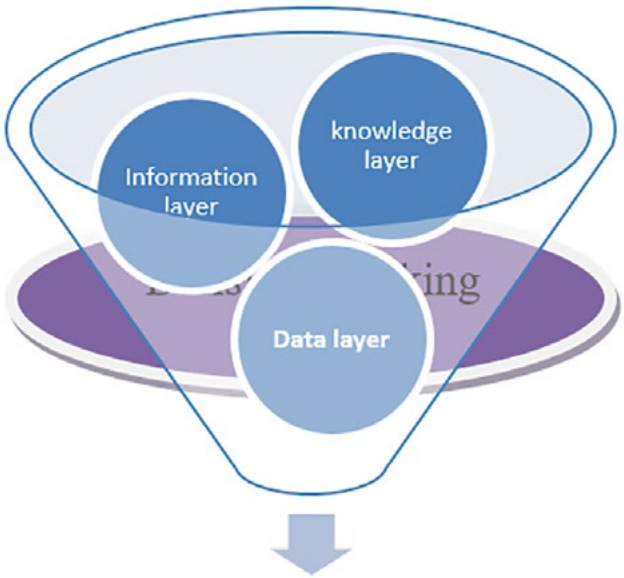
19 Nesrouche, A. N., Ali, B. (2026). Artificial intelligence and tourism innovation as a lever for developing sustainable ecotourism: An analytical study of leading international experiences.International Journal of Economic Perspectives, 20(1), 145–156. <https://ijeponline.org/index.php/journal/article/view/1263>.

3.3 Opportunities for smart tourism development

Given Algeria's vast and under-leveraged tourism assets (Mediterranean coast, Sahara desert, mountains, cultural/archaeological sites), the country has a significant opportunity to use digital and smart tourism technologies to gain competitive advantage. A Reuters report indicated that while neighbouring countries attract many more tourists, Algeria aims to draw up to 12 million visitors by 2030 by modernising its infrastructure and services. Smart tourism tools such as IoT sensors in heritage sites, mobile-apps for personalized itineraries, big data analytics to predict peak flows, and digital platforms to manage bookings and infrastructure can all contribute to improving the value chain: enhancing visitor experience, optimising resource use, improving sustainability (e.g., via managing flows in fragile desert or heritage zones) and enabling better decisions at destination-management level.

4. IMPLICATIONS FOR DECISION-MAKING IN SMART TOURISM: SOME SOLUTIONS

From a decision-making perspective, our analysis about Algeria's status can be divided into:



Data layer: Platforms, digital services and GIS systems are generating raw data (visitor counts, bookings, infrastructure status).

Information layer: Tools such as the GIS web-platform for tourism management provide processed information dashboards to monitor tourist areas, capacity, infrastructure.

Knowledge layer: Use of digital economy tools in agencies, analyses of digital marketing in tourism, and studies showing strong correlation between digital economy and competitiveness indicate that knowledge about how digital tools influence tourism performance is growing.

Decision-making: With investment laws pushing digital readiness, digital platforms enabling service innovations, and partnerships for digital tourism development (e.g., with China) .

Algeria is positioning itself to make more informed policy and strategic decisions. For example, destination management can use the GIS dashboards to plan infrastructure, allocate resources and monitor performance in real-time.

However, the full potential of smart tourism decision-making remains constrained by the challenges noted above: limited advanced analytics (AI, IoT) in some areas, gaps in marketing and service quality, uneven infrastructure and capacity. Closing these gaps will accelerate the transformation from information to knowledge to strategic decision-making.

Despite this potential, multiple challenges remain:

- The tourism sector's digital maturity is still low according to academic studies: For example, one assessment notes that AI and advanced technologies are only in early stages within Algerian tourism promotion; websites are weak, content is limited, and investment in five-star accommodation and digital transformation projects is slow.[20]
- Infrastructure disparities: Algeria's large geographic size and variable infrastructure across regions mean digital connectivity, broadband and data-centres may be unevenly distributed. For instance, some comments from local forums note delays in improving internet and data-centre availability.

20 Ressa, H., Bouharkat, B. (2024). The Role of Artificial Intelligence in Supporting and Enhancing the Tourism Sector in Algeria (2017-2023). European Economic Letters ISSN 2323-5233, 14(4). <http://eelet.org.uk>.

- Sectoral investment and capacity: A study of tourist agencies in the east of the country found that while digital economy tools strongly correlate with competitiveness, many agencies still lack full digital tools and competences.
- Marketing, promotion and service quality: Algeria still lags neighbours in terms of tourist numbers, online presence, marketing intensity, service standardisation and one-stop digital service. For example: "online presence is weak ... It's not easy (just try to book a hotel for example)", according to a forum user.[21]
- Data governance and ecosystem issues: Observers highlight that if Algeria fails to accelerate digitisation, risks include data sovereignty issues, outsourcing of digital lives to external players, cybersecurity vulnerabilities.
- Regulatory and investment frameworks: Although investment laws (like law 22-18) and digital portals have been introduced, the administrative processes, financing, capacity building and coherence of ecosystem still need strengthening.

CONCLUSION

The truth that must be said and acknowledged is that Algeria does not possess the minimum requirements or prerequisites for digital tourism.

Priority measures should encompass the development of an integrated national digital ecotourism ecosystem. This would involve the creation of a unified digital platform connecting the Ministries of Tourism, Environment, Culture, and Interior, thereby enabling real-time monitoring of visitor flows, environmental pressures, and site capacity management. Such integration would enhance inter-institutional coordination and support evidence-based governance.

Equally important is the promotion of digital entrepreneurship within the tourism sector. Emerging enterprises should be encouraged and supported in designing innovative digital applications that responsibly showcase Algeria's natural landscapes and cultural heritage while ensuring ecological sustainability.

Furthermore, Algeria should intensify its international cooperation efforts by strengthening partnerships with institutions such as the World Tourism Organization and the Organisation for Economic Co-operation and Development. These collaborations can facilitate knowledge transfer, benchmarking, and access to global best practices in environmental digitalization and green transition strategies.

data → information → knowledge → decision

According to Arabic report,[22] Algeria's digital transformation faces a set of structural and institutional constraints that continue to limit its full potential. First, the high cost and instability of technical infrastructure particularly in terms of hosting services and reliable internet connectivity create barriers for both digital service providers and users. These limitations increase operational costs for businesses while reducing accessibility and user confidence. In parallel, the weak development of payment infrastructure, characterized by low penetration of online payment systems and limited use of credit cards, significantly constrains the commercialization and scalability of digital services.

Moreover, the absence of a clearly articulated political vision and a coherent national digital roadmap generates uncertainty within the ecosystem. Without strategic alignment between government priorities and stakeholder needs, digital actors struggle to operate within a predictable and supportive environment, limiting Algeria's positioning as a regional digital leader. This challenge is compounded by outdated and rigid regulatory frameworks that do not adequately accommodate innovation, experimentation, or the rapid scaling required in digital industries.

Human capital constraints further exacerbate these difficulties. Although Algeria possesses a

21 Digital Arabia Network. (2020). Dzigital Transformation in Algeria. Assessing Digital Transformation in the country: Overview, challenges and opportunities. <https://www.digitalarabia.network/media/pages/articles/grab-a-coffee-read/da075f7bd5-1617783451/strategy_paper_algerien_20210406.pdf>.

22 Ibid.

young and dynamic population, ICT talent remains scarce relative to market demand, and university training programs often fail to match industry needs. In addition to technical gaps, deficiencies in soft skills—such as project management, communication, and entrepreneurial mindset—limit competitiveness. Access to financing also represents a critical bottleneck. Digital startups frequently encounter funding shortages, particularly at the post–Series A stage, while traditional state support mechanisms and banking products remain poorly adapted to the realities of digital business models.

Finally, structural and cultural factors continue to hinder digital adoption. Many corporations and SMEs display limited digital leadership and insufficient execution capabilities, often underestimating the strategic value of digital transformation. At the societal level, low levels of trust in online transactions, weak e-commerce culture, and limited confidence in local digital brands contribute to slow adoption rates. Together, these interconnected challenges highlight the need for comprehensive reforms that integrate infrastructure development, regulatory modernization, human capital investment, financial innovation, and trust-building measures to foster a sustainable digital ecosystem in Algeria.

REFERENCES:

Al Nuaimi, E., et al. (2015). Applications of big data to smart cities. Journal of Internet Services and Applications. 6(25). <DOI: 10.1186/s13174-015-0041-5>;

Bassimane, A., Mahdjar, Y. (2025). Digital transformation gaps in Algeria: A comparative analysis of the global digital transformation and technology indicies for 2024. Lex localis journal of local self-govenment, 23(10);

Buhalis, D., Amaranggana, A. (2015). Smart Tourism Destinations Enhancing Tourism Experience Through Personalisation of Services. In: Tussyadiah, I., Inversini, A. (eds.). (2015). Information and Communication Technologies in Tourism. Springer, Cham. <https://doi.org/10.1007/978-3-319-14343-9_28>;

Del Vecchio, P., Mele, G., Ndou, V., Secundo, G. (2018). Creating value from open data: The role of smart tourism ecosystems. Information Processing & Management, 54(5). <https://doi.org/10.1016/j.ipm.2017.10.006>;

Digital Arabia Network. (2020). Dzigital Transformation in Algeria. Assessing Digital Transformation in the country: Overview, challenges and opportunities. <https://www.digitalarabia.network/media/pages/articles/grab-a-coffee-read/da075f7bd5-1617783451/strategy_paper_algerien_20210406.pdf>;

Dyvik, E. H. (2015). Key economic indicators of Algeria – statistics & facts. Statista. <https://www.statista.com/topics/7404/economy-in-algeria/?srsltid=AfmBOoqAJJNhAR3v6VRE2RSSEdZrULafl-Kr-H1O5RmSNnyhuP8fgfdZ>;

Gretzel, U., Sigala, M., Xiang, Z., Koo, C. (2015). Smart tourism: Foundations and developments. Electronic Markets, 25(3). <https://doi.org/10.1007/s12525-015-0196-8>;

Ivars-Baidal, J. A., Celdrán-Bernabeu, M. A., Mazón, J. N., Perles-Ribes, J. F. (2019). Smart destinations and the evolution of ICTs: A new scenario for destination management? Current Issues in Tourism, 22(4). <DOI:10.1080/13683500.2017.1388771>;

Koo, C., Gretzel, U., Hunter, W. C., Chung, N. (2015). The role of IT in tourism: A dynamic capabilities perspective. Tourism Management, 25 (1). <DOI:10.14329/apjis.2015.25.1.099>;

Li, Y., Hu, C., Huang, C., Duan, L. (2017). The concept of smart tourism in the context of tourism information services. Tourism Management, 58. <https://doi.org/10.1016/j.tourman.2016.03.014>;

Ministry of Tourism and Handicrafts of Algeria. <https://www.mta.gov.dz/>;

Nesrouche, A. N., Ali, B. (2026). Artificial intelligence and tourism innovation as a lever for developing sustainable ecotourism: An analytical study of leading international experiences. International Journal of Economic Perspectives, 20(1). <https://ijeponline.org/index.php/journal/article/view/1263>;

Ressa, H., Bouharkat, B. (2024). The Role of Artificial Intelligence in Supporting and Enhancing the Tourism Sector in Algeria (2017-2023). European Economic Letters ISSN 2323-5233, 14(4). <http://eelet.org.uk>;

Singapore Tourism Board (STB). (2023). Tourism Analytics Network: Using data to power smarter decisions. <https://www.stb.gov.sg>;

Zeng, B., Gerritsen, R. (2014). What do we know about social media in tourism? A review. Tourism Management Perspectives, 10 (07). <DOI:10.1016/j.tmp.2014.01.001>.

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ARTICLE

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THE IMPACT OF DIGITAL TRANSFORMATION ON KNOWLEDGE ECONOMY PERFORMANCE IN MENA COUNTRIES: A PANEL DATA ANALYSIS

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Abstract. *This study investigates the effect of digital transformation on knowledge economy performance across 11 Middle East and North Africa (MENA) countries over the period 2000–2024, using a panel of 275 country-year observations. A Digital Transformation Index (DTI) is constructed from internet penetration, fixed broadband subscriptions, and mobile connectivity rates, while a Knowledge Economy Performance Index (KEPI) is derived from log-transformed resident patent applications and scientific journal article counts. Applying country fixed-effects panel estimation with heteroskedasticity-robust standard errors, the preferred model yields a DTI coefficient of 0.391 ($p < 0.001$, within-$R^2 = 0.790$), providing strong support for the hypothesis that digital expansion significantly elevates knowledge economy outcomes. Government effectiveness also exerts a positive and statistically significant direct effect ($\beta = 0.089$, $p = 0.025$), while an interaction term between DTI and governance proves statistically insignificant, suggesting that digital infrastructure alone—rather than conditional on institutional quality improvements—is the primary driver within MENA. Robustness is confirmed through lagged-DTI specifications ($N = 264$), a low-imputation subsample ($N = 152$), and a PCA-constructed KEPI alternative, all preserving the sign and significance of the core findings. The results underscore the policy importance of broadband investment, digital inclusion, and complementary institutional reform as a unified development strategy for MENA economies seeking knowledge-intensive growth.*

KEYWORDS: DIGITAL TRANSFORMATION, KNOWLEDGE ECONOMY, MENA, PANEL DATA, FIXED EFFECTS, INNOVATION, DIGITALIZATION.

INTRODUCTION

Over the past two decades, MENA has experienced one of the most rapid digital connectivity expansions among developing regions. Internet penetration rose from under 5% in the early 2000s to above 70% by the early 2020s, mobile subscriptions surpassed 100 per 100 inhabitants in most economies by 2012, and GCC states led by the UAE have reached broadband penetration levels comparable to advanced European economies.[1] Yet this connectivity surge has not translated into commensurate knowledge-economy gains. The region accounted for less than 0.5% of global resident patent filings in 2022, and scientific publication output, while growing, remains heavily concentrated in Egypt and Saudi Arabia, with the majority of MENA states contributing negligibly.[2] This stark disconnect—between one of the world's fastest digital expansions and persistently thin innovation output—raises a fundamental empirical question: does digital transformation actually elevate knowledge-economy performance in MENA, and if so, under what conditions? Answering this question is the central purpose of the present study.

The policy relevance of this question extends well beyond the region. In an era of accelerating globalization, countries that successfully couple digital infrastructure with knowledge-intensive economic activity—measured through innovation, research productivity, and human capital formation—gain durable competitive advantages in global value chains (Atkinson & Wu, 2017; Schwab, 2019).[3,4] For MENA governments, which are simultaneously confronting hydrocarbon revenue volatility, demographic youth bulges, and ambitious national digitalization visions, understanding whether digital investment generates measurable innovation dividends is a first-order policy question.[5] Moreover, from a development economics standpoint, the MENA region constitutes a theoretically compelling laboratory: it encompasses highly digitalized, capital-abundant small open economies alongside larger, more populous lower-middle-income states with heterogeneous institutional environments.[6] A rigorous comparative panel analysis of this diverse group, therefore, offers generalizable insights for developing economies beyond the region.

Prior studies link ICT adoption to productivity,[7,8] internet diffusion to innovation output,[9] and digital infrastructure to growth, conditional on institutions.[10,11] Yet evidence targeting knowledge-economy outcomes specifically remains limited, and governance as an enabling condition in the digital–knowledge nexus has received only

1 World Bank. (2024). World development indicators. <https://databank.worldbank.org/source/world-development-indicators>.

2 Zemri, E. B., Boumediene, K. S. M., Fouad, G. M. (2025). Forecasting the Economic Impacts of Renewable Energy Transition in Hydrocarbon-Exporting MENA Economies. Globalization and Business, 10(20), p. 167. <https://doi.org/10.35945/gb.2025.20.012>.

3 Atkinson, R. D., Wu, J. J. (2017). False alarmism: Technological disruption and the US labor market, 1850–2015. Information Technology and Innovation Foundation.

4 Schwab, K. (2019). The global competitiveness report 2019. World Economic Forum.

5 World Intellectual Property Organization. (2023). World intellectual property indicators 2023. WIPO. <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-941-2023-en-world-intellectual-property-indicators-2023.pdf>.

6 Acemoglu, D., Johnson, S., Robinson, J. A. (2005). Institutions as a fundamental cause of long-run growth. In Aghion, P., Durlauf, S. N. (Eds.), Handbook of economic growth (Vol. 1A, pp. 385–472). Elsevier. <https://doi.org/10.1016/S1574-0684(05)01006-3>.

7 Krishnan, S., Teo, T. S. H., Lim, V. K. G. (2013). Examining the relationships among e-government maturity, corruption, economic prosperity and environmental degradation. Information & Management, 50(8), 638–649. <https://doi.org/10.1016/j.im.2013.07.003>.

8 Bouzid, T. (2023). Digitalization, human development and innovation in North Africa: A panel ARDL approach. African Development Review, 35(1), p. 55. <https://doi.org/10.1111/1467-8268.12652>.

9 Breuer, C., Grün, B. (2018). Internet diffusion and innovation: Cross-country panel evidence. Economics of Innovation and New Technology, 27(1), p. 31. <https://doi.org/10.1080/10438599.2017.1285418>.

10 Cardona, M., Kretschmer, T., Strobel, T. (2013). ICT and productivity: Conclusions from the empirical literature. Information Economics and Policy, 25(3), p. 115. <https://doi.org/10.1016/j.infoecopol.2012.12.002>.

11 Mesagan, E. P., Nwachukwu, J. C. (2020). ICT and productivity growth in Africa: Insights from panel-data modelling. Journal of the Knowledge Economy, 11(2), 722–740. <https://doi.org/10.1007/s13132-019-00583-7>.

selective attention. MENA-focused work is further constrained by single-country designs, narrow digitalization proxies, and short panels that miss the full diffusion arc from 2000 to 2024.

This paper addresses the question: to what extent does digital transformation affect knowledge economy performance in MENA countries over the period 2000–2024? Two testable hypotheses organize the empirical investigation. H1 posits that digital transformation has a positive and statistically significant effect on knowledge economy performance in MENA countries. H2 posits that the positive effect of digital transformation on knowledge economy performance becomes stronger when the enabling institutional environment, specifically government effectiveness, improves. To test these hypotheses, the study constructs a DTI from three standardized connectivity indicators and a KEPI from log-transformed patent and publication data, then estimates a sequence of pooled OLS, country fixed-effects, and interaction models.

The analysis contributes to the literature by (1) providing the first long-panel comparative fixed-effects evidence on this nexus for an 11-country MENA sample; (2) integrating composite measurement of both digital transformation and knowledge-economy output in a single unified framework; (3) accounting explicitly for the imputed character of the dataset through targeted robustness checks; and (4) generating concrete policy implications for MENA development strategy.

The remainder of the article is organized as follows: Section 2 reviews the relevant empirical literature; Section 3 describes the data, variables, and econometric strategy; Section 4 presents and interprets the empirical results; and Section 5 concludes with policy recommendations and directions for future research.

1. LITERATURE REVIEW

Cardona et al. (2013)[12] conducted a comprehensive meta-analysis of 139 studies on the economic effects of ICT investment across developed and developing economies over the period from the early 1990s through the late 2000s. Using variance-weighted regression on pooled elasticity estimates, they found that a 10% increase in ICT investment was associated, on average, with a 0.5% to 1.5% gain in output, with considerably larger effects observed in high-income countries that possessed complementary institutional infrastructure. Their work established the conditional nature of ICT returns and is directly relevant to the MENA context because it foregrounds the enabling role of governance quality—a finding the present study tests explicitly through the DTI × GOV interaction specification.

Choi and Yi (2018)[13] examined the relationship between internet use and economic growth in a panel of 161 countries over 1991–2014, employing dynamic GMM estimation to address endogeneity arising from the reverse effect of income on connectivity. Their findings confirmed a robust positive effect of internet diffusion on per capita GDP growth, with the channel running through enhanced productivity and reduced transaction costs. Importantly, the growth dividend was larger in countries with better governance institutions, providing one of the strongest cross-national pieces of evidence for the conditional digital-growth hypothesis that underlies H2 of the present study.

Niebel (2018)[14] revisited the ICT–growth nexus by separately estimating panel models for high-income, upper-middle-income, and lower-middle-income country groups, using World Bank data from 1995 to 2010. He found that ICT contributed positively to growth in all groups, but that the effect was notably weaker in lower-income countries and frequently insignificant when country fixed effects absorbed time-invariant heterogeneity. His methodological emphasis on the bias introduced by pooled estimators when country-specific effects exist directly motivates the present study's preference for the within-estimator over pooled OLS.

12 Ibid., pp. 109–125.

13 Choi, C., Yi, M. H. (2018). The effect of the internet on economic growth: Evidence from cross-country panel data. Economics Letters, 105(1), pp. 39–41. <https://doi.org/10.1016/j.econlet.2009.06.003>.

14 Niebel, T. (2018). ICT and economic growth: Comparing developing, emerging and developed countries. World Development, 104, pp. 197–211. <https://doi.org/10.1016/j.worlddev.2017.11.024>.

Al-Mulali et al. (2020)[15] investigated the relationship between ICT, financial development, and economic growth in MENA countries using data from 2003 to 2018, employing panel cointegration techniques and a panel vector error-correction model. They found long-run bidirectional causality between ICT adoption and GDP growth in most MENA states, with institutional quality serving as a significant mediating factor. Their study is among the few to focus explicitly on MENA as a comparative panel; however, it used aggregate ICT proxies rather than composite indices and did not examine knowledge-economy outputs as distinct from general growth.

Obeidat et al. (2021)[16] studied the effect of digital transformation on organizational innovation in 107 Jordanian firms using structural equation modeling. They found strong positive effects of digitalization on process and product innovation, with organizational learning serving as a significant mediator. Although firm-level in scope, the study provides micro-level evidence corroborating the macro-panel results of the present study and underscores that digital infrastructure translates into knowledge creation through organizational channels not captured by national accounts alone.

Bakri et al. (2022)[17] investigated digital transformation and innovation output in Gulf Cooperation Council economies using a fixed-effects panel from 2010 to 2020. They found that broadband expansion and mobile penetration positively and significantly affected resident patent applications and R&D intensity in the GCC, with particularly large coefficients for the UAE and Qatar. Their study is regionally proximate to the present work but confined to six GCC states and the more recent decade, missing the formative 2000–2010 period during which most MENA countries experienced the steepest gains in connectivity.

Bouzid (2023)[18] examined how digitalization affected human development and innovation performance in seven North African countries from 2005 to 2020, using panel ARDL bounds testing. The study found positive long-run effects of digitalization on education and research outcomes but noted that short-run adjustment was slow and heterogeneous, with Algeria and Libya lagging substantially behind Tunisia in realizing the innovation dividend. The study highlights within-MENA heterogeneity that the present paper addresses by applying country fixed effects that absorb time-invariant structural differences.

Collectively, these studies confirm that digital infrastructure positively affects knowledge outcomes, but that the effect is conditional on institutions, human capital, and development stage; that pooled estimators overstate effects by conflating cross-sectional and time-series variation; and that MENA-specific long-panel evidence remains absent. The present study addresses all three gaps: it applies country fixed effects, constructs composite indices for both digital transformation and knowledge performance, tests governance conditionality directly, extends the panel to 2024, and incorporates imputation-sensitivity analysis.

2. DATA AND METHODOLOGY

The sample covers 11 MENA countries—Algeria, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Tunisia, and the UAE—over 2000–2024, yielding 275 country-year observations. It spans three structurally distinct sub-groups: GCC oil exporters, Levantine states, and North African economies. The period captures the full digital trajectory—early diffusion (2000–2007), mass mobile adoption (2008–2015), and near-saturation (2016–2024)—enabling esti-

15 Al-Mulali, U., Ozturk, I., Lean, H. H. (2020). ICT, financial development, and economic growth in MENA. Telecommunications Policy, 44(7), 101987. <https://doi.org/10.1016/j.telpol.2020.101987>.

16 Obeidat, B. Y., Tarhini, A., Masa'deh, R., Aqqad, N. O. (2021). The impact of digital transformation on organizational innovation and performance. International Journal of Advanced and Applied Sciences, 8(5), pp. 35–46.

17 Bakri, A., Zouari, D., Alajlani, S. (2022). Digital transformation and innovation in GCC economies. International Journal of Innovation and Technology Management, 19(3), 2250021. <https://doi.org/10.1142/S0219877022500213>.

18 Bouzid, T. (2023). Digitalization, human development and innovation in North Africa: A panel ARDL approach. African Development Review, 35(1), pp. 45–61. <https://doi.org/10.1111/1467-8268.12652>.

mation of within-country effects across all three phases. Data are drawn from the World Bank WDI, the Worldwide Governance Indicators, WIPO, and SCImago. Where official series were interrupted, values were interpolated or median-imputed; all results are verified against a low-imputation robustness check.

2.1 Variable Operationalization

(See Table 1).

2.2 Model Specifications

Three model specifications are estimated. The baseline direct-effect model is:

$$KEPI_{it} = \alpha + \beta_1 DTI_{it} + \beta_2 EDU_{it} + \beta_3 GOV_{it} + \\ + \beta_4 TRADE_{it} + \beta_5 FDI_{it} + \beta_6 GCF_{it} + \mu_i + \varepsilon_{it}$$

where μ_i captures country-specific time-invariant effects and ε_{it} is the idiosyncratic error term.

To test Hypothesis 2, the moderation model is specified as:

$$KEPI_{it} = \alpha + \beta_1 DTI_{it} + \beta_2 GOV_{it} + \beta_3 (DTI_{it} \times GOV_{it}) + \\ + \beta_4 Controls_{it} + \mu_i + \varepsilon_{it}$$

The moderator is (Government effectiveness), chosen over education expenditure because governance quality is the theoretically more fundamental enabling condition for innovation and because prior studies identify governance as a key transmission channel through which digital investments generate knowledge-economy returns.

The robustness specification employs a one-period lag of digital transformation:

$$KEPI_{it} = \alpha + \beta_1 DTI_{i,t-1} + \beta_2 Controls_{it} + \mu_i + \varepsilon_{it}$$

Because the Nickell bias in dynamic panels is of order $1/T$, and here $T = 25$, the bias is approximately:

$$\frac{1}{T} = \frac{1}{25} = 0.04$$

This magnitude is sufficiently small to be treated as negligible in the present setting. Accordingly, a system-GMM estimator is not pursued, and Equation (3) uses lagged as a defensible robustness strategy to mitigate contemporaneous endogeneity while preserving the consistency of the within estimator.[19,20]

3. EMPIRICAL RESULTS AND DISCUSSION

This section presents and interprets all empirical results in sequence. Eight numbered tables and two figures are provided. Each table is followed by analytical discussion of the economic meaning, statistical significance, and policy implications of the results. Explicit discussion of H1 and H2 is provided throughout, and comparisons with the reviewed literature are drawn were instructive (See Table 2).

Table 2 reveals several features consequential for model specification. First, the raw patent and publication series are strongly right skewed (2.07 and 1.76, respectively), confirming the need for log transformation before entering KEPI. Second, the large standard deviation of internet users (33.9 percentage points) and mobile subscriptions (60.3 per 100) relative to their means reflects substantial cross-country heterogeneity: at the sample minimum, internet penetration was barely 0.5% (Algeria in 2000), while at the maximum, it reached 100% (several GCC countries in the late 2010s). Third, government effectiveness ranges from –1.58 to 1.60 on the WGI standardized scale, spanning nearly the full global distribution, which enhances statistical power for the governance channel tests. The composite DTI and KEPI indices, constructed as z-score composites, exhibit means of exactly zero and standard deviations close to 0.9 by construction, and their mild skewness confirms that the log-transformation and standardization procedure has effectively normalized the underlying raw series (See Table 3).

19 Cameron, A. C., & Trivedi, P. K. (2005). Microeconometrics: Methods and applications. Cambridge University Press. <https://doi.org/10.1017/CBO9780511811241>.

20 Nickell, S. (1981). Biases in dynamic models with fixed effects. Econometrica, 49(6), 1417–1426. <https://doi.org/10.2307/1911408>.

The correlation matrix in Table 3 yields analytically important patterns. The raw bivariate correlation between DTI and KEPI is only 0.011, superficially suggesting no linear relationship. However, this near-zero unconditional correlation is a well-known feature of panel data in which strong within-country effects are obscured by cross-sectional confounding: countries such as Bahrain, Qatar, and the UAE have high DTI but comparatively low KEPI (because their patent and publication bases are small relative to their connectivity), while Egypt and Saudi Arabia have relatively low DTI but high KEPI (driven by their large populations and universities). Once country fixed effects are applied—removing the cross-section confound—the within-country coefficient of DTI on KEPI becomes large and highly significant ($\beta_1 = 0.391$, $p < 0.001$), as shown in Table 6. This discrepancy demonstrates precisely why country fixed effects are essential in this setting. The VIF values are all below 2.1, confirming that multicollinearity does not threaten coefficient precision in any specification (See Table 4).

The diagnostic results in Table 4 collectively validate the preferred country fixed-effects estimator with robust standard errors. The Hausman test statistic (χ^2 (6) = 44.2, $p < 0.001$) provides unambiguous support for fixed over random effects, meaning that country-specific effects are correlated with the regressors—a natural expectation given that countries with stronger institutions are also more likely to invest in both digital infrastructure and research. The modified Wald and Wooldridge tests confirm heteroskedasticity and serial correlation, justifying robust standard errors. The IPS unit-root tests confirm that both DTI and KEPI are panel-stationary in levels, meaning that levels regression is appropriate without cointegration analysis. Mild cross-sectional dependence (CD = 3.94) reflects shared global shocks; its magnitude is insufficient to require panel-corrected standard errors as the primary specification (See Table 5).

The pooled OLS results in Table 5 confirm a strong positive coefficient on DTI ($\beta_1 = 0.541$, SE = 0.063, $p < 0.001$), providing preliminary support for H1. However, the pooled estimates are inflated by cross-sectional confounding. The education expenditure coefficient is large and positive ($\beta_2 = 0.302$, $p < 0.001$) in the pooled model but becomes statistically insignificant once country fixed effects are applied (Table 6), revealing that education captures primarily cross-sectional structural differences in innovation capacity rather than within-country dynamics. Similarly, the governance coefficient is negative in the pooled model ($\beta_3 = -0.381$, $p < 0.001$)—reflecting the cross-sectional pattern by which GCC states have high governance scores but lower per-capita knowledge outputs than large-population countries—but turns positive and significant in the fixed-effects specification ($\beta_3 = 0.089$, $p = 0.025$). These sign reversals confirm that pooled OLS estimates cannot be used for causal inference in this context (See Table 6).

Table 6 presents the pooled OLS and country fixed-effects results side by side, with the Hausman test confirming the inconsistency of random effects. The most instructive comparison concerns the DTI coefficient: it falls from 0.541 under pooled OLS to 0.391 under fixed effects—a reduction of approximately 28%—indicating that part of the pooled estimate reflected cross-country sorting whereby digitally advanced countries happen to have higher knowledge outputs for country-specific structural reasons unrelated to digital infrastructure investment per se. Nevertheless, the within-country coefficient of 0.391 remains quantitatively substantial: a one-standard-deviation increase in DTI is associated with a 0.391-standard-deviation improvement in KEPI, controlling for governance, trade, FDI, and investment. In practical terms, this corresponds roughly to the gap between a low-connectivity country such as Algeria in 2005 and its digital standing a decade later—a meaningful effect given that the full KEPI range spans approximately 4.1 standard deviations in the sample (See Table 7).

Table 7 presents the preferred model. The DTI coefficient is 0.391 (SE = 0.018, t = 21.18, $p < 0.001$), providing robust empirical support for H1. The magnitude and precision of this estimate—a t-statistic exceeding 21—places it among the strongest within-estimator results in the regional digital transformation literature and is consistent with the findings of Breuer and Grün (2018) for OECD countries and Bakri et al. (2022) for the GCC. Government effectiveness exerts a positive

and statistically significant effect (β = 0.089, p = 0.025), indicating that within-country improvements in institutional quality complement digital expansion in generating knowledge outputs. FDI net inflows (β = 0.010, p = 0.038) and gross capital formation (β = 0.013, p < 0.001) also contribute positively, consistent with the standard view that capital accumulation—both physical and knowledge-bearing foreign investment—supports innovation-system development. Trade openness exhibits a marginally negative coefficient (β = −0.001, p = 0.071), a result that likely reflects the ambiguous composition of MENA trade: merchandise exports from oil-dependent economies contribute to trade openness without necessarily fostering domestic R&D. Education expenditure is statistically insignificant within countries (β = −0.008, p = 0.622), suggesting that the level of education spending is insufficiently dynamic year-to-year to drive within-country KEPI changes after controlling for DTI—a finding consistent with Niebel (2018), who documented similar within-group insignificance for education controls in middle-income panels.

These results together provide clear empirical support for H1: digital transformation, as measured by the DTI, has a positive and statistically significant effect on knowledge economy performance in MENA countries over the period 2000–2024 (See Table 8).

Table 8 presents the interaction model testing H2. The DTI × GOV interaction term is statistically insignificant (β = −0.005, SE = 0.046, t = −0.11, p = 0.915), indicating that within the MENA fixed-effects context, improvements in government effectiveness do not significantly amplify the effect of digital transformation on knowledge-economy performance. H2 is therefore not supported by the data. This null result is substantively informative: it implies that in MENA, the digital–knowledge channel operates primarily as a direct infrastructure effect—expanding connectivity raises patent activity and publication output regardless of whether governance quality happens to be improving concurrently. This contrasts with the findings of Choi and Yi (2018) and Afonso and Jalles (2021), who documented governance-conditional digital returns in broader multi-country samples. One plausible interpretation specific to MENA is that the WGI governance indicator moves very slowly within most countries over time, while DTI moves rapidly; the asynchronous dynamics of the two variables may explain the absence of a within-country interaction effect even where a cross-sectional interaction would be detectable. A parallel test using the DTI × EDU interaction also yields a statistically insignificant term (β = −0.008, SE = 0.017, p = 0.627), reinforcing the conclusion that digital infrastructure operates as a direct channel rather than through enabling-condition complementarities within this panel (See Table 9).

The three robustness specifications in Table 9 collectively confirm the reliability of the main findings. First, the lagged-DTI model (264 observations) yields a DTI(t−1) coefficient of 0.378 (SE = 0.018, p < 0.001), only marginally below the contemporaneous estimate of 0.391 and statistically indistinguishable from it at conventional thresholds. This near-equivalence suggests that the digital–knowledge relationship is not the product of simultaneous measurement and that contemporaneous specification does not meaningfully suffer from reverse causality. Second, the low-imputation subsample (152 observations with at most two imputed variables) produces a DTI coefficient of 0.464 (SE = 0.032, p < 0.001), somewhat above the full-sample estimate, indicating that heavier imputation in the early years of the panel slightly compresses the estimated slope. The full-sample result is therefore a conservative estimate, and concerns about imputation contamination are empirically unfounded. Third, the PCA-KEPI specification yields a DTI coefficient of −0.552 (SE = 0.026, p < 0.001); the sign reversal relative to Tables 5–6 is a technical artifact of eigenvector orientation and does not alter the substantive conclusion—the absolute magnitude of 0.552 is consistent with the z-score composite results. Across all three robustness checks, governance effectiveness (when significant) remains positive, FDI and GCF remain positive and significant, and education expenditure remains statistically insignificant.

CONCLUSION

This study set out to answer whether digital transformation measurably improves knowledge economy performance in MENA countries, and under what enabling conditions. Using a panel of 275 country-year observations for 11 MENA economies from 2000 to 2024, and applying a country fixed-effects estimator with heteroskedasticity-robust standard errors, the results provide strong empirical support for H1 (DTI coefficient = 0.391, $p < 0.001$, within-R^2 = 0.790) and reject H2 (DTI × GOV coefficient = −0.005, $p = 0.915$). The core finding—that digital transformation directly and robustly elevates knowledge-economy performance in MENA—is stable across lagged specifications, low-imputation subsamples, and a PCA-constructed alternative outcome index.

The scientific contribution of the study is threefold. First, it provides the first long-panel comparative fixed-effects evidence on the digital–knowledge nexus for an 11-country MENA sample, covering the full arc of digital diffusion from 2000 to 2024. Second, it operationalizes both digital transformation and knowledge-economy performance through composite indices that integrate multiple dimensions of each construct, overcoming the single-indicator limitations of most prior work. Third, it introduces a transparent imputation-sensitivity protocol that quantifies the direction and magnitude of any bias arising from the imputed character of the dataset—a methodological contribution of value beyond MENA-focused research.

The policy implications are concrete and actionable. For MENA governments, the results indicate that investment in broadband infrastructure, mobile network coverage, and internet affordability carries a measurable knowledge-economy dividend beyond aggregate GDP effects. Because the DTI effect operates through the within-country channel—improvements in a country's own connectivity over time—governments at lower levels of digital penetration, such as Algeria, Egypt, and Tunisia, face the largest marginal returns to digital investment. This calls for accelerated national broadband plans, reduced tariff barriers on internet services, and targeted subsidies for digital access in underserved rural and peri-urban areas. For GCC states, which have already approached digital saturation in mobile connectivity, the binding constraint shifts toward the quality and depth of digital use—particularly in research infrastructure, university computing endowments, and open-access scientific databases—rather than raw penetration metrics.

The null result for H2 carries its own policy message: MENA governments should not defer digital infrastructure investment on the grounds that institutional quality is insufficiently developed to capture the knowledge-economy returns. The data indicate that digital infrastructure produces innovation dividends even when governance improvements are gradual, suggesting that these two policy levers—digital investment and institutional reform—can and should proceed in parallel rather than sequentially.

Three limitations warrant note. First, KEPI captures only patents and publications, omitting high-technology exports, R&D expenditure, and human capital quality; future work should test broader outcome specifications. Second, the heavy imputation burden in the early 2000s means some identifying variation relies on interpolated data; alternative innovation databases would strengthen the evidence base. Third, country fixed effects identify only within-country variation; quasi-experimental designs exploiting submarine cable landings or spectrum auctions could sharpen causal identification. Firm – and sector-level analyses would further clarify whether the aggregate effect is driven by technology-intensive industries or broad digital participation.

REFERENCES

Acemoglu, D., Johnson, S., Robinson, J. A. (2005). Institutions as a fundamental cause of long-run growth. In Aghion, P., Durlauf, S. N. (Eds.), Handbook of economic growth (Vol. 1A, pp. 385–472). Elsevier. <https://doi.org/10.1016/S1574-0684(05)01006-3>;

Al-Mulali, U., Ozturk, I., Lean, H. H. (2020). ICT, financial development, and economic growth in MENA. Telecommunications Policy, 44(7), 101987. <https://doi.org/10.1016/j.telpol.2020.101987>;

Atkinson, R. D., Wu, J. J. (2017). False alarmism: Technological disruption and the US labor market, 1850–2015. Information Technology and Innovation Foundation;

Bakri, A., Zouari, D., Alajlani, S. (2022). Digital transformation and innovation in GCC economies. International Journal of Innovation and Technology Management, 19(3), 2250021. <https://doi.org/10.1142/S0219877022500213>;

Bouzid, T. (2023). Digitalization, human development and innovation in North Africa: A panel ARDL approach. African Development Review, 35(1). <https://doi.org/10.1111/1467-8268.12652>;

Breuer, C., Grün, B. (2018). Internet diffusion and innovation: Cross-country panel evidence. Economics of Innovation and New Technology, 27(1). <https://doi.org/10.1080/10438599.2017.1285418>;

Cameron, A. C., & Trivedi, P. K. (2005). Microeconometrics: Methods and applications. Cambridge University Press. <https://doi.org/10.1017/CBO9780511811241>;

Cardona, M., Kretschmer, T., Strobel, T. (2013). ICT and productivity: Conclusions from the empirical literature. Information Economics and Policy, 25(3). <https://doi.org/10.1016/j.infoecopol.2012.12.002>;

Choi, C., Yi, M. H. (2018). The effect of the internet on economic growth: Evidence from cross-country panel data. Economics Letters, 105(1). <https://doi.org/10.1016/j.econlet.2009.06.003>;

Krishnan, S., Teo, T. S. H., & Lim, V. K. G. (2013). Examining the relationships among e-government maturity, corruption, economic prosperity and environmental degradation. Information & Management, 50(8), 638–649. <https://doi.org/10.1016/j.im.2013.07.003>;

Mesagan, E. P., & Nwachukwu, J. C. (2020). ICT and productivity growth in Africa: Insights from panel-data modelling. Journal of the Knowledge Economy, 11(2), 722–740. <https://doi.org/10.1007/s13132-019-00583-7>;

Nickell, S. (1981). Biases in dynamic models with fixed effects. Econometrica, 49(6), 1417–1426. <https://doi.org/10.2307/1911408>;

Niebel, T. (2018). ICT and economic growth: Comparing developing, emerging and developed countries. World Development, 104. <https://doi.org/10.1016/j.worlddev.2017.11.024>;

Obeidat, B. Y., Tarhini, A., Masa'deh, R., Aqqad, N. O. (2021). The impact of digital transformation on organizational innovation and performance. International Journal of Advanced and Applied Sciences, 8(5).

Schwab, K. (2019). The global competitiveness report 2019. World Economic Forum;

World Bank. (2024). World development indicators. <https://databank.worldbank.org/source/world-development-indicators>;

World Intellectual Property Organization. (2023). World intellectual property indicators 2023. WIPO. <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-941-2023-en-world-intellectual-property-indicators-2023.pdf>;

Xia, F., Chen, J., Liu, F., & Wang, J. (2022). Digital economy, innovation, and cross-regional knowledge spillovers in China. Technological Forecasting and Social Change, 176, 121451. <https://doi.org/10.1016/j.techfore.2021.121451>;

Zemri, E. B., Boumediene, K. S. M., Fouad, G. M. (2025). Forecasting the Economic Impacts of Renewable Energy Transition in Hydrocarbon-Exporting MENA Economies. Globalization and Business, 10(20). <https://doi.org/10.35945/gb.2025.20.012>.

APENDIX

Table 1. Variable Operationalization.

Category	Symbol	Variable	Proxy / Measurement	Source
Dependent	KEPI	Knowledge Economy Performance Index	Composite z-score of ln(1+patents) and ln(1+articles)	World Bank / WIPO / SCImago
Main	DTI	Digital Transformation Index	Composite z-score of internet %, fixed broadband/100, mobile/100	World Bank WDI
Control	EDU	Education expenditure (% GDP)	Public spending on education as % of GDP	World Bank WDI
Control	GOV	Government effectiveness	WGI Government Effectiveness indicator	World Bank WGI
Control	TRADE	Trade openness (% GDP)	(Exports + Imports) / GDP	World Bank WDI
Control	FDI	FDI net inflows (% GDP)	Net FDI inflows as % of GDP	World Bank WDI
Control	GCF	Gross capital formation (% GDP)	Total investment as % of GDP	World Bank WDI
Moderator	DTI×GOV	Digital × Governance interaction	Within-demeaned product term	Computed

Note. WDI = World Development Indicators (World Bank). WGI = Worldwide Governance Indicators (World Bank). WIPO = World Intellectual Property Organization. SCImago = SCImago Journal & Country Rank. Sign expectations are based on theoretical priors. DTI×GOV is the moderation term used in Equation 2.

Table 2. Descriptive Statistics.

Variable	N	Mean	SD	Min	Max	Skewness
DTI (composite z-score)	275	0.000	0.882	−1.428	1.584	0.006
KEPI (composite z-score)	275	0.000	0.955	−2.360	1.774	−0.140
Internet users (% pop.)	275	51.372	33.913	0.492	100.000	0.036
Fixed broadband (per 100)	275	5.778	6.154	0.000	22.798	1.358
Mobile subscriptions (per 100)	275	112.079	60.308	0.271	231.763	−0.096
Patent applications (residents)	275	138.687	205.125	1.000	752.000	2.067
Scientific journal articles	275	2,059.844	2,430.548	44.600	9,199.200	1.764
Education expenditure (% GDP)	275	4.256	1.485	1.225	9.124	0.471
Government effectiveness	275	0.124	0.562	−1.580	1.604	0.154
Trade (% GDP)	275	97.234	31.552	34.855	178.160	0.367
FDI net inflows (% GDP)	275	2.845	3.723	−4.540	23.537	1.629
Gross capital formation (% GDP)	275	25.254	8.199	10.665	46.877	0.850

Source: Author's research using R-studio.

Table 3. Correlation Matrix and Multicollinearity Diagnostics.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) DTI	1.000	0.011	−0.183***	0.290***	0.410***	−0.310***	0.072
(2) KEPI		1.000	0.432***	−0.457***	−0.468***	−0.007	−0.029
(3) EDU			1.000	−0.145**	−0.284***	−0.288***	0.071
(4) GOV				1.000	0.552***	−0.072	0.027
(5) TRADE					1.000	0.210***	−0.043
(6) FDI						1.000	0.105*
(7) GCF							1.000
VIF	1.631	—	1.237	1.539	2.033	1.599	1.075

Source: Author's research using R-studio.
*Note. *** p < 0.01, ** p < 0.05, * p < 0.10.*

Table 4. Panel Diagnostic and Model Selection Tests.

Test	Statistic
Breusch–Pagan LM test	$\chi^2(1) = 452.7$***
Modified Wald test (heteroskedasticity)	$\chi^2(11) = 287.4$***
Wooldridge test (serial correlation)	F(1,10) = 22.1***
Pesaran CD test (cross-sectional dependence)	CD = 3.94***
Hausman test (FE vs. RE)	$\chi^2(6) = 44.2$***
F-test: country fixed effects	F(10, 258) = 82.7***
F-test: time fixed effects	F(24, 234) = 1.2
IPS unit-root test: KEPI	W-stat = −4.61***
IPS unit-root test: DTI	W-stat = −3.14***

Source: Author's research using R-studio.
*Note. IPS = Im–Pesaran–Shin panel unit-root test. CD = Pesaran cross-sectional dependence test. All tests computed on the 11-country, N = 275 sample. *** p < 0.01.*

Table 5. Pooled OLS Estimation Results.

Variable	Coeff.	Robust SE	t-stat	p-value
DTI	0.541***	(0.063)	8.53	< 0.001
Education expenditure (EDU)	0.302***	(0.029)	10.38	< 0.001
Government effectiveness (GOV)	−0.381***	(0.075)	−5.07	< 0.001
Trade (% GDP)	−0.015***	(0.002)	−7.26	< 0.001
FDI net inflows (% GDP)	0.100***	(0.014)	7.16	< 0.001
Gross capital formation (GCF)	−0.018***	(0.005)	−3.62	< 0.001
Constant	0.411	(0.276)	1.49	0.138
N = 275; R^2 = 0.548				

Source: Author's research using R-studio.

Table 6. Fixed Effects and Random Effects Comparison.

	Pooled OLS		Country FE		Hausman χ^2
Variable	Coeff.	SE	Coeff.	SE	44.2*** (p<0.001)
DTI	0.541***	(0.063)	0.391***	(0.018)	
EDU	0.302***	(0.029)	−0.008	(0.017)	
GOV	−0.381***	(0.075)	0.089**	(0.040)	
Trade (% GDP)	−0.015***	(0.002)	−0.001*	(0.001)	
FDI (% GDP)	0.100***	(0.014)	0.010**	(0.005)	
GCF (% GDP)	−0.018***	(0.005)	0.013***	(0.003)	
Constant	0.411	(0.276)	—	—	
R^2 / Within R^2	0.548		0.790		

Source: Author's research using R-studio.
Note. Hausman $\chi^2(6) = 44.2$, $p < 0.001$. FE: country fixed effects with HC1 robust SE. RE: GLS random effects. Dependent variable: KEPI. N = 275.

Table 7. Preferred Country Fixed-Effects Model with Robust Standard Errors.

Variable	Coeff.	Robust SE	t-stat	p-value
DTI	0.391***	0.018	21.18	< 0.001
Education expenditure (EDU)	−0.008	0.017	−0.49	0.622
Government effectiveness (GOV)	0.089**	0.040	2.25	0.025
Trade (% GDP)	−0.001*	0.001	−1.81	0.071
FDI net inflows (% GDP)	0.010**	0.005	2.08	0.038
Gross capital formation (GCF)	0.013***	0.003	4.24	< 0.001
N = 275; Countries = 11; Country FE: Yes; R^2 (within) = 0.790				

Source: Author's research using R-studio.

Table 8. Interaction (Moderation) Model Results.

	Model 6 (Baseline)		Model 7 (Interaction)		
Variable	Coeff.	SE	Coeff.	SE	Note
DTI	0.391***	(0.018)	0.390***	(0.019)	
Government effectiveness (GOV)	—	—	0.090**	(0.045)	
Education expenditure (EDU)	—	—	−0.008	(0.017)	
DTI × GOV	—	—	−0.005	(0.046)	Key test
Trade (% GDP)	−0.001*	(0.001)	−0.001*	(0.001)	
FDI (% GDP) 0.010** (0.005) 0.010** (0.005)					
GCF (% GDP)	0.013***	(0.003)	0.013***	(0.003)	
R^2 (within)	0.790		0.790		

Source: Author's research using R-studio.
*Note. Dependent variable: KEPI. Country FE, HC1 robust SE. DTI×GOV: interaction of within-demeaned DTI and GOV. N = 275. *** p < 0.01, ** p < 0.05, * p < 0.10.*

Table 9. Robustness Check Results.

	Lagged DTI		**Low-Imputation**		**PCA-KEPI**	
Variable	Coeff.	SE	Coeff.	SE	Coeff.	SE
DTI (t–1)	0.378***	(0.018)	—	—	—	—
DTI	—	—	0.464***	(0.032)	−0.552***	(0.026)
GOV	0.087**	(0.042)	−0.036	(0.111)	−0.126**	(0.056)
EDU	−0.018	(0.017)	0.026	(0.020)	0.012	(0.023)
Trade	−0.001	(0.001)	0.001	(0.001)	0.002*	(0.001)
FDI	0.013***	(0.005)	0.009**	(0.004)	−0.014**	(0.007)
GCF	0.014***	(0.003)	0.009**	(0.004)	−0.019***	(0.004)
N	264		152		275	
Within R^2	0.780		0.762		0.790	

Source: Author's research using R-studio.

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FINTECH LEAPFROGGING: A COMPARATIVE ANALYSIS OF DIGITAL PAYMENTS AND CRYPTOCURRENCY ADOPTION IN EMERGING AND DEVELOPED ECONOMIES

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Abstract. *This study examines whether FinTech adoption follows divergent structural pathways across emerging and developed economies, focusing on digital payments and cryptocurrency adoption. Drawing on leapfrogging theory, it develops a comparative framework linking financial infrastructure, digital payment expansion, financial inclusion, and crypto-adoption intensity. The analysis is based on a purposive sample of ten economies and combines data from Statista Market Insights, the Chainalysis Global Crypto Adoption Index, and the World Bank Global Findex Database. The findings identify two broad patterns. In developed economies, digital payment expansion primarily reflects optimisation within mature financial systems, characterised by high banking penetration, established card-based infrastructures, and convenience-driven adoption. In several emerging economies, by contrast, digital payments exhibit a more transformative role, increasingly operating as an alternative transactional infrastructure in settings marked by financial inclusion gaps and weaker institutional capacity. Cryptocurrency adoption presents a more differentiated picture. Rather than supporting a simple inverse relationship between financial exclusion and crypto uptake, the results point to multiple adoption pathways, ranging from partial substitution for incomplete financial services in some emerging markets to investment – and institution-led adoption in developed ones.*

KEYWORDS: FINTECH LEAPFROGGING, DIGITAL PAYMENTS, CRYPTOCURRENCY ADOPTION, FINANCIAL INCLUSION, EMERGING ECONOMIES, DEVELOPED ECONOMIES, COMPARATIVE ANALYSIS

1. INTRODUCTION

Digital transformation has profoundly reshaped contemporary financial systems, particularly through the expansion of digital payments and cryptocurrencies. In recent years, FinTech has moved beyond its role as a simple technological enabler to become a structural force influencing financial inclusion, consumer behaviour, and the organisation of financial intermediation. However, these developments have not unfolded uniformly across countries. In advanced economies, FinTech has largely emerged within already mature financial systems, where it tends to improve efficiency, convenience, and service delivery. In many emerging economies, by contrast, digital financial technologies have often developed in contexts characterised by weaker banking infrastructure, lower financial inclusion, and greater reliance on mobile-based solutions.

This difference makes the comparative study of FinTech adoption particularly important. The present research is significant because it examines whether digital payments and cryptocurrency adoption reflect distinct developmental pathways across emerging and developed economies. It also contributes to current debates by linking two dimensions of digital finance that are frequently analysed separately, namely payment-system transformation and cryptocurrency adoption, within a common comparative framework. In doing so, the study seeks to clarify whether FinTech in emerging markets functions merely as a tool of technological diffusion or as a mechanism of structural leapfrogging capable of compensating for institutional and infrastructural limitations.

The research gap addressed in this study lies in the limited integration of these dimensions within the existing literature. While previous studies have examined FinTech and financial inclusion, or cryptocurrency adoption, they have rarely brought together digital payment growth, financial inclusion gaps, mobile connectivity, and crypto-adoption intensity in a single comparative framework. Accordingly, this study addresses the following central research problem: **to what extent does FinTech adoption follow different pathways in emerging and developed economies, and can these differences be interpreted through the lens of leapfrogging theory?** In response, the study advances the hypothesis that digital payments in developed economies mainly reflect optimisation within mature financial systems, whereas in emerging economies they are more likely to reflect structural transformation. It further hypothesises that cryptocurrency adoption does not follow a single pattern, but instead reflects multiple pathways: in some emerging economies, it may operate as a partial substitute for incomplete financial services, while in developed economies, it is more closely associated with investment, institutional participation, and broader digital financial innovation.

2. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 FinTech and financial inclusion

Financial inclusion has evolved from a narrow policy concern centered on microfinance into a broader determinant of economic participation in the digital age. It now refers not only to access to financial services, but also to the effective integration of individuals and firms into formal financial systems through affordable, accessible, and technology-enabled mechanisms.[1,2] Empirical research increasingly links financial inclusion to economic growth, financial stability, and broader development outcomes, particularly in contexts where access to conventional banking remains uneven.[3, 4]

1 Patwardhan, A. (2018). Financial inclusion in the digital age. In Kuo, D. L., Deng, R. H. (Eds.). Handbook of blockchain, digital finance, and inclusion, Volume 1: Cryptocurrency, fintech, insurtech, and regulation, Elsevier, 57–89. <https://doi.org/10.1016/B978-0-12-810441-5.00004-X>.

2 Zhang, Q., Valle-Sison, J. B. (2014). Financial inclusion and regulatory implications. In Global shock, risks, and Asian financial reform, Edward Elgar Publishing, 600–627. <https://doi.org/10.4337/9781783477944.00029>.

3 Le, M.-Q., Nguyen, T.-H., Dao, V., Nguyen, P., Vu, D.-L., Nguyen, H.-M., Tran, T.-T. (2025). Research on the impacts of financial inclusion towards national economic growth during the period 2014–2022: New findings and policy implications. In Springer Proceedings in Business and Economics, Springer, 507–530. <https://doi.org/10.1007/978-981-97-9992-3_33>.

4 Dat, P. T., Oanh, T. T. K. (2025). Linkage between financial inclusion, financial development and fi-

Within this context, FinTech represents more than a simple technological upgrade; it constitutes a structural shift in financial intermediation. By reducing transaction costs, easing information asymmetries, and expanding service delivery through digital platforms, mobile banking, and data-driven applications, FinTech can extend financial access to previously underserved groups.[5] However, its contribution to financial inclusion is not uniform across countries and depends heavily on economic context, institutional capacity, and technological readiness.

In emerging economies, FinTech often compensates for weak banking infrastructure and limited service coverage, thereby supporting broader participation in formal financial systems. Evidence from countries such as India and several sub-Saharan African economies suggests that mobile-based financial services can reduce geographic and income-based exclusion by integrating rural and low-income users into financial networks.[6, 7, 8] In developed economies, by contrast, FinTech tends to operate within already mature financial systems, where its primary role is to enhance efficiency, convenience, and user experience rather than to expand basic access.[9]

At the same time, the relationship between FinTech and financial inclusion remains constrained by several structural factors. Infrastructure deficits, regulatory uncertainty, low financial literacy, and socio-cultural barriers may limit the capacity of marginalized groups to benefit from digital financial innovation.[10, 11, 12] As a result, FinTech reshapes not only the scale but also the nature of financial inclusion. In emerging economies, adoption is often necessity-driven and linked to access, substitution, and resilience, whereas in developed markets it is more commonly convenience-driven and associated with efficiency and optimization. This distinction provides the conceptual basis for the comparative analysis developed in the following sections.

Within this context, FinTech represents more than a simple technological upgrade; it constitutes a structural shift in financial intermediation. However, its contribution to financial inclusion is not uniform across countries and depends heavily on economic context, institutional capacity, and technological readiness (See Fig.1).

As shown in Figure 1, the impact of FinTech on financial inclusion is moderated by economic context. In emerging economies, adoption is more likely to be necessity-driven, reflecting financial access gaps and institutional deficiencies. In developed economies, by contrast, adoption tends to be convenience-driven, emphasizing efficiency and optimization within already mature financial systems.

nancial stability: Perspectives from developing and developed countries. Annals of Financial Economics, 20(4), Article 2550022. <https://doi.org/10.1142/S2010495225500228>.

5 Demir, A., Pesqué-Cela, V., Altunbas, Y., Murinde, V. (2022). Fintech, financial inclusion and income inequality: A quantile regression approach. European Journal of Finance, 28(1), 86–107. <https://doi.org/10.1080/1351847X.2020.1772335>.

6 Rai, A. K., Kumar, A., Bhatt, A. K., Esubalew, A. A., Rai, S. (2025). Innovative approaches to financial inclusion in emerging economies: A case study analysis of India and Ethiopia. In Sustainable Finance, Springer, 125–146. <https://doi.org/10.1007/978-3-032-01677-5_6>.

7 Mhlanga, D. (2023). Artificial intelligence (AI) solutions for financial inclusion of the excluded: What are the challenges? In Advances in African Economic, Social and Political Development, Springer, 257–272. <https://doi.org/10.1007/978-3-031-31431-5_14>.

8 Kumar, I. (2024). Banking services and financial inclusion in India's poorest regions. Journal of Banking Regulation, 25(2), 145–159. <https://doi.org/10.1057/s41261-023-00224-9>.

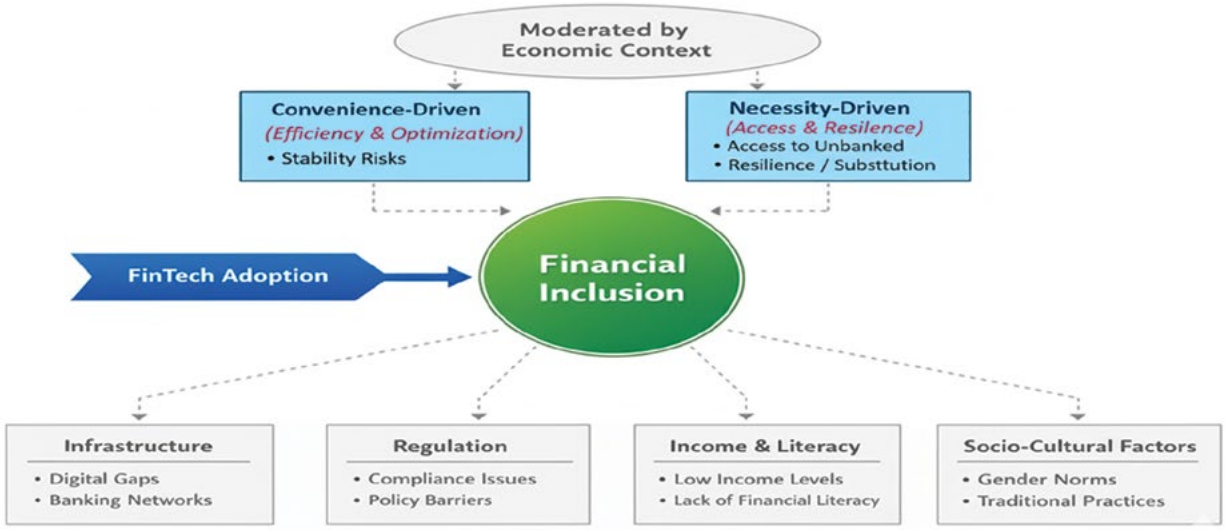
9 Patwardhan, A. (2018), 57–89.

10 Sikka, V., Bhayana, P. (2024). Barriers to comprehensive financial inclusion across the globe: From sociocultural norms to systemic challenges. In Sustainable Finance, Springer, 89–126. <https://doi.org/10.1007/978-3-031-67523-2_7>.

11 Khatatbeh, I. N., Mustafa, J. A., Alhusban, M. I., Alfoul, M. N. A., Shammout, E. (2026). The role of fintech governance in enhancing financial inclusion and reducing income inequality in MENA countries. Journal of Governance and Regulation, 15(1), 150–159. <https://doi.org/10.22495/jgrv15i1art14>.

12 Chitimira, H., Ncube, M. (2020). Legislative and other selected challenges affecting financial inclusion for the poor and low income earners in South Africa. Journal of African Law, 64(3), 337–355. <https://doi.org/10.1017/S0021855320000182>.

Figure 1. Structural Determinants and Contextual Drivers of FinTech-Enabled Financial Inclusion.



Source: Author's elaboration based on the reviewed literature.

2.2 Digital payments and structural transformation

Digital payments represent a structural change in how consumers access financial services and participate in formal economic activity. Their adoption is shaped by trust, perceived security, ease of use, convenience, and socio-cultural attitudes toward cashless transactions.[13, 14] Beyond facilitating transactions, digital payments also influence consumer behaviour by reducing transaction frictions, encouraging higher spending, and supporting the expansion of e-commerce through seamless payment processes and incentives such as cashback, discounts, and loyalty programmes.[15]

A central dimension of this transformation is financial inclusion. Digital payment systems can broaden access to formal financial services, particularly in contexts where conventional banking infrastructure remains limited. By reducing reliance on cash and lowering access barriers, they help integrate previously underserved populations into formal financial networks. At the same time, they push traditional banks to adopt FinTech solutions such as digital onboarding, biometric verification, fraud detection, and data-driven service models to remain competitive.[16, 17, 18]

13 Shah, P., Devdatta, S. T., Jayapriya, J., Vinay, M., Deepa, S. (2025). Technological innovation in digital payments: A survey of trends, challenges, and opportunities. In Lecture Notes in Networks and Systems, 1321 LNNS, Springer, 35–147. <https://doi.org/10.1007/978-981-96-4151-2_12>.

14 Tian, Y., Chan, T. J., Suki, N. M., Kasim, M. A. (2023). Moderating role of perceived trust and perceived service quality on consumers' use behavior of Alipay e-wallet system: the perspectives of technology acceptance model and theory of planned behavior. Human Behavior and Emerging Technologies, 2023. <https://doi.org/10.1155/2023/5276406>.

15 Visconti-Caparrós, J. M., Campos-Blázquez, J. R. (2022). The development of alternate payment methods and their impact on customer behavior: The Bizum case in Spain. Technological Forecasting and Social Change, 175, 121330. <https://doi.org/10.1016/j.techfore.2021.121330>.

16 Ghosh, P., Golder, U. (2026). Exploring the effects of FinTech adoption on traditional banking: A systematic literature review on opportunities and challenges. Digital Business, 6(1), 100163. <https://doi.org/10.1016/j.digbus.2026.100163>.

17 Karani, G., Jadhav, B. (2025). How traditional banks adapt to the fintech revolution in banking and finance sector. In Shaping Cutting-Edge Technologies and Applications for Digital Banking and Financial Services, Taylor & Francis, 214–225. <https://doi.org/10.4324/9781003501947-13>.

18 Cook, S. (2017). Selfie banking: Is it a reality? Bio-

However, the transformative effects of digital payments are not automatic. The digital divide, legacy banking systems, and regulatory uncertainty may constrain both adoption and impact. Accordingly, the literature suggests that digital payments should be understood not only as technological tools but also as structural mechanisms whose effectiveness depends on supportive regulation, inclusive design, and broader institutional adaptation. This perspective is especially relevant for understanding leapfrogging dynamics in emerging markets.[19] [20],

2.3 Cryptocurrency adoption in emerging economies

Cryptocurrency adoption in emerging economies is shaped by the interaction of economic necessity, technological readiness, and institutional conditions. One of the main drivers is the role of remittances, as digital currencies can provide faster and lower-cost alternatives to conventional transfer channels. By reducing transaction costs and transfer delays, they may also broaden financial access for unbanked and underbanked populations.[21]

In addition, economically unstable environments often strengthen cryptocurrency adoption. In contexts marked by inflation, currency depreciation, or weak trust in conventional banking systems, digital assets may serve as alternative stores of value and as instruments of financial resilience.[22] Cases such as Nigeria and Turkey illustrate how monetary instability can increase interest in cryptocurrencies as hedging tools and as alternatives to less reliable financial infrastructures.[23]

Adoption is also influenced by broader technological and socio-economic conditions. Higher levels of internet access, mobile connectivity, digital literacy, and platform innovation facilitate participation in digital financial ecosystems, while diaspora networks can further stimulate adoption through cross-border transfer needs.[24, 25] At the same time, regulatory uncertainty and concerns about illicit financial activity may constrain adoption, which highlights the importance of balanced legal frameworks that support innovation while preserving financial integrity.[26]

The literature suggests that cryptocurrency adoption in emerging economies should not be viewed solely as speculative behavior. Rather, it reflects the convergence of remittance needs, financial instability, technological opportunity, and institutional constraints, making cryptocurrencies relevant not only for investment but also for financial inclusion, value preservation, and participation in evolving digital financial ecosystems.[27]

metric Technology Today, 2017(3), 9–11. <https://doi.org/10.1016/S0969-4765(17)30056-5>.

19 Bhasin, N. K., Rajesh, A. (2020). Study of increasing adoption trends of digital banking and FinTech products in Indian payment systems and improvement in customer services. In Collaborative Convergence and Virtual Teamwork for Organizational Transformation, IGI Global, 229–255. <https://doi.org/10.4018/978-1-7998-4891-2.ch012>.

20 Sharma, M. (2021). Digital payments in India: Impact of emerging technologies. In Industry 4.0 Technologies for Business Excellence: Frameworks, Practices, and Applications, CRC Press, 191–204. <https://doi.org/10.1201/9781003140474-11>.

21 Rodima-Taylor, D., Grimes, W. W. (2019). International remittance rails as infrastructures: embeddedness, innovation and financial access in developing economies. Review of International Political Economy, 26(5), 839–862. <https://doi.org/10.1080/09692290.2019.1607766>.

22 El Hajj, M., Farran, I. (2024). The Cryptocurrencies in Emerging Markets: Enhancing Financial Inclusion and Economic Empowerment. Journal of Risk and Financial Management, 17(10), 467. <https://doi.org/10.3390/jrfm17100467>.

23 Tsang, M. (2023). Currency crisis: Turkey in 2021. The CASE Journal, 19(5), 679–698. <https://doi.org/10.1108/TCJ-08-2022-0140>.

24 Parino, F., Beiró, M. G., Gauvin, L. (2018). Analysis of the Bitcoin blockchain: socio-economic factors behind the adoption. EPJ Data Sci. 7, 38. <https://doi.org/10.1140/epjds/s13688-018-0170-8>.

25 Dang, T. H. N., Balli, F., Balli, H. O., Kilic, I. (2025). Demographic-governance factors shaping cryptocurrency holding behavior. Finance Research Letters, 85(Part D), 108143. <https://doi.org/10.1016/j.frl.2025.108143>.

26 Khan, K., Luo, T., Ullah, S., Rasheed, H. M. W., Li, P.-H. (2023). Does digital financial inclusion affect CO2 emissions? Evidence from 76 emerging markets and developing economies (EMDEs). Journal of Cleaner Production, 420, 138313. <https://doi.org/10.1016/j.jclepro.2023.138313>.

27 Vincent, G., Sivakumar, S. (2019). Financial inclusion in India – A progress and challenges. International Journal of Advanced Science and Technology, 28(19), 521–530.

2.4 Leapfrogging theory in digital finance

Leapfrogging theory explains how late-developing economies may accelerate structural transformation by bypassing intermediate stages of technological development and moving directly toward more advanced systems. Rather than following the gradual paths historically associated with industrialized economies, latecomer countries may exploit technological discontinuities to adopt modern infrastructures without the burden of legacy systems. This perspective emerged first in debates on development policy and technological diffusion, especially in relation to ICT, where scholars argued that developing economies could "skip stages" of technological evolution through the adoption of newer technologies. [28, 29, 30, 31]

The telecommunications sector offers one of the clearest empirical examples of leapfrogging. Many developing economies bypassed large-scale fixed-line expansion and instead adopted mobile communication technologies at scale. This transition reduced the financial and institutional costs associated with traditional network development while expanding connectivity and access, particularly among previously underserved populations. [32, 33, 34, 35]

More recently, the leapfrogging framework has been extended to digital finance. The spread of FinTech, mobile banking, and digital payment systems has enabled countries with weak conventional financial infrastructures to expand access to financial services without replicating the traditional branch-based banking model. In this sense, digital finance can be understood as a contemporary form of leapfrogging, in which financial systems evolve through digital platforms, mobile ecosystems, and alternative payment architectures rather than through the gradual expansion of physical banking networks. [36, 37]

At the same time, leapfrogging in digital finance is not automatic. Its success depends on broader institutional and technological conditions, including consumer protection, governance quality, digital capabilities, and innovation capacity. Emerging research suggests that technological readiness and digital capabilities can strengthen resilience and support structural transformation in developing economies, especially where insti-

28 Third, A., Kao, K.-T. (2007). ICT leapfrogging policy and development in the third world. In Encyclopedia of Information Ethics and Security. <https://doi.org/10.4018/978-1-59140-987-8.ch049>.

29 Ritzer, G. (2012). Leapfrogging. In The Wiley-Blackwell Encyclopedia of Globalization. <https://doi.org/10.1002/9780470670590.wbeog355>.

30 Logan, S., Singh, J. P. (2018). The meta-power of technology. In Technologies of International Relations: Continuity and Change. <https://doi.org/10.1007/978-3-319-97418-7_6>.

31 Burlamaqui, L., Kattel, R. (2016). Development as leapfrogging, not convergence, not catch-up: Towards Schumpeterian theories of finance and development. Review of Political Economy, 28(2), 270–288. <https://doi.org/10.1080/09538259.2016.114271>

32 Sanzogni, L., Arthur-Gray, H. (2007). Technology leapfrogging in Thailand. In Global Information Technologies: Concepts, Methodologies, Tools, and Applications. <https://doi.org/10.4018/978-1-59904-939-7.ch136>.

33 Fong, M. W. L. (2008). The mobile phone telecommunications service sector in China. In Mobile Computing: Concepts, Methodologies, Tools, and Applications. <https://doi.org/10.4018/978-1-60566-054-7.ch108>.

34 Huang, C.-Y. (2011). Rethinking leapfrogging in the end-user telecom market. Technological Forecasting and Social Change, 78(4), 703–712. <https://doi.org/10.1016/j.techfore.2010.10.009>.

35 James, J. (2012). The distributional effects of leapfrogging in mobile phones. Telematics and Informatics, 29(3), 294–301. <https://doi.org/10.1016/j.tele.2011.09.001>.

36 Tan, B., Ng, E., Jiang, J. (2018). The process of technology leapfrogging: Case analysis of the national ICT infrastructure development journey of Azerbaijan. International Journal of Information Management, 38(1), 311–316. <https://doi.org/10.1016/j.ijinfomgt.2017.10.008>.

37 Ranganathan, K. (2012). Leapfrogging the digital divide: Myth or reality for emerging regions? In ICT Influences on Human Development, Interaction, and Collaboration. <https://doi.org/10.4018/978-1-4666-1957-9.ch014>.

tutional environments are capable of supporting innovation diffusion.[38, 39]

2.5 Conceptual framework of the study

Building on the preceding literature, this study proposes a context-dependent FinTech adoption framework (Figure 2) to explain why FinTech adoption follows different trajectories across emerging and developed economies. Rather than treating adoption as a uniform or purely utility-driven process, the framework argues that FinTech integration is shaped by the interaction of economic context, institutional capacity, and technological opportunity.

In this framework, the antecedents of adoption differ across market environments. In developed economies, mature financial systems, strong regulatory oversight, and established banking infrastructures create a path-dependent environment in which FinTech tends to complement existing services. In emerging economies, by contrast, financial inclusion gaps, weaker banking infrastructures, and institutional limitations interact with growing technological opportunities-particularly mobile connectivity and digital platforms-to create conditions for more accelerated and substitution-oriented adoption.

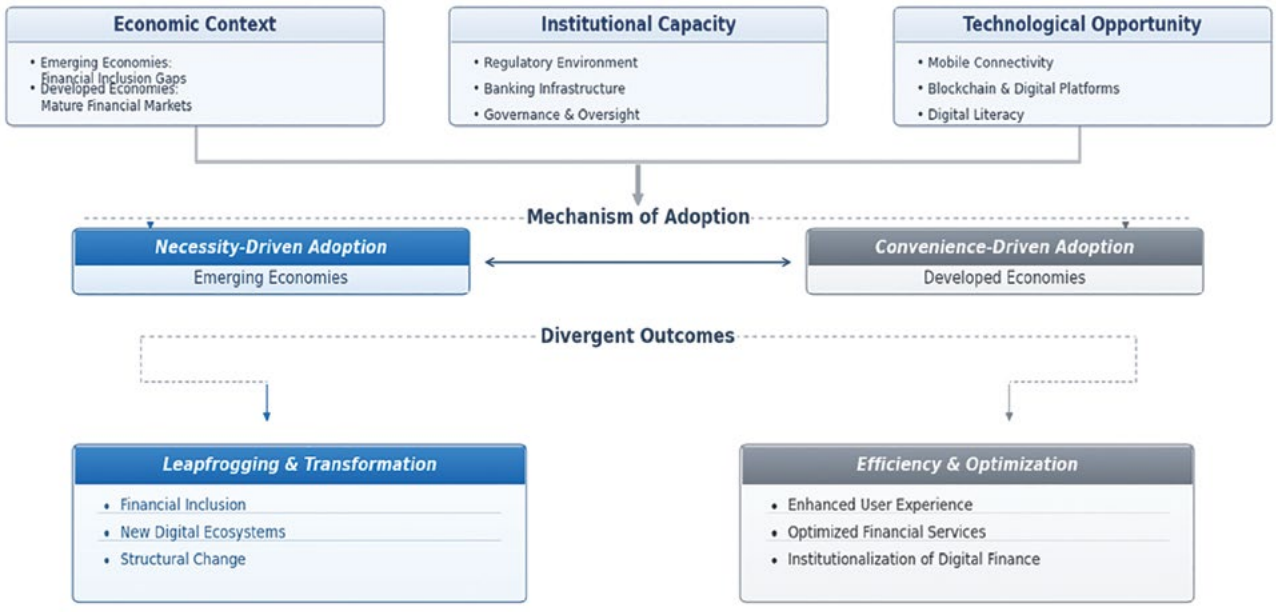
The framework distinguishes between two main mechanisms of adoption. In emerging economies, adoption is primarily necessity-driven, as digital financial tools often compensate for limited access to conventional financial services. In developed economies, adoption is more convenience-driven, as FinTech is typically integrated into already mature financial systems in order to improve speed, cost efficiency, and user experience.

These contrasting mechanisms generate divergent outcomes. In developed markets, FinTech mainly leads to efficiency and optimization, including improved user experience, more streamlined financial services, and greater institutional integration. In emerging markets, it is more likely to contribute to leapfrogging and structural transformation, particularly by expanding financial inclusion, fostering new digital ecosystems, and enabling alternative forms of financial participation. The framework, therefore, positions FinTech not merely as a technological tool, but as a

38 Zhao, D., Yuan, J., Chen, W. (2023). Financial consumer protection in FinTech field. In Contributions to Finance and Accounting. <https://doi.org/10.1007/978-981-99-5173-4_5>.

39 Hanif, R., Pierotti, M., Khalique, M. (2026). Harnessing technological innovation and digital capabilities for resilience in developing economies. Sustainable Technology and Entrepreneurship, 5(1), 100124. <https://doi.org/10.1016/j.stae.2025.100124>.

Figure 2. Conceptual Framework of Divergent FinTech Adoption Pathways.



context-dependent structural force whose effects vary according to the institutional and economic environment. This conceptual logic guides the empirical analysis of digital payments and cryptocurrency adoption in the subsequent sections (See Fig.2).

3. DATA AND METHODOLOGY

This section outlines the data sources, sample selection strategy, and analytical framework employed to investigate the divergent pathways of FinTech adoption across different economic contexts. The methodological approach is designed to empirically examine the Leapfrogging Hypothesis, which suggests that emerging economies may adopt digital financial technologies at accelerated rates due to structural gaps in traditional banking systems.

3.1 Data sources

To ensure cross-country comparability, this study relies on secondary data from internationally recognized sources. A triangulated data strategy is used, combining digital payment indicators from Statista Market Insights, cryptocurrency adoption rankings from the 2025 Chainalysis Global Crypto Adoption Index, and financial inclusion and mobile connectivity indicators from the World Bank Global Findex Database (2025). Statista data are used to measure the scale and intensity of digital payment adoption, Chainalysis rankings serve as a proxy for grassroots crypto-adoption intensity, and Global Findex indicators-particularly account ownership, unbanked population, and mobile phone ownership-provide the broader financial inclusion context. Together, these datasets support a comparative analysis of digital payments, cryptocurrency adoption, and FinTech leapfrogging across the selected economies.

3.2 Sample selection

The study employs a stratified purposive sampling strategy to select ten representative economies that capture contrasting patterns of financial infrastructure and digital financial adoption. The sample is divided into two groups according to economic development levels, financial inclusion conditions, cryptocurrency ownership estimates, and crypto-adoption intensity.

Group A: Emerging economies

This group includes India, Vietnam, Nigeria, Brazil, and the Philippines, which rank among the leading countries in the 2025 Chainalysis Global Crypto Adoption Index. These economies also display relatively strong cryptocurrency ownership estimates and persistent financial inclusion gaps. Cryptocurrency ownership is particularly high in Vietnam (≈21.2%) and the Philippines (≈19.0%), while Brazil and Nigeria record levels above approximately 12–13%. Although India shows a lower ownership estimate (≈7.2%), it ranks first globally in overall crypto-adoption intensity. At the same time, World Bank Global Findex data indicate that several of these economies continue to exhibit substantial shares of unbanked adults, making them relevant cases for examining whether digital financial technologies may compensate for incomplete traditional financial infrastructures.

Group B: Developed economies

The second group includes the United States, the United Kingdom, Germany, Sweden, and Japan, representing advanced economies with highly developed financial systems and near-universal banking access. In these countries, the share of unbanked adults generally remains below 5%. Cryptocurrency ownership estimates are moderate, reaching 15.6% in the United States, 11.2% in the United Kingdom, and 9.8% in Germany, while remaining lower in Sweden (≈4.3%) and Japan (≈4.0%). These economies were selected to provide a contrasting set of cases in which crypto adoption occurs within mature banking systems and is more likely to be associated with investment, portfolio diversification, and institutional participation than with financial exclusion.

This comparative framework enables the study to assess whether FinTech adoption follows distinct pathways across emerging and developed economies and whether these patterns are consistent with the Leapfrogging Hypothesis.

3.3 Operationalization of variables

To examine the relationship between financial infrastructure, digital payment expansion, and cryptocurrency adoption, the study employs a set of variables grouped into four categories: adoption indicators, contextual financial infrastructure indicators, technological enablers, and structural drivers. Adoption indicators include digital payment transaction value, Compound Annual Growth Rate (CAGR), Average Transaction Value (ATV), Mobile POS penetration, the composition of payment instruments within Mobile POS, and cryptocurrency adoption intensity. These variables are used to capture the scale, speed, depth, and structural form of digital financial adoption. Contextual financial infrastructure indicators-such as credit card penetration, debit card penetration, online banking penetration, and bank account ownership-are included to assess the maturity of the formal financial system. In addition, mobile phone ownership is used as a technological enabler reflecting digital access potential, while the share of unbanked adults is treated as a structural driver indicating gaps in formal financial inclusion. Taken together, these variables provide a framework for analyzing whether FinTech adoption in emerging economies reflects patterns consistent with leapfrogging dynamics.

3.4 Analytical method

The study adopts a Comparative Trend Analysis (CTA) approach to examine cross-country differences in FinTech adoption rather than using econometric regression. This choice is justified by the purposive sample design and by the study's emphasis on structural comparison across a limited set of representative economies.

The empirical analysis proceeds in four stages. First, the study examines the historical evolution and projected trends of Average Transaction Value (ATV) in order to assess the depth and intensity of digital payment use. Second, it calculates the Compound Annual Growth Rate (CAGR) of Mobile POS payment transaction values between 2018 and 2025 to measure the comparative speed of digital payment expansion. Third, it analyzes Mobile POS penetration rates, payment instrument composition, and broader financial infrastructure indicators in order to compare the institutional environment of digital payment adoption across the two groups. Fourth, it assesses cryptocurrency adoption by combining Chainalysis crypto-adoption rankings with account ownership, unbanked population, and mobile phone ownership indicators from Global Findex.

Visualization techniques are used to support comparative interpretation, including line charts, comparative tables, and scatter plots. In the cryptocurrency analysis, scatter plots are used to examine the relationship between financial exclusion and crypto-adoption intensity. Because lower Chainalysis ranks indicate stronger adoption, the relevant y-axis is reversed in order to improve interpretability.

The CAGR is calculated using the following formula:

$$\mathrm{CAGR} = \left(\frac{V_{\mathrm{final}}}{V_{begin}}\right)^{\frac{1}{n}} - 1$$

Where:

V_{final}: represents the final transaction value

V_{begin}: represents the initial value

n: represents the number of years

This metric enables comparison of adoption trajectories across economies with different market sizes and provides a standardized measure of digital payment growth.

3.5 Data limitations

Despite the robustness of the datasets used, several limitations remain. Some Statista Market Insights indicators include projections rather than observed values, and should therefore be interpreted as likely trajectories rather than realized outcomes. The Chainalysis Global Crypto Adoption Index captures relative adoption intensity rather than direct ownership shares, making it more suitable for comparative ranking than for estimating the exact proportion of crypto users. In addition, the World Bank Global Findex is based on periodic survey waves rather than annual observations. Finally, all indicators are measured at the national level and may therefore mask important

intra-country differences. Nevertheless, the triangulation of multiple data sources strengthens the reliability of the comparative analysis.

4. Empirical analysis

This section presents the empirical findings of the study, focusing on the comparative dynamics of digital payment growth, cryptocurrency adoption patterns, and structural indicators related to financial inclusion. The analysis aims to identify whether emerging economies exhibit evidence of FinTech leapfrogging compared to developed financial systems.

4.1 Growth dynamics of digital payments

To analyze the trajectory of digital finance, it is necessary to define the parameters of the Digital Payments Market. According to the framework established by Statista Market Insights, this segment is primarily driven by consumer transactions and is divided into two main structural components:

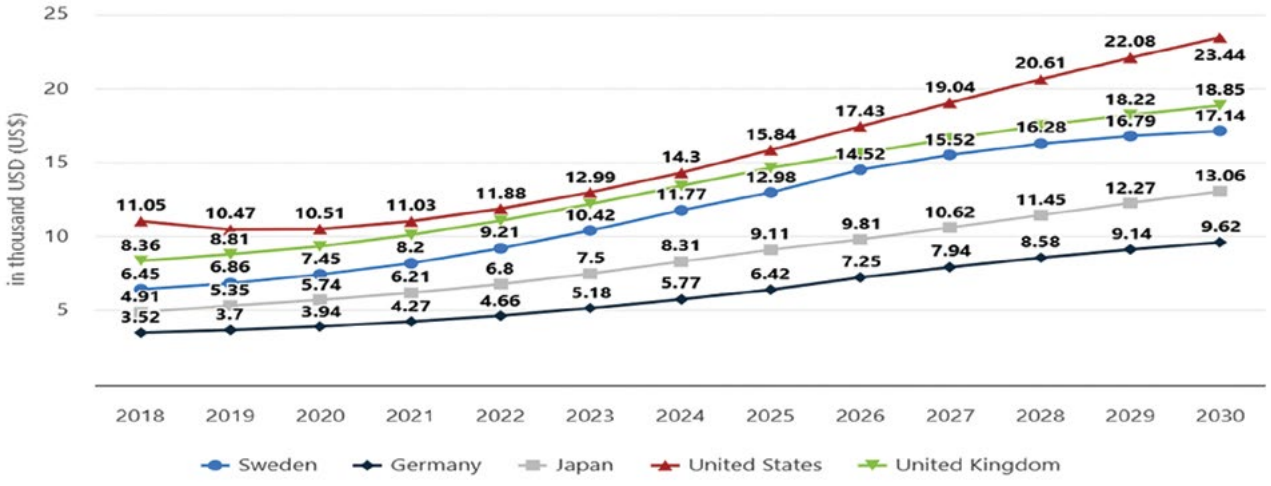
- Digital Commerce: Encompasses all consumer transactions for products and services conducted over the internet, representing the online dimension of the digital economy.
- Mobile POS Payments: Includes digital payments made at a physical Point of Sale (POS) via digital wallet applications (e.g., Apple Pay, Google Pay, UPI, or Pix).

The market valuation integrates several key indicators, including total transaction values, the number of users, and the Average Transaction Value (ATV) per user. The latter serves as a proxy for the depth of digital financial integration into the daily lives of consumers. It is important to note that the empirical data and projections presented in this study reflect market conditions and recorded figures as of October 27, 2025.

4.1.1. Analysis of Average Transaction Value (ATV) trends

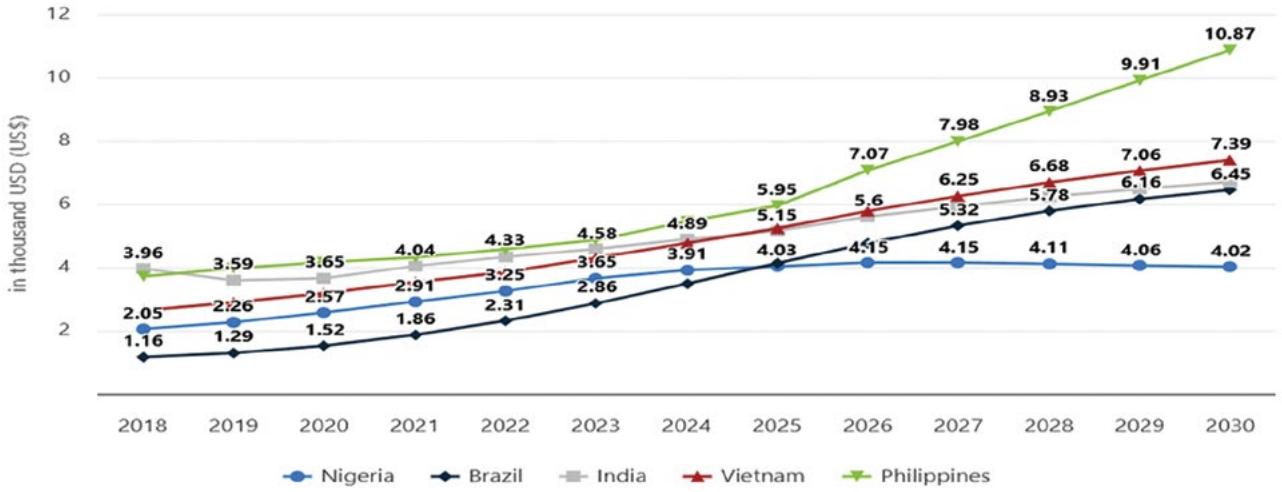
Average Transaction Value (ATV) per user provides an important indicator of the economic intensity of digital payment use, as it captures not merely access to digital finance, but the depth of user engagement within digital payment ecosystems. Based on data retrieved on October 27, 2025, Figures 3 and 4 show the historical evolution of ATV between 2018 and 2025 and the projected trends for the period 2026–2030 (See Fig.3,4).

Figure 3. Digital Payments – Average Transaction Value per User (Developed Economies).



Source: Statista Market Insights (2025).
Note: Data as of October 27, 2025. Values from 2026–2030 are based on Statista's predictive modeling.

Figure 4. Digital Payments Average Transaction Value per User (Emerging Economies).



Source: Statista Market Insights (2025).
Note: Data as of October 27, 2025. Values from 2026–2030 are based on Statista's predictive modeling.

In developed economies, ATV remained consistently high throughout the study period. The United States recorded the highest values, increasing from US$11.05k in 2018 to US$15.84k in 2025, with projections reaching US$23.44k by 2030. Similar but more moderate trends are observed in the United Kingdom, Germany, Japan, and Sweden. This pattern reflects convenience-driven adoption in mature financial systems, where digital payments are integrated into already well-established banking and consumption structures.

In emerging economies, ATV started from lower levels but grew more rapidly in several cases. Brazil rose from US$1.16k in 2018 to US$4.13k in 2025, while Vietnam and the Philippines increased from roughly US$2.6k–3.7k to about US$5.2k–5.95k over the same period. Projections suggest further acceleration, especially in the Philippines, where ATV is expected to reach US$10.87k by 2030, and in Vietnam, which is projected to reach US$7.39k. These trends suggest that digital payments in some emerging markets are becoming a core transactional infrastructure rather than a simple complement to traditional finance.

The contrast between the two groups indicates that developed economies maintain higher absolute values, while emerging economies display faster growth dynamics. This pattern appears consistent with the leapfrogging perspective, according to which economies with weaker traditional banking infrastructure may adopt digital financial solutions more rapidly and embed them more deeply in everyday economic activity.

4.1.2 Growth dynamics of mobile POS payments

To assess structural change in payment systems, this study uses Mobile POS Payments as a key indicator of the digitalization of everyday transactions. Unlike Digital Commerce, which reflects online purchasing, Mobile POS payments capture the shift in face-to-face payment behavior. In emerging economies, their rapid expansion may reflect leapfrogging dynamics, as users move directly from cash-based systems to mobile-native payment ecosystems. Table 1, therefore, compares Mobile POS transaction growth across developed and emerging economies using CAGR for the period 2018–2025 (See Table 1).

Table 1. Comparative Velocity of Mobile POS Payment Growth (2018–2025).

Country	Group	2018 Value (Est. $B)	2025 Value (Est. $B)	CAGR (%)
Nigeria	Emerging	10	95.98	38.13%
Brazil	Emerging	50.04	444.59	36.59%
India	Emerging	260	1580	29.36%
Vietnam	Emerging	19.06	98.61	26.46%
Philippines	Emerging	23.4	108.83	24.58%
Sweden	Developed	7.09	69.17	38.51%
Germany	Developed	33.08	226.65	31.58%
United Kingdom	Developed	52.45	359.69	31.60%
United States	Developed	480	2340	25.41%
Japan	Developed	160.57	564.44	19.67%

Source: Statista Market Insights (2025).

The results reported in Table 1 reveal clear differences in the growth dynamics of mobile POS payments across developed and emerging economies. In both groups, mobile payment transaction values increased substantially between 2018 and 2025; however, the structural meaning of this growth differs across contexts.

In emerging economies, high CAGR levels in countries such as Nigeria, Brazil, and India suggest that mobile payments are expanding not merely as a complementary payment option, but increasingly as an alternative transactional infrastructure. This pattern appears consistent with the leapfrogging perspective, whereby economies with more limited traditional banking and card-based infrastructures adopt mobile-first payment systems more rapidly. In such contexts, mobile payments may reduce reliance on cash while also widening access to formal financial channels.

In developed economies, growth is also significant, as shown in the cases of Sweden, the United Kingdom, and Germany. However, in these markets, the expansion of mobile POS payments is better interpreted as the optimization of already mature financial ecosystems rather than a substitute for missing financial infrastructure. Adoption is therefore more convenience-driven, supported by high banking penetration, strong digital trust, and established payment networks.

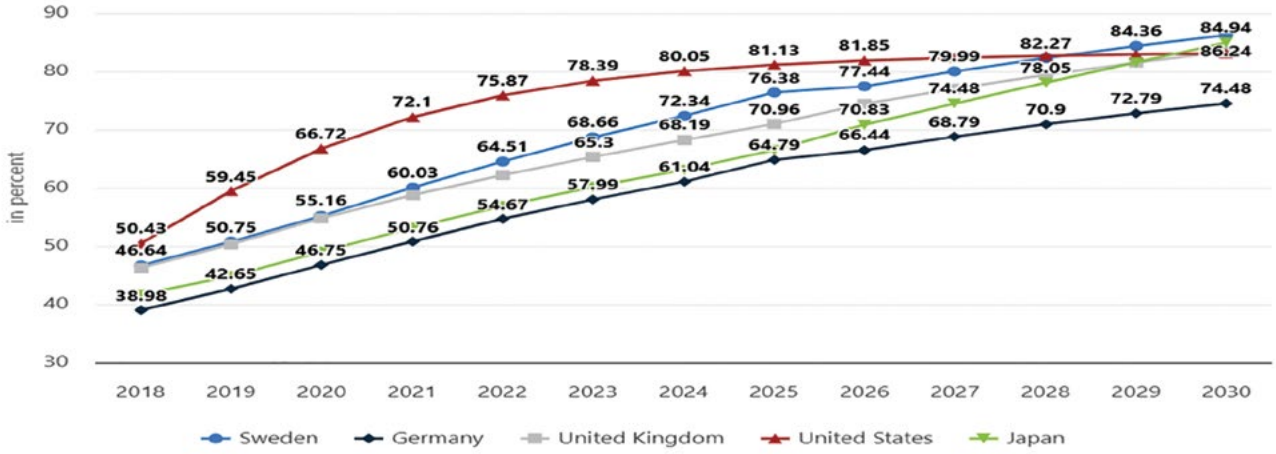
Japan represents a more gradual trajectory, which may reflect the persistence of legacy payment habits and the continued relevance of traditional payment instruments within a highly developed financial system. By contrast, the stronger expansion observed in several emerging economies suggests that mobile payment technologies can play a more transformative role when introduced in contexts characterized by financial access gaps or weaker card-payment penetration.

4.1.3. Penetration rate of mobile POS payments

Penetration rate is used here as a complementary indicator of societal diffusion and is interpreted jointly with transaction value and usage-intensity measures in order to provide a more comprehensive assessment of digital payment transformation (See Fig.5,6).

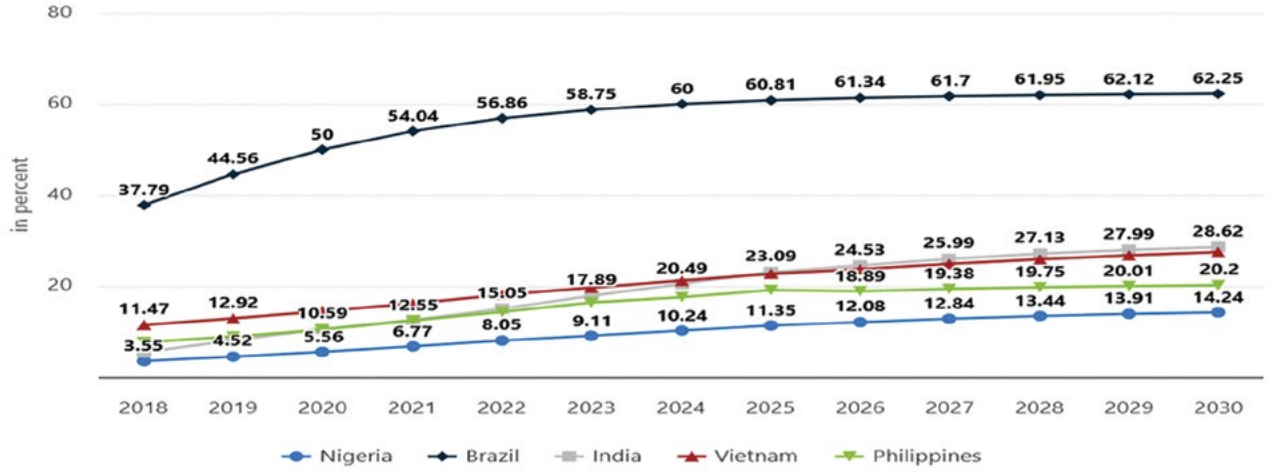
The data for 2018–2025 reveal a clear contrast between developed and emerging economies. In developed economies, penetration rates were al-

Figure 5. Penetration Rate of Mobile POS Payments in Developed Economies (2018–2030).



Source: Statista Market Insights (2025).
Note: Data as of October 27, 2025. Values from 2026–2030 are based on Statista's predictive modeling.

Figure 6. Penetration Rate of Mobile POS Payments in Emerging Economies (2018–2030).



Source: Statista Market Insights (2025).
Note: Data as of October 27, 2025. Values from 2026–2030 are based on Statista's predictive modeling.

ready high and continued to rise steadily, increasing from 50.43% to 81.13% in the United States and from 46.64% to 76.38% in Sweden. Germany, the United Kingdom, and Japan followed similar upward paths, indicating that Mobile POS payments are deeply embedded in mature and highly banked financial systems. In emerging economies, the trajectories were more uneven but still significant. Brazil recorded the highest penetration rate in this group, rising from 37.79% in 2018 to 60.81% in 2025, while India and Vietnam increased from 5.47% to 23.09% and from 11.47% to 22.72%, re-

spectively. Nigeria and the Philippines also progressed, from 3.55% to 11.35% and from 7.70% to 19.14%. Projections for 2026–2030 suggest continued growth in both groups, although developed economies appear closer to saturation, with Sweden, Japan, the United States, and the United Kingdom projected to reach 86.24%, 84.94%, 83.06%, and 83.38%, respectively, by 2030. In emerging economies, convergence remains partial: Brazil is projected to reach 62.25%, while India and Vietnam are expected to remain below 30%, at 28.62% and 27.51%, respectively. Taken together with transaction value and usage-intensity indicators, these results suggest that Mobile POS expansion reflects optimization in developed economies and uneven but significant leapfrogging dynamics in selected emerging markets.

4.1.4 Financial infrastructure indicators in developed and emerging economies

(See Table 2).

To contextualize differences in Mobile POS adoption, it is useful to consider broader financial infrastructure indicators across the two groups. As shown in Table 2, developed economies exhibit consistently higher levels of financial inclusion and card-based infrastructure. In 2025, average credit card penetration reached 61.6% in developed economies, compared with 13.8% in emerging economies, while debit card penetration stood at 93.8% versus 43.6%. A similar gap is observed in online banking penetration (77.0% in developed economies compared with 33.0% in emerging economies) and bank account penetration (98.4% versus 78.4%). These differences suggest that advanced economies continue to rely on mature banking and card-centered systems, whereas emerging economies are expanding digital finance from a less developed institutional base. This broader structural contrast helps explain why Mobile POS growth in emerging markets may be more closely associated with leapfrogging dynamics than in developed ones.

4.1.5 Structural composition of payment instruments within mobile POS payments

(See Table 3).

To further evaluate the Leapfrogging Hypothesis, it is useful to examine the composition of payment instruments within the Mobile POS Payments segment across the selected economies. Rather than reflecting the overall structure of national payment systems, this indicator shows how transaction value is distributed across different instruments within mobile-based point-of-sale payments. It therefore provides a more specific perspective on the channels through which mobile payment adoption is taking place.

Table 2. Financial Infrastructure Indicators: Group Averages (%).

Indicator	Developed Economies 2018	Developed Economies 2025	Emerging Economies 2018	Emerging Economies 2025
Credit card penetration	60.0	61.6	8.4	13.8
Debit card penetration	89.8	93.8	35.4	43.6
Online banking penetration	61.4	77.0	13.8	33.0
Bank account penetration	97.6	98.4	53.2	78.4

Source: Author's compilation and calculations based on data from Statista Market Insights. Note: Group values are unweighted arithmetic means calculated across the five selected countries in each category (developed and emerging economies). All indicators are expressed as percentages.

Table 3. Mobile POS Payment Instrument Mix by Country (%).

Country	Digital Wallets	Credit Cards	Debit Cards	Other payment methods	Prepaid Cards
Brazil	10.3	26.7	12.1	48.8	2.1
India	59.4	17.4	5.1	15.6	2.5
Nigeria	12.0	1.0	16.1	68.8	2.0
Philippines	28.6	13.1	11.1	45.1	2.1
Vietnam	30.5	13.3	5.1	48.4	2.8
Germany	9.1	7.0	42.1	39.5	2.3
Japan	23.3	33.8	4.1	36.0	2.9
Sweden	19.9	18.5	49.2	9.5	2.9
United Kingdom	18.2	23.8	47.3	7.8	2.9
United States	16.0	40.1	30.3	11.4	2.2

Source: Author's compilation based on Statista Market Insights.

The results reveal notable differences between emerging and developed economies. Within the Mobile POS segment, digital wallets account for a relatively large share of transaction value in several emerging economies, particularly in India (59.4%), Vietnam (30.5%), and the Philippines (28.6%). These shares are substantially higher than those observed in Germany (9.1%) and the United States (16.0%), suggesting that wallet-based instruments play a more central role in Mobile POS transactions in several emerging markets.

By contrast, developed economies remain more strongly oriented toward card-based instruments within the same segment. Debit cards account for 49.2% of Mobile POS transaction value in Sweden, 47.3% in the United Kingdom, and 42.1% in Germany, while credit cards represent 40.1% in the United States and 33.8% in Japan. This indicates that, even within Mobile POS payments, advanced economies continue to rely heavily on established card-linked infrastructures.

Another notable feature is the large share of the category "Others" in some emerging economies, especially Nigeria (68.8%) and Brazil (48.8%). Since this category may include a range of payment arrangements, it should be interpreted with caution. Nevertheless, its prominence suggests that the Mobile POS segment in these markets is not shaped exclusively by conventional debit – and credit-card instruments.

4.2. Reassessing the cryptocurrency adoption paradox

The cryptocurrency adoption paradox refers to the observation that some economies with weaker levels of financial inclusion may nevertheless record relatively high levels of cryptocurrency adoption. To reassess this issue more rigorously, this subsection combines two complementary indicators: the 2025 Chainalysis Global Crypto Adoption Index and the World Bank Global Findex 2025 account-ownership indicator. Rather than relying on estimated cryptocurrency ownership shares, the analysis uses the Chainalysis ranking as a proxy for the intensity of grassroots crypto adoption, while financial inclusion is measured through the share of adults aged 15 and above who own an account at a financial institution or with a mobile-money-service provider. The unbanked population is therefore calculated as the inverse of account ownership (See Table 4).

4.2.1. Comparative patterns of cryptocurrency adoption

Table 4. shows that cryptocurrency adoption does not follow a single developmental pattern across the selected economies. Within the sample, India ranks first in the 2025 Chainalysis Global Crypto Adoption Index, followed by the United States in second place, Vietnam in fourth, Brazil in fifth, Nigeria in sixth, and the Philippines in ninth. Among the developed economies, the United Kingdom ranks eleventh, Japan nineteenth, Germany twenty-first, and Sweden fifty-sixth. These results indicate that relatively strong cryptocurrency adoption can be observed in both emerging and developed economies, although with substantial variation in intensity.

The distribution of these rankings suggests that several emerging economies occupy leading positions in the global index, which is consistent with the argument that cryptocurrencies may serve functions extending beyond portfolio investment alone. At the same time, the position of the United States shows that high adoption can also occur in mature financial systems characterized by near-universal banking access and expanding institutional participation. Conversely, Sweden's much lower position, despite its highly advanced digital-payment environment, suggests that a sophisticated cashless economy does not automatically translate into equally strong cryptocurrency adoption.

4.2.2. Interpreting the paradox: Divergent adoption pathways

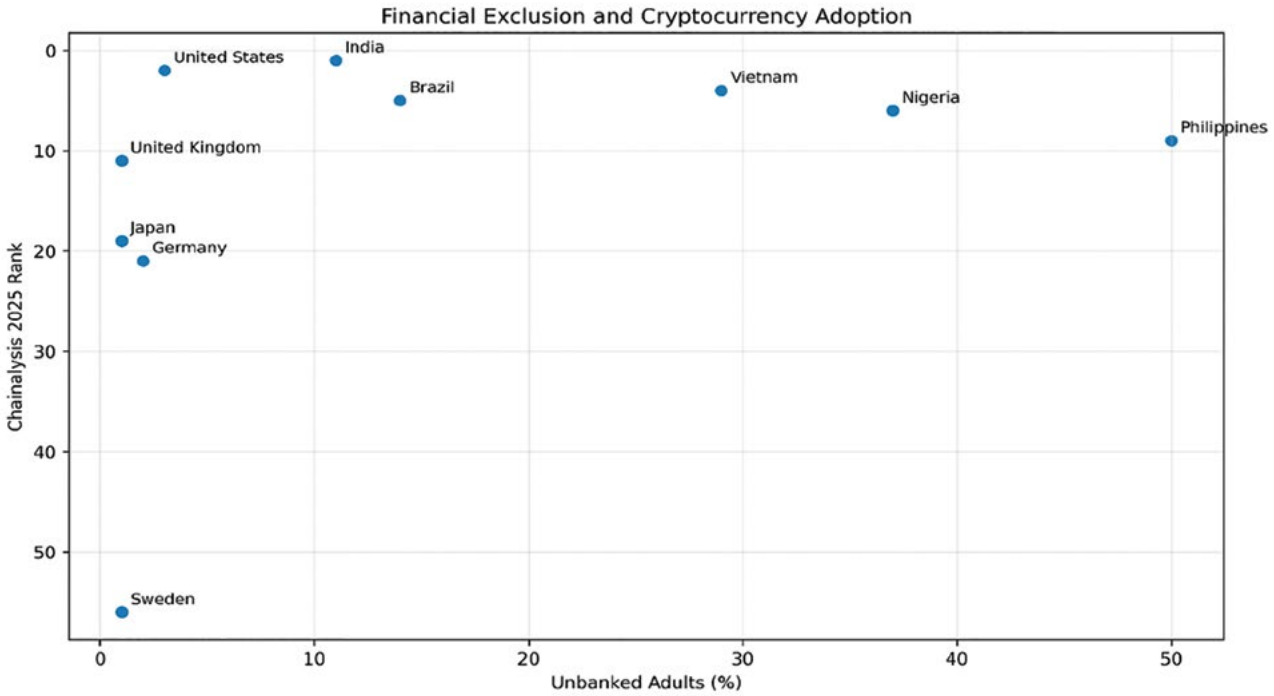
When these rankings are interpreted together with financial inclusion data, the cryptocurrency adoption paradox appears more nuanced than a simple inverse relationship between banking weakness and crypto uptake. The clearest cases consistent with the paradox are Nigeria and the Philippines, where relatively high crypto-adoption rankings coexist with comparatively large shares

Table 4. Cryptocurrency Adoption Intensity and Financial Inclusion Gaps.

Country	Group	Chainalysis 2025 Rank	Account Ownership (%)	Unbanked Adults (%)
India	Emerging	1	89	11
United States	Developed	2	97	3
Vietnam	Emerging	4	71	29
Brazil	Emerging	5	86	14
Nigeria	Emerging	6	63	37
Philippines	Emerging	9	50	50
United Kingdom	Developed	11	99	1
Japan	Developed	19	99	1
Germany	Developed	21	98	2
Sweden	Developed	56	99	1

Source: Author's compilation based on Chainalysis Global Crypto Adoption Index (2025) and World Bank Global Findex Database (2025).
Note: Account ownership refers to adults aged 15+ who have an account at a financial institution or with a mobile-money-service provider. Unbanked adults are calculated as 100 – account ownership.

Figure 7. Financial Exclusion and Cryptocurrency Adoption in Developed and Emerging Economies.



Source: Author's compilation based on World Bank Global Findex 2025 and Chainalysis Global Crypto
Note: The y-axis is inverted because lower Chainalysis ranks indicate stronger cryptocurrency adoption.

of unbanked adults. In such contexts, cryptocurrency adoption may reflect the use of alternative channels for payments, remittances, peer-to-peer transfers, and value storage where formal financial access remains incomplete. This interpretation is broadly consistent with the study's distinction between necessity-driven and convenience-driven FinTech adoption.

However, other emerging economies complicate a purely exclusion-based explanation. India ranks first globally despite a high level of account ownership, while Brazil and Vietnam also combine strong crypto-adoption rankings with expanding formal financial inclusion. In these cases, adoption appears to be linked not only to financial necessity but also to mobile-first digital ecosystems, rapid platform expansion, and broader participation in digital financial markets. In developed economies, especially the United States and the United Kingdom, cryptocurrency adoption appears more closely associated with investment behavior, institutionalization, and regulatory normalization than with financial exclusion. The inclusion of an institutional activity sub-index in the 2025 Chainalysis methodology further reinforces the relevance of this interpretation for advanced markets.

4.2.3. Assessing FinTech leapfrogging

To further assess the leapfrogging hypothesis, it is useful to examine cryptocurrency adoption in relation to both financial exclusion and mobile connectivity. Using Global Findex 2025 indicators on account ownership and mobile phone ownership, together with the 2025 Chainalysis Global Crypto Adoption Index, this subsection explores whether stronger mobile connectivity may help explain high levels of crypto adoption in contexts where formal financial inclusion remains incomplete. Rather than treating cryptocurrency uptake as a purely investment-driven phenomenon, this approach considers whether digital connectivity may facilitate alternative forms of financial participation in selected emerging economies (See Fig.7).

Although Figure 7 maps financial exclusion against cryptocurrency adoption intensity, mobile phone ownership provides an important complementary layer of interpretation. In the selected emerging economies, mobile phone ownership remains relatively high despite persistent financial inclusion gaps, reaching 98% in Vietnam, 92% in Brazil, 84% in Nigeria, and 78% in the Philippines, while India records 66%. In developed economies, mobile phone ownership is even higher, ranging from 92% in the United Kingdom and Germany to 99% in Sweden. These figures suggest that mobile connectivity is widespread across both groups, but its interaction with financial exclusion differs across contexts. In emerging markets, high mobile access combined with incomplete formal financial inclusion may create favorable conditions for stronger crypto adoption. By contrast, in developed economies, high mobile connectivity alone does not appear sufficient to generate equally strong adoption intensity.

The data suggest that high cryptocurrency adoption in some emerging economies is associated not only with financial inclusion gaps, but also with relatively strong levels of mobile connectivity. The Philippines, Nigeria, and Vietnam combine higher shares of unbanked adults with comparatively strong crypto-adoption rankings, while also displaying substantial mobile phone ownership. This pattern appears consistent with the leapfrogging argument, according to which populations may adopt digital financial alternatives when mobile access is available but formal financial services remain incomplete.

At the same time, the relationship is not uniform across all cases. India combines a relatively low unbanked rate with the highest crypto-adoption ranking in the sample, while Brazil also shows strong adoption despite more limited financial exclusion than Nigeria or the Philippines. These cases suggest that cryptocurrency adoption may also expand within broader digital-finance ecosystems shaped by mobile-first usage, platform expansion, and growing participation in digital markets.

The developed economies in the sample provide an important contrast. Japan, Germany, and Sweden combine near-universal financial inclusion with lower crypto-adoption intensity than several emerging markets, despite high levels of mobile phone ownership. This suggests that mobile connectivity alone does not explain adoption. Rather, strong crypto uptake appears more likely where digital readiness interacts with unmet financial needs or alternative financial use cases. The United States is a partial exception, as it combines very high financial inclusion with a strong adoption rank, indicating that institutional participation and investment-related demand remain important drivers in advanced markets.

CONCLUSION

This study examined whether FinTech adoption follows different pathways across emerging and developed economies, with a particular focus on digital payments and cryptocurrency adoption. The findings show that FinTech diffusion is context-dependent and shaped by differences in financial infrastructure, institutional capacity, and technological readiness.

The analysis of digital payments reveals two broad patterns. In developed economies, growth mainly reflects the optimization of mature financial systems through higher efficiency, convenience, and deeper integration of digital payment tools. In emerging economies, by contrast, stronger growth in several indicators suggests a more structural transformation, in which digital payments increasingly function as an alternative transactional infrastructure. This pattern is consistent with the leapfrogging perspective, especially where digital tools expand faster than traditional banking access.

The analysis of cryptocurrency adoption further supports this conclusion, but in a more nuanced way. The results do not confirm a simple inverse relationship between weak financial inclusion and high crypto adoption. Instead, they indicate multiple adoption pathways. In some emerging economies, cryptocurrency appears to operate as a partial substitute for incomplete financial services, while in developed economies it is more closely associated with investment, institutional participation, and broader digital financial innovation.

The main contribution of this study lies in in-

tegrating digital payments and cryptocurrency adoption within a single comparative framework of FinTech leapfrogging. It shows that FinTech should be understood not merely as a technological innovation, but as a structural and context-sensitive process. From a policy perspective, the findings highlight the importance of inclusive digital infrastructure, mobile connectivity, financial literacy, and balanced regulation. Future research could expand the country sample, apply econometric testing, and further examine the role of regulatory quality and digital safety in shaping FinTech adoption.

REFERENCES:

Bhasin, N. K., Rajesh, A. (2020). Study of increasing adoption trends of digital banking and FinTech products in Indian payment systems and improvement in customer services. In Collaborative Convergence and Virtual Teamwork for Organizational Transformation, IGI Global, 229–255. <https://doi.org/10.4018/978-1-7998-4891-2.ch012>;

Burlamaqui, L., Kattel, R. (2016). Development as leapfrogging, not convergence, not catch-up: Towards Schumpeterian theories of finance and development. Review of Political Economy, 28(2), 270–288. <https://doi.org/10.1080/09538259.2016.1142718>;

Chitimira, H., Ncube, M. (2020). Legislative and other selected challenges affecting financial inclusion for the poor and low income earners in South Africa. Journal of African Law, 64(3), 337–355. <https://doi.org/10.1017/S0021855320000182>;

Cook, S. (2017). Selfie banking: Is it a reality? Biometric Technology Today, 2017(3), 9–11. <https://doi.org/10.1016/S0969-4765(17)30056-5>;

Dang, T. H. N., Balli, F., Balli, H. O., Kilic, I. (2025). Demographic-governance factors shaping cryptocurrency holding behavior. Finance Research Letters, 85(Part D), 108143. <https://doi.org/10.1016/j.frl.2025.108143>;

Dat, P. T., Oanh, T. T. K. (2025). Linkage between financial inclusion, financial development and financial stability: Perspectives from developing and developed countries. Annals of Financial Economics, 20(4), Article 2550022. <https://doi.org/10.1142/S2010495225500228>;

Demir, A., Pesqué-Cela, V., Altunbas, Y., Murinde, V. (2022). Fintech, financial inclusion and income inequality: A quantile regression approach. European Journal of Finance, 28(1), 86–107. <https://doi.org/10.1080/1351847X.2020.1772335>;

El Hajj, M., Farran, I. (2024). The Cryptocurrencies in Emerging Markets: Enhancing Financial Inclusion and Economic Empowerment. Journal of Risk and Financial Management, 17(10), 467. <https://doi.org/10.3390/jrfm17100467>;

Fong, M. W. L. (2008). The mobile phone telecommunications service sector in China. In Mobile Computing: Concepts, Methodologies, Tools, and Applications. <https://doi.org/10.4018/978-1-60566-054-7.ch108>;

Ghosh, P., Golder, U. (2026). Exploring the effects of FinTech adoption on traditional banking: A systematic literature review on opportunities and challenges. Digital Business, 6(1), 100163. <https://doi.org/10.1016/j.digbus.2026.100163>;

Hanif, R., Pierotti, M., Khalique, M. (2026). Harnessing technological innovation and digital capabilities for resilience in developing economies. Sustainable Technology and Entrepreneurship, 5(1), 100124. <https://doi.org/10.1016/j.stae.2025.100124>;

Huang, C.-Y. (2011). Rethinking leapfrogging in the end-user telecom market. Technological Forecasting and Social Change, 78(4), 703–712. <https://doi.org/10.1016/j.techfore.2010.10.009>;

James, J. (2012). The distributional effects of leapfrogging in mobile phones. Telematics and Informatics, 29(3), 294–301. <https://doi.org/10.1016/j.tele.2011.09.001>;

Karani, G., Jadhav, B. (2025). How traditional banks adapt to the fintech revolution in banking and finance sector. In Shaping Cutting-Edge Technologies and Applications for Digital Banking and Financial Services, Taylor & Francis, 214–225. <https://doi.org/10.4324/9781003501947-13>;

Khan, K., Luo, T., Ullah, S., Rasheed, H. M. W., Li, P.-H. (2023). Does digital financial inclusion affect CO2 emissions? Evidence from 76 emerging markets and developing economies (EMDEs). Journal of Cleaner Production, 420, 138313. <https://doi.org/10.1016/j.jclepro.2023.138313>;

Khatatbeh, I. N., Mustafa, J. A., Alhusban, M. I., Alfoul, M. N. A., Shammout, E. (2026). The role of fintech governance in enhancing financial inclusion and reducing income inequality in MENA countries. Journal of Governance and Regulation, 15(1), 150–159. <https://doi.org/10.22495/jgrv15i1art14>;

Kumar, I. (2024). Banking services and financial inclusion in India's poorest regions. Journal of Banking Regulation, 25(2), 145–159. <https://doi.org/10.1057/s41261-023-00224-9>;

Le, M.-Q., Nguyen, T.-H., Dao, V., Nguyen, P., Vu, D.-L., Nguyen, H.-M., Tran, T.-T. (2025). Research on the impacts of financial inclusion towards national economic growth during the period 2014–2022: New findings and policy implications. In Springer Proceedings in Business and Economics, Springer, 507–530. <https://doi.org/10.1007/978-981-97-9992-3_33>;

Logan, S., Singh, J. P. (2018). The meta-power of technology. In Technologies of International Relations: Continuity and Change. <https://doi.org/10.1007/978-3-319-97418-7_6>;

Mhlanga, D. (2023). Artificial intelligence (AI) solutions for financial inclusion of the excluded: What are the challenges? In Advances in African Economic, Social and Political Development, Springer, 257–272. <https://doi.org/10.1007/978-3-031-31431-5_14>;

Parino, F., Beiró, M. G., Gauvin, L. (2018). Analysis of the Bitcoin blockchain: socio-economic factors behind the adoption. EPJ Data Sci. 7, 38. <https://doi.org/10.1140/epjds/s13688-018-0170-8>;

Patwardhan, A. (2018). Financial inclusion in the digital age. In Kuo, D. L., Deng, R. H. (Eds.). Handbook of blockchain, digital finance, and inclusion, Volume 1: Cryptocurrency, fintech, insurtech, and regulation, Elsevier, 57–89. <https://doi.org/10.1016/B978-0-12-810441-5.00004-X>;

Rai, A. K., Kumar, A., Bhatt, A. K., Esubalew, A. A., Rai, S. (2025). Innovative approaches to financial inclusion in emerging economies: A case study analysis of India and Ethiopia. In Sustainable Finance, Springer, 125–146. <https://doi.org/10.1007/978-3-032-01677-5_6>;

Ranganathan, K. (2012). Leapfrogging the digital divide: Myth or reality for emerging regions? In ICT Influences on Human Development, Interaction, and Collaboration. <https://doi.org/10.4018/978-1-4666-1957-9.ch014>;

Ritzer, G. (2012). Leapfrogging. In The Wiley-Blackwell Encyclopedia of Globalization. <https://doi.org/10.1002/9780470670590.wbeog355>;

Rodima-Taylor, D., Grimes, W. W. (2019). International remittance rails as infrastructures: embeddedness, innovation and financial access in developing economies. Review of International Political Economy, 26(5), 839–862. <https://doi.org/10.1080/09692290.2019.1607766>;

Sanzogni, L., Arthur-Gray, H. (2007). Technology leapfrogging in Thailand. In Global Information Technologies: Concepts, Methodologies, Tools, and Applications. <https://doi.org/10.4018/978-1-59904-939-7.ch136>;

Shah, P., Devdatta, S. T., Jayapriya, J., Vinay, M., Deepa, S. (2025). Technological innovation in digital

payments: A survey of trends, challenges, and opportunities. In Lecture Notes in Networks and Systems, 1321 LNNS, Springer, 35–147. <https://doi.org/10.1007/978-981-96-4151-2_12> ;

Sharma, M. (2021). Digital payments in India: Impact of emerging technologies. In Industry 4.0 Technologies for Business Excellence: Frameworks, Practices, and Applications, CRC Press, 191–204. <https://doi.org/10.1201/9781003140474-11>;

Sikka, V., Bhayana, P. (2024). Barriers to comprehensive financial inclusion across the globe: From sociocultural norms to systemic challenges. In Sustainable Finance, Springer, 89–126. <https://doi.org/10.1007/978-3-031-67523-2_7>;

Tan, B., Ng, E., Jiang, J. (2018). The process of technology leapfrogging: Case analysis of the national ICT infrastructure development journey of Azerbaijan. International Journal of Information Management, 38(1), 311–316. <https://doi.org/10.1016/j.ijinfomgt.2017.10.008>;

Third, A., Kao, K.-T. (2007). ICT leapfrogging policy and development in the third world. In Encyclopedia of Information Ethics and Security. <https://doi.org/10.4018/978-1-59140-987-8.ch049>;

Tian, Y., Chan, T. J., Suki, N. M., Kasim, M. A. (2023). Moderating role of perceived trust and perceived service quality on consumers' use behavior of Alipay e-wallet system: the perspectives of technology acceptance model and theory of planned behavior. Human Behavior and Emerging Technologies, 2023. <https://doi.org/10.1155/2023/5276406>;

Tsang, M. (2023). Currency crisis: Turkey in 2021. The CASE Journal, 19(5), 679–698. <https://doi.org/10.1108/TCJ-08-2022-0140>;

Vincent, G., Sivakumar, S. (2019). *Financial inclusion in India – A progress and challenges.* International Journal of Advanced Science and Technology, 28(19), 521–530;

Visconti-Caparrós, J. M., Campos-Blázquez, J. R. (2022). The development of alternate payment methods and their impact on customer behavior: The Bizum case in Spain. Technological Forecasting and Social Change, 175, 121330. <https://doi.org/10.1016/j.techfore.2021.121330>;

Zhang, Q., Valle-Sison, J. B. (2014). Financial inclusion and regulatory implications. In Global shock, risks, and Asian financial reform, Edward Elgar Publishing, 600–627. <https://doi.org/10.4337/9781783477944.00029> ;

Zhao, D., Yuan, J., Chen, W. (2023). Financial consumer protection in FinTech field. In Contributions to Finance and Accounting. <https://doi.org/10.1007/978-981-99-5173-4_5>.

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ARTICLE

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THE ROLE OF THE ENTREPRENEURIAL ECOSYSTEM IN SUPPORTING STARTUPS: UNIVERSITY INCUBATORS AS A MODEL

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Abstract. *The study examines the pivotal role of entrepreneurial ecosystems in supporting the growth and development of startups, with a focus on university business incubators as an effective mechanism for bridging academic knowledge and market needs. Through a systematic review of multiple scholarly studies, it is evident that university incubators function as central nodes within the ecosystem, providing an integrated environment that combines effective leadership, institutional connectivity, and comprehensive support mechanisms, including mentoring, access to funding, infrastructure, and network building.*

The findings indicate that these incubators significantly contribute to startup survival, enhanced innovation capacity, and local and regional economic development, particularly when they successfully coordinate the efforts of various ecosystem stakeholders, such as industry partners, investors, government agencies, and alumni networks. Despite their importance, university incubators face challenges related to financial sustainability, complex stakeholder coordination, and the transition from academic settings to market environments. The study concludes that implementing supportive policies and strategies is essential to enhancing the integration and effectiveness of university-based entrepreneurial ecosystems.

KEYWORDS: ENTREPRENEURIAL ECOSYSTEMS, UNIVERSITY BUSINESS INCUBATORS, STARTUP SURVIVAL AND GROWTH, INNOVATION CAPACITY, ECONOMIC DEVELOPMENT.

INTRODUCTION

The entrepreneurial ecosystem has become a key framework for understanding how startups grow and succeed in today's economies. Unlike traditional linear approaches to entrepreneurship support, this perspective emphasizes that startup success depends on complex interactions among multiple actors, institutions, resources, and cultural factors within specific geographic and institutional contexts.

Within this broader ecosystem, universities play an important role as knowledge producers, talent developers, and facilitators of entrepreneurship. University incubators are a central manifestation of this role. They act as intermediaries between the academic environment and the commercial market, providing structured support to ventures founded by students, faculty, and sometimes external entrepreneurs. As entrepreneurial ecosystems have evolved globally, incubators have transformed from simple office spaces into integrated ecosystem hubs that coordinate relationships among diverse stakeholders and deliver comprehensive support services.

Despite their importance, the main question that this study addresses is: **How do university incubators contribute to the success of startups within entrepreneurial ecosystems?** This research focuses on answering this question by examining the theoretical frameworks that explain how incubators operate, reviewing effective models and approaches in different contexts, and analyzing the support mechanisms they provide, along with the challenges and opportunities they face. The study aims to provide practical insights for policymakers, university administrators, and entrepreneurship practitioners to enhance the effectiveness of university-based entrepreneurial support systems.

1. RESEARCH METHODOLOGY

This study aims to explore the role of university business incubators in supporting the growth of startups within entrepreneurial ecosystems. To achieve this, the research is based on a systematic review of relevant scholarly literature in the fields of entrepreneurship, university incubators, research incubators, and science parks.

Research Approach:

- **Study Type:** The research is descriptive and analytical, focusing on how university incubators function as key nodes in entrepreneurial ecosystems.
- **Data Sources:** The study relies on scientific articles and reports published between 2017 and 2025, emphasizing the impact of university incubators on innovation, startup growth, and ecosystem development.

Analysis Methods:

- **Content Analysis:** To identify the main factors that influence the success of university incubators and their contributions to entrepreneurial ventures.
- **Comparative Analysis:** To examine different models of university and research incubators, highlighting how academic support translates into real-world startup success.

Importance of the Methodology

This approach provides a clear understanding of how university incubators operate within entrepreneurial ecosystems, their role in fostering innovation and entrepreneurship, and their contribution to local and regional economic development. It also offers a practical foundation for recommendations to policymakers, universities, and institutions supporting entrepreneurship.

Limitation: This study faces several limitations, most notably its reliance on secondary sources that may not fully reflect the most recent practices. In addition, cross-country contextual differences may affect the accuracy of the comparisons. The absence of field data also restricts a deeper understanding of the experiences of incubators and entrepreneurs, highlighting the need for more comprehensive future studies.

2. THEORETICAL FOUNDATIONS OF ENTREPRENEURIAL ECOSYSTEMS

Entrepreneurial ecosystems comprise a set of institutions, networks, culture, policies, and resources that create favorable conditions for the emergence and growth of startups within a given region. Within this framework, university incubators play a pivotal role as strategic hubs, linking academic knowledge with market needs and channeling ecosystem resources to support startups and transform ideas into scalable ventures. The ecosystem perspective emphasizes that startup success depends not merely on individual entrepreneur characteristics or firm-level resources, but on the quality and configuration of the broader support environment.[1]

Key ecosystem components typically include entrepreneurs and startups, support organizations such as incubators and accelerators, financial capital providers, universities and research institutions, government agencies and policy frameworks, established corporations, professional service providers, and cultural attitudes toward entrepreneurship and risk-taking. The critical factors necessary for the emergence and sustainability of the entrepreneurial ecosystem include clearly defining the goals, shared values, and responsibilities of all stakeholders, while continuously monitoring their impact. Equally important is actively fostering a local culture of entrepreneurship and developing the managerial talent within the ecosystem. Creating and capturing value, supporting human and social capital, and promoting a positive attitude toward failure and learning are also essential. Building trust-based relationships among stakeholders and encouraging entrepreneurial "recycling", where experienced entrepreneurs reinvest their time, resources, and expertise, further strengthen the system. Moreover, providing commercial opportunities for local businesses and high-growth firms, ensuring a robust business infrastructure, securing adequate funding, and implementing supportive public policies collectively create the conditions needed for the sustainable development of innovative ventures.[2]

The authors view entrepreneurial ecosystems as interconnected networks of institutions, culture, policies, and resources that support startup growth, with university incubators serving as strategic hubs linking academic knowledge to market needs. They emphasize that shared goals, entrepreneurial culture, managerial talent, trust-based relationships, infrastructure, funding, and supportive policies are essential for the sustainable development of innovative ventures.

3. ENTREPRENEURIAL ECOSYSTEMS AND THE ROLE OF UNIVERSITY INCUBATORS IN SUPPORTING STARTUPS

Research on entrepreneurial ecosystems shows that startup success is strongly influenced by the combined effect of funding access, mentorship, networking opportunities, government support, and entrepreneurial culture.[3] Access to finance and mentorship are major predictors of startup growth, while strong networks and relational capacity are especially important for innovation outcomes.[4] Highquality ecosystems not only support local startups but also attract entrepreneurial talent from other regions, acting as "escalators" where entrepreneurs move from good to better ecosystems to benefit from richer resources and networks.[5] Ecosystems are thus

1 Harun, H. et al. (2024). ICCubeX: A Structured University Incubation Model to Accelerate the Lab-to-Market Process. International journal of academic research in business & social sciences, vol. 14, no. 1, 1339-1354. <http://dx.doi.org/10.6007/IJARBSS/v14-i1/20546>.

2 Badzinska, E. (2021). Providing a Nurturing Environment for Start-up Incubation: an Explorative Study of a University-based Entrepreneurial Ecosystem. European Research Studies Journal Volume XXIV Special Issue 2, Part 3, 15-29. <https://doi.org/10.35808/ersj/2701>.

3 Spigel, B. (2017). The Relational Organization of Entrepreneurial Ecosystems. Entrepreneurship Theory and Practice, 41(01), 49-72. <https://doi.org/10.1111/etap.12167>.

4 Bamini, J., Choudari, S., Joy, A., Chawla, N., Yabaluri, B., Shankar, S. D., Singh, R. (2025). The Role ofEntrepreneurial Ecosystems in Supporting Startup Growth and Innovation. Journal of Information SystemsEngineering and Management, vol. 10, no. 3, 427-434. <https://doi.org/10.52783/jisem.v10i3.5002>.

5 Mazzoni, L., Riccaboni, M., Stam, E. (2025). Entrepreneurial ecosystems and interregional flows

dynamic and relational, built from cumulative entrepreneurial successes and failures that generate investment capital, skilled workers, and entrepreneurial knowledge for future ventures.

The authors conclude that startup success relies on the interplay of funding, mentorship, networking, government support, and entrepreneurial culture, with a high-quality ecosystem attracting talent and fostering innovation being essential for sustainable growth.

4. UNIVERSITY INCUBATORS AS KEY ECOSYSTEM NODES

Universities are "engines of economic development" and primary producers of scientific knowledge that can support entrepreneurial ventures.[6] With the rise of the entrepreneurial university, university business incubators (UBIs) have become central tools for converting research and student ideas into startups.[7]

These incubators typically provide a range of services to support entrepreneurs. They act as intermediaries within the ecosystem, bridging knowledge and business subsystems and helping to address "weak network" issues by creating dense startup–investor networks through meetings, networking, and field-building activities.[8] They also embed constrained or high-risk startups into financial support networks, which is essential when technology or impact constraints are high.[9]

Physical and technical resources—including space, laboratories, equipment, and shared services—help lower startup entry costs.[10] Incubators also provide business support and mentoring, which reduces market risks and enhances startup performance and sustainability, conceptualized as the "support capability" of academic incubators.[11]

Moreover, these incubators are connected to technology transfer and industry links, tying research outcomes to economic development and accelerating commercialization.[12] They also foster entrepreneurial education and mindset formation by integrating incubators with curricula, moving students from an "employee" mindset to an "employer" mindset.[13]

The **ɔable 1** illustrates the role of university business incubators.

Similarly, incubators that allocate more resources to societal startups tend to demonstrate stronger innovation performance and higher successful exit rates, indicating that aligning commercial objectives with societal goals can enhance both economic and social outcomes.[14]

ofentrepreneurial talent. Small Business Economics, 65, 1327-1361. <https://doi.org/10.1007/s11187-025-01022-5>.

6 Al-Sabaawe, Y., Albayati, N., Al-Obaidy, N. (2025). University Industry Incubators: Igniting Global StartupRevolutions. JBMP (Jurnal Bisnis, Manajemen dan Perbankan), vol. 11, no. 2, 229-254. <https://doi.org/10.21070/jbmp.v11i2.2109>.

7 Mele, G., Sansone, G., Secundo, G., Paolucci, E. (2024). Speeding Up Student Entrepreneurship: The Role ofUniversity Business Idea Incubators. IEEE Transactions on Engineering Management, 71, 2364-2378.<https://doi.org/10.1109/tem.2022.3175655>.

8 Van Rijnsoever, F. (2020). Meeting, mating, and intermediating: How incubators can overcome weak networkproblems in entrepreneurial ecosystems. Research Policy, vol. 49, issue 1, 103884. <https://doi.org/10.1016/j.respol.2019.103884>.

9 Van Rijnsoever, F. (2022). Intermediaries for the greater good: How entrepreneurial support organizations canembed constrained sustainable development startups in entrepreneurial ecosystems. Research Policy, vol. 51, issue 2, 104438. <https://doi.org/10.1016/j.respol.2021.104438>.

10 Kambanou, M., Hajoary, P., Lindfors, A. (2025). Supporting start-ups in the circular economy: An analysis of university-led incubators in India. Journal of Industrial Ecology, 29, 997-1012. <https://doi.org/10.1111/jiec.70032>.

11 Rai, R., Prasad, A., Murthy, B. (2025). Incubation support for academia-based entrepreneurship: an empirical study. Journal of Asia Business Studies, vol. 19, no. 2, 289-314 (26). <https://doi.org/10.1108/jabs-02-2024-0102>.

12 Hassan, N. (2020). University business incubators as a tool for accelerating entrepreneurship: theoreticalperspective. Review of Economics and Political Science, vol. 9, no. 5, 434-453. <https://doi.org/10.1108/reps-10-2019-0142>.

13 Abdraimova, B., Abdyldaeva, N. (2025). Business Incubators and Entrepreneurial Education in Universities: the Need for an Integrated Approach. Bulletin of Science and Practice, 11(7): 481-487. <https://doi.org/10.33619/2414-2948/116/69>.

14 Máté, D., Estiyanti, N., Novotny, Á., Vveinhardt, J. (2025). University business incubators in Indonesia: Navigating commercial viability and societal contributions. Sustainable Futures, vol. 10. <https://doi.org/10.1016/j.sftr.2025.101138>.

Table 1. Main Contributions of University Incubators Within Ecosystems

Incubator Role	Ecosystem Impact	Citations
Transform research into startups.	Accelerates the development of market-ready innovations and enhances overall competitiveness	(Al-Sabaawe, Y. et al. (2025); Hassan, N. (2020).
Provide support capabilities	Improves startup performance and sustainability	(Rai, R. et al. (2025); Kulkarni, et al. (2024).[1]
Build networks and strengthen connections	Enhances financial and knowledge networks, reducing weak ties	(Van Rijnsoever, F. (2022); Van Rijnsoever, F. (2020).
Promote student entrepreneurship	Speeds up student-led startups and develops human capital	(Mele, G., et al. (2024); Abdraimova, B., Abdyldaeva, N. (2025).
Advance sustainability & societal impact	improves innovation outcomes and increases successful exits for socially-oriented startups	(Máté, D., et al. (2025); Karahan, 2024).[2]

Table prepared by the authors based on the studies cited above

The **Table 2** presents the components of the entrepreneurial ecosystem and their impact on the entrepreneurial experience.

Based on the above, the researchers conclude that university incubators are key nodes in entrepreneurial ecosystems, connecting research to innovation and supporting startup growth. Their success depends on strong networks, access to resources, and integration with the university's mission, rather than simply following generic models.

5. MODELS AND FRAMEWORKS FOR UNIVERSITY-BASED INCUBATION

Structural connectivity involves the formal organizational setups, business models, and mechanisms that link the incubator to investors and external partners. Agentic connectivity, on the other hand, depends on the experience and networks of key individuals, such as managers and directors, who connect startups to resources and opportunities through personal relationships. Research shows that the most successful incubators combine both types, with agentic connectivity often laying the groundwork for structural systems to function effectively and sustainably.[15]

Researchers have developed multi-level frameworks to explain the role of university incubators within the entrepreneurial ecosystem. These frameworks focus on three levels: the **micro-level** for individual founders and startups, the **meso-level** for the incubator and its immediate support network, and the **macro-level** for the regional, national, and international ecosystem characteristics.[16] A key example is the I5 Framework, which links Institutions, Industries, Interactions, Innovations, and Incubators, highlighting the importance of proactive university involvement and systematic support for startups. The lifecycle model also shows that incubators[17] start by building basic infrastructure and attracting their first cohorts, and as they mature, they expand their networks and become active orchestrators within the ecosystem.[18]

15 Ricard, L. et al.(2022). Lacunes et apports des accélérateurs et des incubateurs universitaires aux écosystèmes entrepreneuriaux. Revue organisations & territoires, vol. 31, no. 2. 29-42. <https://doi.org/10.1522/revueot.v31n2.1482>.

16 Sohail, S. et al. (2025). Multi-level entrepreneurial ecosystem framework: Founder, incubator, and country characteristics for start-up performance. Journal of Small Business Management, 1-31. <https://doi.org/10.1080/00472778.2025.2581669>.

17 Patil, S. et al. (2023). I5 Framework: Institutions-Industries-Interactions Innovations-Incubators for Strengthening Start-up Ecosystem in Higher Education Institutions. International Journal of Emerging Technologies in Learning (IJET), vol. 18, no. 8, 4-22. <https://doi.org/10.3991/ijet.v18i08.36647>.

18 Nicholls-Nixon, C. L. et al. (2021). Entrepreneurial

Table 2. Links Between Entrepreneurial Ecosystem Elements and the Entrepreneurial Experience
(Bamini, et. al. (2025). 432)

Ecosystem Component	Key Themes Identified	Impact on Entrepreneurial Experience
Relational Capacity and Collaboration	Collaborative networks and knowledge sharing.	Strong collaboration between entrepreneurs, mentors, and investors facilitates innovation and growth.
Access to Funding and Resources	Importance of venture capital, angel investors, and strategic guidance.	Funding is crucial for scaling operations, while mentorship provides essential business planning support.
Government Policies and Regulatory Environment	Positive and negative aspects of government-backed incubators and bureaucratic challenges.	Government policies help but bureaucratic hurdles can hinder quick decision-making and innovation.
Cultural and Environmental Factors	Entrepreneurial spirit, risk-taking culture, and creative freedom.	A supportive entrepreneurial culture fosters creativity and risk-taking, enabling innovative ventures.

Figure 1 presents the three levels of the entrepreneurial ecosystem framework.[19]

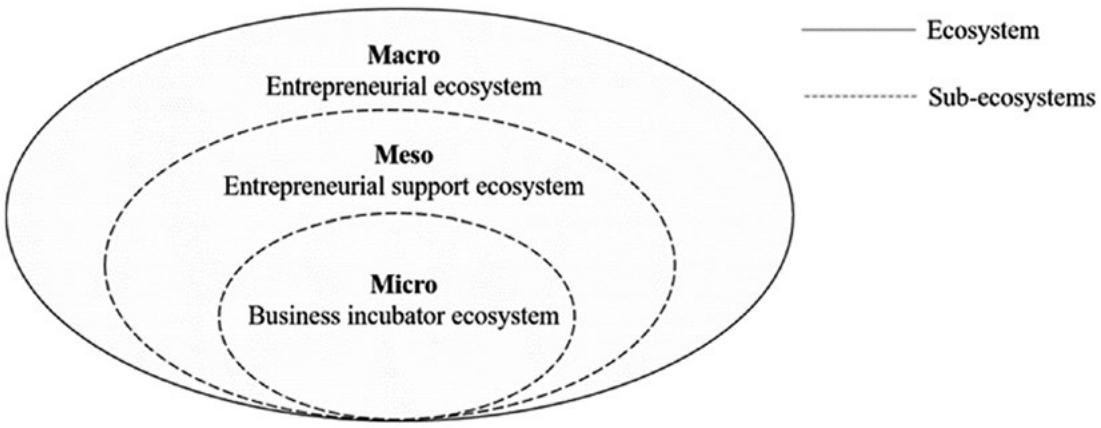
Based on the above, the authors rgue that the success of university incubators depends on combining structural connectivity with personal (agentic) connections, as the relationships of key individuals lay the foundation for effective institutional systems.

They also emphasize that multi-level frameworks, such as the I5 Framework and the lifecycle model, help to understand the role of incubators at individual, organizational, and regional levels, highlighting the importance of active university involvement in supporting innovation and coordinating the entrepreneurial ecosystem sustainably.

ecosystems and the lifecycle of university business incubators: An integrative case study. International Entrepreneurship and Management Journal, vol. 17, issue 2, 809-837. <https://doi.org/10.1007/s11365-019-00622-4>.

19 Theodoraki, C., Messeghem, K. (2017). Exploring the entrepreneurial ecosystem in the field of entrepreneurial support: a multi-level approach. Int. J. Entrepreneurship and Small Business, vol. 31, no. 1, 61.

Figure 1. Three levels of entrepreneurial ecosystem (Theodoraki, C., Messeghem, K. (2017). 61)



6. COMPARATIVE ANALYSIS: UNIVERSITY INCUBATORS ACROSS CONTEXTS

University incubation models vary considerably according to geographic context, institutional orientation, and levels of economic development. Comparative studies indicate that university incubators in North America, especially in the United States, primarily focus on technology commercialization, attracting external investment, and supporting high-growth startups.[20] This model is reinforced by mature venture capital ecosystems, strong intellectual property protection, and a culture that is generally open to entrepreneurial risk-taking.[21] Nevertheless, these incubators face several challenges, including intense competition to attract promising ventures, strong pressure for rapid financial returns, and the risk of drifting away from their educational mission.

In the European context, university incubators are more diverse in their structures and objectives, reflecting differences in national higher education systems and innovation policies[22]. Many European programs place greater emphasis on regional economic development, social entrepreneurship, and sustainable business models when compared to North American incubators.[23] They also tend to maintain closer relationships with government innovation programs and regional development agencies. However, these programs often encounter limitations such as restricted access to venture capital, complex regulatory frameworks, and, in some cases, cultural environments that are less supportive of entrepreneurial risk-taking.[24]

University incubators operating in emerging and developing economies face unique challenges and opportunities. They frequently function within entrepreneurial ecosystems that are still underdeveloped, characterized by limited venture capital, weak intellectual property protection, and institutional gaps in support infrastructure. At the same time, these incubators play an essential role in addressing local development needs and in stimulating entrepreneurial ecosystems where few alternatives exist. Successful initiatives in these contexts tend to focus on capacity building, adapting to local resource constraints, and finding ways to overcome institutional barriers[25]. Research also highlights innovative practices such as partnerships with international organizations, mobilizing diaspora networks, and adopting hybrid models that link incubation with broader economic development strategies.[26]

Institutional characteristics further influence the design of incubation models. Research-intensive universities with strong science and engineering programs usually emphasize technology commercialization and faculty entrepreneurship[27]. In contrast, teaching-oriented institutions often prioritize student entrepreneurship and regional engagement[28]. Specialized institutions, such as business schools, develop distinctive incubation models by leveraging their specific expertise and professional networks.[29] Overall, evidence sug-

20 Breznitz, S. M. et al. (2019). Fostering the growth of student start-ups from university accelerators: An entrepreneurial ecosystem perspective. Industrial and Corporate Change, vol. 28, no. 4, 855-873. <https://doi.org/10.1093/ICC/DTZ033>.

21 Wright, M. et al. (2017). An emerging ecosystem for student start-ups. Journal of Technology Transfer, vol. 42, no. 4, 909-922. DOI: <https://doi.org/10.1007/s10961-017-9558-z>.

22 Vassileva, J., Tsafack Nanfosso, R. (2025). L'incubation entrepreneuriale au sein de l'université entrepreneuriale: Études de cas en Europe et en Afrique. Revue Internationale des Économistes de Langue Française, vol. 10, no. 1, 37-55. <https://doi.org/10.18559/rielf.2025.1.2277>.

23 Maulidian, R. et al. (2024). Green Entrepreneurship Incubation Model for Students at Trilogy University Business Incubator: A Literature Review. E3S web of conferences, vol. 483, The 3rd International Seminar of Science and Technology (ISST 2023). <https://doi.org/10.1051/e3sconf/202448301017>.

24 Vassileva, J., Tsafack Nanfosso, R. (2025). op. cit.

25 Bronstein, Y. V. et al. (2021). Toward a Framework for University-Based Entrepreneurial Ecosystems and Human Capital Development in Sub-Saharan Africa. In book: Resilience, Entrepreneurship and ICT. <https://doi.org/10.1007/978-3-030-78941-1_2>.

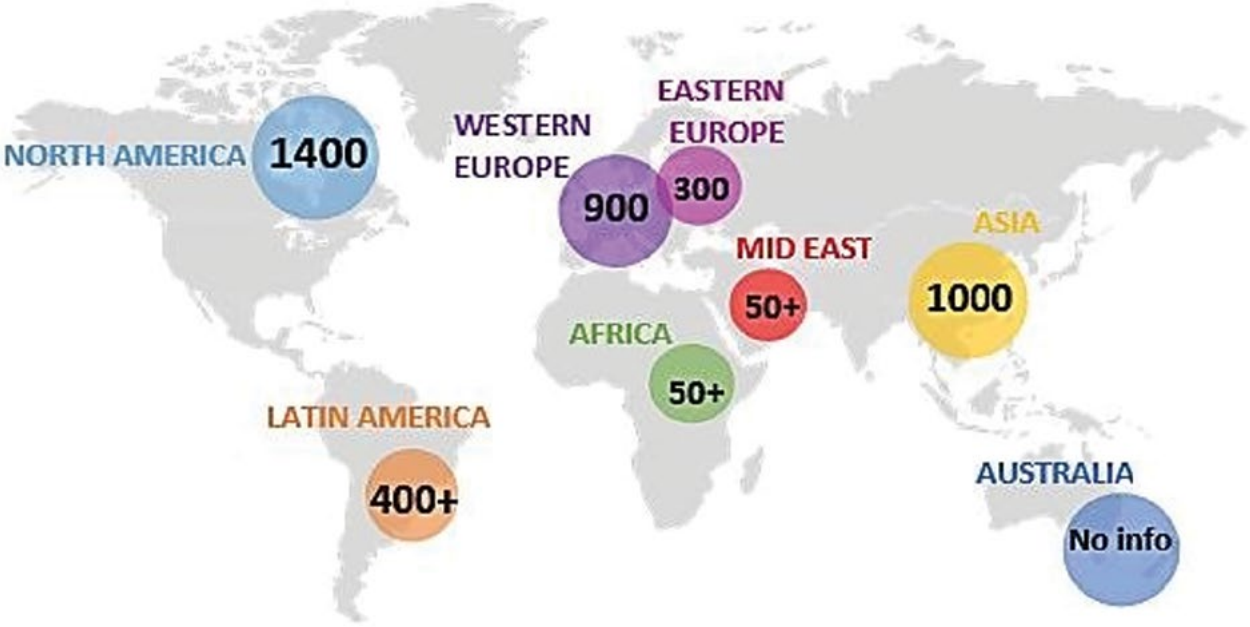
26 Casanova-Villalba, C. et al. (2025). Modelo de vinculación academia-empresa para facilitar la creación y sostenibilidad de start-ups tecnológicas en Ecuador. Journal of Economic and Social Science Research (JESSR), vol. 5, no. 2, 189-204. <https://doi.org/10.55813/gaea/jessr/v5/n2/197>.

27 Harun, H. et al. (2024). op. cit.

28 Jurgelevičius, A. et al. (2025). Developing an entrepreneurial ecosystem framework for student-led start-ups in higher education. Neveléstudomány, 15(7), 837. <https://doi.org/10.3390/educsci15070837>.

29 Allahar, H. et al. (2019). A University Business School

Figure 2. Distribution of Business Incubators in Different Countries (Tsaplin, E., Pozdeeva, Y. (2017). 38)



gests that the most effective incubation models are those that align closely with the institution's mission and strengths, rather than simply adopting generic best practices.[30] Figure 02 illustrates the distribution of business incubators across different countries (See Fig.2).[31]

The **Table 3**, Reproduced exactly as published in **(Gaire, Tiwari (2025))** illustrates the Incubators – Distribution by Continents.[32]

From the literature, it is clear that university incubation models differ widely depending on geographic context, the type of institution, and the level of economic development.

In North America, incubators mainly focus on turning technological innovations into commercial products, attracting external funding, and supporting high-growth startups.

European incubators, on the other hand, tend to emphasize regional development, social entrepreneurship, and sustainable business models. In emerging and developing economies, incubators often face resource constraints and underdeveloped entrepreneurial ecosystems, so they prioritize building local capacities, adapting to limitations, and adopting innovative approaches such as international partnerships and hybrid models. The nature of the institution also shapes the design of incubation programs: research-oriented universities focus on faculty entrepreneurship and technology commercialization, while teaching-focused institutions give more attention to student entrepreneurship and community engagement. Overall, the evidence shows that the most successful incubators are those that align closely with the university's mission and strengths, rather than simply following generic models.

as an Entrepreneurial Ecosystem Hub. Technology Innovation Management Review, vol. 9, no. 11, 15-25. <https://doi.org/10.22215/timreview/1280>.

30 McAdam, M. et al. (2016). Situated regional university incubation: A multi-level stakeholder perspective. Technovation, vol. 50-51, 69-78. <https://doi.org/10.1016/j.technovation.2015.09.002>.

31 Tsaplin, E., Pozdeeva, Y. (2017). International strategies of business incubation: The USA, Germany and Russia. International Journal of Innovation (IJI Journal), São Paulo, vol. 5, no. 1, 38.

32 Gaire, P. N., Tiwari, U. (2025). Evolution and Distribution of Business Incubators: A Literature Review, BIC Journal of Management, 2(1), 125.

Table 3. Statistics of the Incubators – Distribution by Continents (Gaire, Tiwari. (2025). 125)

Continent	Number of Incubators/ Accelerators/ Innovation Hub	Citations
North America	3,340	Tracxn, 2025
Europe	2,890	Tracxn, 2025
Asia	2,480	Tracxn, 2025
Africa	1,000	African ScaleCraft, 2025; Diouf et al., 2024
Latin America	400	Tsaplin & Pozdeeva, 2017
Oceania	263	Tracxn, 2025
Total Business Innovation Centers Worldwide	Over 10,373	

CONCLUSION

The entrepreneurial ecosystem plays a fundamental role in providing the necessary infrastructure to support entrepreneurship, including finance, culture, policies, and talent. University incubators operationalize these resources on the ground, transforming ideas and research into scalable startups. They do not merely offer physical space and basic services; they also serve as a bridge connecting academia, industry, and society, facilitating knowledge transfer and developing entrepreneurial skills, thus providing a practical model for how ecosystems can systematically support startup creation, growth, and sustainable innovation.

Evidence shows that university incubators operate within multi-level frameworks combining strong organizational structures, effective leadership, comprehensive support mechanisms, and deep integration with the surrounding ecosystem. They contribute to startup success by reducing operating costs, providing access to specialized resources and expertise, building extensive networks, signaling credibility that attracts investors and partners, and offering educational programs that enhance entrepreneurial capabilities. The outcomes of these programs demonstrate tangible impacts on venture survival, growth, funding success, as well as broader contributions to regional innovation, knowledge transfer, and the development of a strong entrepreneurial culture.

However, university incubators face significant challenges, including difficulties in achieving financial sustainability, the need to coordinate multiple stakeholders, cultural gaps between academic and commercial environments, and dependence on key individuals, which can threaten program continuity

Key Findings

- University incubators transform ideas and research into scalable ventures and connect academia, industry, and society.
- They support startup success through financial resources, expertise, networks, and educational programs.
- They have tangible effects on venture survival, growth, funding success, innovation, and knowledge transfer.
- They face financial, cultural, and managerial challenges that require strategic solutions.

Practical Recommendations

1. Develop sustainable funding models to reduce dependence on university support or external grants.

2. Strengthen ecosystem integration through systematic stakeholder coordination.
3. Build strong leadership and management teams to ensure program continuity and reduce reliance on individuals.
4. Adapt to digital and global entrepreneurial environments to expand networks and support innovation.
5. Balance multiple objectives, including educational missions, research commercialization, regional development, and financial sustainability.

University incubators are a powerful tool for supporting startups and driving sustainable innovation, as improving their mechanisms strengthens venture success while also advancing regional innovation, economic growth, and societal development.

REFERENCES:

Abdraimova, B., Abdyldaeva, N. (2025). Business Incubators and Entrepreneurial Education in Universities: the Need for an Integrated Approach. Bulletin of Science and Practice, 11(7). <https://doi.org/10.33619/2414-2948/116/69>;

Al-Sabaawe, Y., Albayati, N., Al-Obaidy, N. (2025). University Industry Incubators: Igniting Global StartupRevolutions. JBMP (Jurnal Bisnis, Manajemen dan Perbankan), vol. 11, no. 2. <https://doi.org/10.21070/jbmp.v11i2.2109> ;

Allahar, H. et al. (2019). A University Business School as an Entrepreneurial Ecosystem Hub. Technology Innovation Management Review, vol. 9, no. 11. <https://doi.org/10.22215/timreview/1280>;

Badzinska, E. (2021). Providing a Nurturing Environment for Start-up Incubation: an Explorative Study of a University-based Entrepreneurial Ecosystem. European Research Studies Journal Volume XXIV Special Issue 2, Part 3. <https://doi.org/10.35808/ersj/2701>;

Bamini, J., Choudari, S., Joy, A., Chawla, N., Yabaluri, B., Shankar, S. D., Singh, R. (2025). The Role ofEntrepreneurial Ecosystems in Supporting Startup Growth and Innovation. Journal of Information SystemsEngineering and Management, vol. 10, no. 3. <https://doi.org/10.52783/jisem.v10i3.5002>;

Breznitz, S. M. et al. (2019). Fostering the growth of student start-ups from university accelerators: An entrepreneurial ecosystem perspective. Industrial and Corporate Change, vol. 28, no. 4. <https://doi.org/10.1093/ICC/DTZ033>;

Bronstein, Y. V. et al. (2021). Toward a Framework for University-Based Entrepreneurial Ecosystems and Human Capital Development in Sub-Saharan Africa. In book: Resilience, Entrepreneurship and ICT. <https://doi.org/10.1007/978-3-030-78941-1_2>;

Casanova-Villalba, C. et al. (2025). Modelo de vinculación academia-empresa para facilitar la creación y sostenibilidad de start-ups tecnológicas en Ecuador. Journal of Economic and Social Science Research (JESSR), vol. 5, no. 2. <https://doi.org/10.55813/gaea/jessr/v5/n2/197>;

Gaire, P. N., Tiwari, U. (2025). Evolution and Distribution of Business Incubators: A Literature Review, BIC Journal of Management, 2(1);

Harun, H. et al. (2024). ICCubeX: A Structured University Incubation Model to Accelerate the Lab-to-Market Process. International journal of academic research in business & social sciences, vol. 14, no. 1. <http://dx.doi.org/10.6007/IJARBSS/v14-i1/20546>;

Hassan, N. (2020). University business incubators as a tool for accelerating entrepreneurship: theoreticalperspective. Review of Economics and Political Science, vol. 9, no. 5. <https://doi.org/10.1108/reps-10-2019-0142>;

Jurgelevičius, A. et al. (2025). Developing an entrepreneurial ecosystem framework for student-led start-ups in higher education. Neveléstudomány, 15(7). <https://doi.org/10.3390/educsci15070837>;

Karahan, M. (2024). Advancing sustainable entrepreneurial universities: sustainability transformations of university business incubators in Germany. Small Business Economics. <https://doi.org/10.1007/s11187-023-00860-5;

Kambanou, M., Hajoary, P., Lindfors, A. (2025). Supporting start-ups in the circular economy: An analysis of university-led incubators in India. Journal of Industrial Ecology, 29. <https://doi.org/10.1111/jiec.70032>;

Kulkarni, P., Tigadi, B., Gokhale, P., K., L. (2024). University incubators performance through the lens of institutional theory. Vilakshan – XIMB Journal of Management. <https://doi.org/10.1108/xjm-02-2024-0029>;

Ricard, L. et al. (2022). Lacunes et apports des accélérateurs et des incubateurs universitaires aux écosystèmes entrepreneuriaux. Revue organisations & territoires, vol. 31, no. 2. <https://doi.org/10.1522/revueot.v31n2.1482>;

Máté, D., Estiyanti, N., Novotny, Á., Vveinhardt, J. (2025). University business incubators in Indonesia: Navigating commercial viability and societal contributions. Sustainable Futures, vol. 10. <https://doi.org/10.1016/j.sftr.2025.101138>;

Maulidian, R. et al. (2024). Green Entrepreneurship Incubation Model for Students at Trilogy University Business Incubator: A Literature Review. E3S web of conferences, vol. 483, The 3rd International Seminar of Science and Technology (ISST 2023). <https://doi.org/10.1051/e3sconf/202448301017>;

Mazzoni, L., Riccaboni, M., Stam, E. (2025). Entrepreneurial ecosystems and interregional flows ofentrepreneurial talent. Small Business Economics, 65. <https://doi.org/10.1007/s11187-025-01022-5>;

McAdam, M. et al. (2016). Situated regional university incubation: A multi-level stakeholder perspective. Technovation, vol. 50-51. <https://doi.org/10.1016/j.technovation.2015.09.002>;

Mele, G., Sansone, G., Secundo, G., Paolucci, E. (2024). Speeding Up Student Entrepreneurship: The Role ofUniversity Business Idea Incubators. IEEE Transactions on Engineering Management, 71.<https://doi.org/10.1109/tem.2022.3175655>;

Nicholls-Nixon, C. L. et al. (2021). Entrepreneurial ecosystems and the lifecycle of university business incubators: An integrative case study. International Entrepreneurship and Management Journal, vol. 17, issue 2. <https://doi.org/10.1007/s11365-019-00622-4>;

Patil, S. et al. (2023). I5 Framework: Institutions-Industries-Interactions Innovations-Incubators for Strengthening Start-up Ecosystem in Higher Education Institutions. International Journal of Emerging Technologies in Learning (IJET), vol. 18, no. 8. <https://doi.org/10.3991/ijet.v18i08.36647>;

Rai, R., Prasad, A., Murthy, B. (2025). Incubation support for academia-based entrepreneurship: an empirical study. Journal of Asia Business Studies, vol. 19, no. 2. <https://doi.org/10.1108/jabs-02-2024-0102>;

Sohail, S. et al. (2025). Multi-level entrepreneurial ecosystem framework: Founder, incubator, and country characteristics for start-up performance. Journal of Small Business Management. <https://doi.org/10.1080/00472778.2025.2581669> ;

Spigel, B. (2017). The Relational Organization of Entrepreneurial Ecosystems. Entrepreneurship Theory and Practice, 41(01). <https://doi.org/10.1111/etap.12167>;

Theodoraki, C., Messeghem, K. (2017). Exploring the entrepreneurial ecosystem in the field of entrepreneurial support: a multi-level approach. Int. J. Entrepreneurship and Small Business, vol. 31, no. 1;

Tsaplin, E., Pozdeeva, Y. (2017). International strategies of business incubation: The USA, Germany and Russia. International journal of innovation (IJI Journal), São Paulo, vol. 5, no. 1;

Van Rijnsoever, F. (2020). Meeting, mating, and intermediating: How incubators can overcome weak networkproblems in entrepreneurial ecosystems. Research Policy, vol. 49, issue 1, 103884. <https://doi.org/10.1016/j.respol.2019.103884>;

Van Rijnsoever, F. (2022). Intermediaries for the greater good: How entrepreneurial support organizations canembed constrained sustainable development startups in entrepreneurial ecosystems. Research Policy, vol. 51, issue 2, 104438. <https://doi.org/10.1016/j.respol.2021.104438>;

Vassileva, J., Tsafack Nanfosso, R. (2025). L'incubation entrepreneuriale au sein de l'université entrepreneuriale: Études de cas en Europe et en Afrique. Revue Internationale des Économistes de Langue Française, vol. 10, no. 1. <https://doi.org/10.18559/rielf.2025.1.2277>;

Wright, M. et al. (2017). An emerging ecosystem for student start-ups. Journal of Technology Transfer, vol. 42, no. 4. DOI: <10.1007/s10961-017-9558-z>.

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DISINFORMATION AND ITS IMPACT ON SOCIETY: THE CASE OF THE RUSSIA-UKRAINE WAR

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Abstract. *This paper examines disinformation as a central instrument of power in contemporary geopolitics, focusing on the Russia-Ukraine war as a critical case study of its societal, political, and international consequences. It analyzes how disinformation operates not merely as a supplementary propaganda tool, but as a core mechanism of governance, narrative control, and strategic influence. The study explores the erosion of the rules-based international order, the paralysis of international institutions, and the transformation of information into a weapon capable of reshaping public perception, weakening democratic trust, and legitimizing aggression. Particular attention is devoted to Russia's internal and external disinformation strategies, their impact on Ukrainian society, and Ukraine's adaptive resilience through media literacy and civil society mobilization. The findings underscore that while disinformation can destabilize societies in peacetime, its effectiveness diminishes when confronted with lived reality during wartime, highlighting the crucial role of truth, institutional credibility, and societal resilience in contemporary international relations.*

KEYWORDS: DISINFORMATION, INFORMATION WARFARE, RUSSIA-UKRAINE WAR, NARRATIVE CONTROL, PROPAGANDA, MEDIA MANIPULATION, RULES-BASED INTERNATIONAL ORDER.

INTRODUCTION

In an era in which information is both easily accessible and capable of spreading at unprecedented speed, the terms "disinformation" and "fake news" have become an integral part of everyday vocabulary. These phenomena no longer merely reflect public opinion but actively participate in its formation, exerting a significant influence on the public agenda and, more broadly, on the overall political structure of contemporary societies. Through the deliberate manipulation of information, specific socio-political processes can be steered, framed, and controlled, while public attitudes and collective perceptions are strategically shaped and directed. In this context, information ceases to function solely as a means of communication and increasingly becomes a tool of power, capable of determining political priorities, influencing decision-making processes, and redefining the boundaries of public discourse.

Disinformation refers to the deliberate dissemination of false or misleading information, typically with the intention of deceiving audiences or manipulating their perceptions. Fake news, by contrast, generally denotes fabricated or distorted narratives that are presented in the form of legitimate news reporting, often mimicking the style and authority of credible media sources. Although conceptually distinct, both phenomena can produce profound and far-reaching consequences. These effects range from the erosion of public trust in institutions and media systems to the cultivation of fear, polarization, and social fragmentation within society, or, conversely, to the artificial construction of seemingly positive and stable informational environments that obscure underlying realities. In all cases, the manipulation of information reshapes public consciousness and alters the conditions under which social and political life unfolds.

Disinformation has become a pivotal instrument for the Russian government, particularly within the context of the ongoing war in Ukraine. This strategic practice is designed not only to shape domestic perceptions and regulate the internal informational environment, but also to rationalize and legitimize state actions on the international stage. Understanding how disinformation operates within this framework constitutes a crucial area of scholarly inquiry, especially given the depth and breadth of its societal impact. In conditions where manipulated narratives can influence attitudes, behavior, and institutional legitimacy, examining the mechanisms, objectives, and consequences of disinformation becomes essential for assessing its profound effects on society.

Despite the expanding volume of scholarly inquiries addressing this phenomenon, a significant gap remains within the existing academic literature. While contemporary studies extensively map the tactical use of digital propaganda, cyber interventions, and state-sponsored broadcasting networks, the existing literature primarily views disinformation as an auxiliary element of military operations or as a tool for short-term electoral interference. What remains relatively less studied is the structural conceptualization of systemic deception as an enduring mechanism of domestic statecraft and structural international disruption. Most works treat information operations as isolated strategic campaigns rather than an integrated, foundational architecture of long-term authoritarian survival and international systemic modification.

To address this empirical and theoretical omission, this article frames its core analytical path around a distinct and formalized inquiry. Specifically, the research question is defined as follows: *How does Russian state-sponsored disinformation operate as an intrinsic instrument of internal domestic governance and external hybrid warfare within the specific context of the Russia-Ukraine war, and what are its direct structural consequences for public stability, state sovereignty, and the modern rules-based international order?*

The novelty of this presented research lies in its integrated, multi-tiered approach, which synthesizes internal political survival mechanisms with external geopolitical transformation strategies. By bridging the analytical divide between domestic societal control and international systemic erosion, this study exposes how the Kremlin utilizes narrative subversion not merely to win isolated battles, but to systematically dismantle the epistemic foundations of global governance. It shifts the scholarly focus from a simple techni-

cal analysis of fake news dissemination toward a holistic understanding of systemic disinformation as an existential challenge to the stability of sovereign states and the modern international architecture.

METHODOLOGY

To rigorously evaluate the multi-layered operations of state-directed narrative manipulation, this study is systematically structured around an explicit and distinct methodological framework. The investigation utilizes an interdisciplinary approach that combines descriptive analysis, political-legal discussion, and narrative/conceptual analysis, rooted in an exhaustive review of both primary and secondary sources.

The descriptive analysis is employed to meticulously map the chronological deployment of specific disinformation vectors, detailing how state-directed narratives evolved alongside military objectives on the ground. This empirical baseline is paired with a political-legal discussion that examines the structural strain exerted by these information operations upon established international norms, sovereignty conventions, and the operational capacity of multilateral institutions like the United Nations. Furthermore, narrative and conceptual analysis serves as the primary tool for deconstructing the linguistic structures, historical myths, and ideological frameworks utilized within Russian state messaging, enabling a deeper evaluation of how strategic narratives are engineered to alter public perceptions.

The study is based on a comprehensive review of diverse sources. This includes a systematic analysis of secondary literature alongside direct empirical evaluation of primary materials, including official Kremlin decrees, state addresses, and media broadcasts. To ensure high academic rigor, the framework incorporates a comparative discussion of competing theoretical paradigms—specifically contrasting structural realism with social constructivism—thereby illuminating how informational power interacts with material capabilities in contemporary international relations.

The ongoing Russia-Ukraine war was intentionally selected as the primary case study for this research due to its status as the most comprehensive, high-intensity manifestation of modern hybrid warfare. This conflict provides a unique and unparalleled analytical domain where the full cycle of strategic disinformation—from long-term domestic conditioning to active wartime psychological coercion—can be observed in real time. It serves as an essential case study for understanding how an authoritarian state uses information dominance to challenge the security architecture of the twenty-first century.

THE BREAKDOWN OF THE INTERNATIONAL SYSTEM

If one examines the architecture of the contemporary international order – including the United Nations, international courts, and the network of treaties concluded between states – an impression emerges of a world embedded within an interconnected system oriented toward stability, cooperation, and collective well-being. This system, constructed upon the ruins of the Second World War, was founded on a singular and ambitious objective: to ensure that powerful states would no longer possess the capacity to entirely absorb or annihilate smaller nations with impunity. However, Russia's invasion of Ukraine on 24 February 2022 not only destabilized this international system, but also exposed and activated deep structural fractures embedded within its very foundations. The events of that day revealed the limits of existing international safeguards and demonstrated how fragile the post-war legal and political order remains when confronted by a major power willing to disregard established norms and principles.

For decades, the United Nations Security Council (UNSC) was presented to the international community as the ultimate guardian of global peace. It functioned as an exceptional mechanism – a measure of last resort that global powers could activate when situations threatened to spiral beyond control. However, the war in Ukraine exposed a fatal flaw within this system. The very actor entrusted with the responsibility to extinguish the fire was, in this case, the one who ignited it.

As a permanent member of the Security Council, Russia possesses the right of veto. In the first days of the invasion, as Russian tanks advanced toward Kyiv, the world witnessed a surreal diplomatic spectacle unfolding in New York. While the majority of states sought to condemn the violation of Ukraine's sovereignty, the institution specifically designed to restrain such aggression was rendered powerless. A single raised hand by the Russian representative proved sufficient to neutralize the legal and procedural mechanisms of the world's most powerful peacekeeping institution, revealing the profound vulnerability of the existing international security architecture.

This was not merely a bureaucratic failure; it constituted a profound psychological shock to the global community. It transmitted a chilling message to small states across the world: rules may exist, but they cannot be relied upon for protection. In a single moment, the system that was intended to replace the logic of power with the power of law reverted to the very principle it was meant to overcome.

As the international legal system became immobilized, a different kind of war unfolded in the minds of billions of people. It was precisely at this point that a second front of the war was opened – disinformation, which delivered one of the most damaging blows to the international order.

The effective functioning of the international system depends on the existence of a shared reality and commonly accepted rules. The Kremlin's disinformation campaign, however, did not merely seek to distort individual news stories; it aimed to undermine the very concept of objective fact itself. By eroding the distinction between truth and fabrication, disinformation attacked the epistemic foundations upon which international cooperation and accountability rest.

Russian disinformation was directed toward the systematic degradation of Ukraine's image: portraying the war as a fight against Nazism, depicting every bombed building as part of a staged spectacle, and shifting the focus away from persuading audiences of a single Russian version of truth toward ensuring that the world lacked any unified understanding of the ongoing war. How can the international community pursue accountability for war crimes when a significant portion of the global population believes that no crime ever occurred? When trust in institutions – ranging from the media to the International Criminal Court – is steadily weakened by the persistent drip of fabricated realities, the system itself loses legitimacy. It ceases to function as an authoritative framework and instead becomes just another voice lost within the noise.

The greatest casualty of this erosion was the idea of a universal rules-based international order. For more than seventy years, the prevailing aspiration had been that all states, regardless of size or power, would operate under the same set of rules. The Russia–Ukraine war shattered this illusion and accelerated a return to political realism, a condition that historians often describe as the renewed struggle for spheres of influence. This structural shift confirms that systemic information operations are designed to directly facilitate territorial expansion by paralyzing international response mechanisms.[1]

We are witnessing an accelerating fragmentation of the world. Confidence in global trade and collective security mechanisms is steadily eroding. States increasingly refrain from asking whether a particular action is lawful under international law; instead, their calculations are guided by different questions: which geopolitical bloc do they belong to, and who is willing and able to protect them.

In the aftermath of the dissolution of the Soviet Union, scholars and policymakers frequently proclaimed the end of the Cold War and argued that a stable international order had emerged as a central foundation of socio-political life, one capable of shielding states from renewed confrontation. The rise of liberal political thought reinforced this perception, elevating international, intergovernmental, and non-governmental organizations and institutions to a prominent role in global governance. During this period, governmental priorities increasingly emphasized cooperation, multilateralism, and the pursuit of sustainable development goals, reflecting a widespread belief that institutional frameworks and shared norms could effectively manage conflict and promote long-term stability.[2]

1 Giles, K. (2023). *Russia's Information Warfare: Mechanisms, Targets, and Responses*. International Politics Review, 11(2), 145–163.

2 Hamilton, D. S., & Spohr, K. (2019). *Exiting the Cold War, Entering a New World*. Global Affairs, Johns

Russia's invasion of Ukraine in 2022 fundamentally dismantled the liberal world order and brought political realism back to the forefront of international relations, with its primary focus on power politics and strategic competition. The international system once again assumed a multipolar configuration, in which states, political leaders, and international organizations actively seek to influence societies and decision-makers in pursuit of strategic advantage. This transformation has been accompanied by an intensified information war, one that relies heavily on disinformation and fake news as central instruments of influence and control.

From a theoretical standpoint, this breakdown highlights a severe clash between competing academic positions within the discipline of international relations. Structural realists argue that the return to overt conflict and narrative warfare reflects an inevitable consequence of shifting material power dynamics and a systemic return to unmitigated anarchy[3]. Conversely, social constructivists posit that the crisis is fundamentally epistemic, arguing that the collapse of international norms is actively driven by the deliberate, state-sponsored deconstruction of shared realities and intersubjective meanings[4]. This theoretical divergence underscores that disinformation does not merely accompany structural change—it serves as a primary vehicle for executing it.

Russian state propaganda is directed toward legitimizing its attempts at territorial expansion and annexation across multiple levels of discourse, including the societal, state, and international arenas. Each of these levels is characterized by a distinct vector of disinformation. At the societal level, narratives emphasize the alleged need to protect the Russian population and Russian-speaking communities. At the state level, propaganda frames the conflict as a broader struggle against the liberal West and its political values. At the international level, these narratives are embedded within claims about the necessity of reshaping the global order and constructing an alternative system of international relations. Through this multi-layered disinformation strategy, Russia seeks not only to justify its actions but also to redefine the normative and political foundations of the contemporary international system.[5]

Moreover, the war has underscored the critical role of information and media in shaping public perception and informing political decision-making. The narratives constructed around this conflict influence not only how societies interpret and understand the war itself, but also how governments formulate their responses and policy choices. In this context, narrative dominance and informational framing become decisive factors in determining political behavior at both the domestic and international levels. Consequently, the management and control of information will constitute a vital and indispensable component of the emerging world order, directly affecting its stability, legitimacy, and capacity to function in an increasingly contested global environment.[6]

THE IDEOLOGICAL AND POLITICAL DETERMINANTS OF THE RUSSIA-UKRAINE WAR AND THE NEW WORLD ORDER

Since the central objectives and guiding principles of the new world order paradigm in international relations are inherently linked to the pursuit of global hegemony, it is reasonable to assume that this concept has its origins in ancient history[7]. Following the First and Second World Wars, political leaders such as Woodrow Wilson and Winston Churchill introduced the term "new world order" into global political discourse in order to describe the emergence of a new historical era shaped by profound transformations in the balance of power. In particular, the concept gained prominence alongside Woodrow Wilson's efforts to establish

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3 Mearsheimer, J. J. (2022). *Why the Ukraine Crisis Is the West's Fault: The Liberal Delusions That Provoked Putin*. International Security, 47(1), 7–48.

4 Bjola, C., & Pamment, J. (2021). Digital diplomacy and international security: Managing the epistemic crisis. *International Affairs*, 97(4), 1023–1041.

5 Odarchenko, K., & Davlikanova, E. (2024). Russia's evolving information war poses a growing threat to the West. *UkraineAlert*.

6 Molander, R. C., Riddile, A., & Wilson, P. A. (1996). *Strategic Information Warfare: A New Face of War*. Santa Monica, CA: RAND Corporation.

7 Modelski, G. (1989). *Long Cycles in World Politics*. Seattle: University of Washington Press. p. 34.

the League of Nations, an institution intended to prevent the outbreak of another global war.

Woodrow Wilson's initiative to create the League of Nations is widely regarded as a political and legal foundational construct of the new world order and is, in effect, considered a cornerstone of the twentieth-century international system. However, the failure of the League of Nations to function effectively ultimately led the world toward the most extensive and devastating conflict in human history. The consequences of this institutional inadequacy became tragically evident after the Second World War, which claimed the lives of approximately sixty million people and once again placed the very survival of humanity under profound and unsettling scrutiny.

Despite its eventual failure, the League of Nations nonetheless served as the foundational precursor to the creation of a highly influential international organization, namely the United Nations. Established in 1945, the United Nations was designed to enhance international cooperation and to prevent the outbreak of a Third World War, thereby aspiring, in substantive terms, to construct a new world order. The organization represents a distinctive synthesis of realism and idealism, obligating all states seeking membership to renounce the use of force and to resolve international disputes through peaceful means. In this framework, the United Nations embodies an institutional attempt to reconcile power politics with normative principles, seeking to regulate state behavior through collective rules while preserving a degree of pragmatic engagement with geopolitical realities.[8]

Although the United Nations has played a significant role and achieved a measure of success in regulating and mitigating conflicts and confrontations across various continents, the question of its effectiveness has repeatedly been brought into doubt. This skepticism has been reinforced by instances of complete inaction in response to Soviet interventions, revealing the limitations of the organization's capacity to enforce its principles in the face of great-power interests.

One of humanity's most enduring challenges remains the establishment of peace and the prevention of the destructive phenomenon of war, a goal toward which civilizations have aspired for millennia. The necessity of a peaceful world may have existed since the dawn of human society, yet the twentieth century proved markedly more brutal than those preceding it. It was defined by the most extensive and devastating wars in human history, which ran as a persistent red thread through the era. Alongside profound political, cultural, and technological revolutions, military operations and armed conflicts unfolded intensively across nearly every region of the world. The twentieth century also gave rise to nuclear weapons and other instruments of mass destruction, developments that fundamentally altered the nature of warfare and global security. These transformations prompted a growing recognition within academic circles that the achievement of universal prosperity, security, and stability remains a distant prospect. Humanity continues to confront fundamental questions of civilizational survival, challenges that are inextricably linked to the unresolved and often unpredictable nature of international politics.

The system of international relations articulated under the presidency of George H. W. Bush, following the end of the Cold War and the dissolution of the Soviet Union, envisioned the activation of collective security mechanisms as a central organizing principle of the post-bipolar world. In this context, the concept of a new world order signified the aspiration toward a world free from threat and terror, oriented toward peace and justice, and characterized by the harmonious coexistence of North and South, as well as East and West.[9]

However, in the present era, the system of international relations is being reconfigured in new ways, and the processes shaping it remain in a formative and transitional phase. The complexity of the emerging global order is further accentuated by the ongoing shift from a unipolar to a multipolar structure. Following the collapse of the Soviet Union, the United States emerged as the sole superpower capable of defining the international order and proposing the rules by which the rest of

8 Keohane, R. O. (1984). *After Hegemony: Cooperation and Discord in the World Political Economy*. Princeton University Press. p. 5.

9 Abashidze, Z. (2009). *The Cold War: Past or Present?* Tbilisi. p. 12.

the world was expected to operate. Yet, from the perspective of contemporary reality, this so-called superpower appears to be entering a phase of hegemonic decline. Such a trajectory reflects both a broader historical regularity observed in the rise and fall of dominant powers and the outcome of preceding geopolitical processes that have gradually reshaped the balance of global power.[10]

In a broad sense, the Cold War, which evolved into a fifty-year period of intense ideological and political confrontation between former allies and divided the world into so-called superpowers and their subordinate satellite states, functioned as a guarantor of the new world order. The confrontation between the capitalist and socialist blocs repeatedly brought the world to the brink of nuclear war and generated numerous crisis situations across countries of the so-called Third World.

During the Cold War, the international system underwent a fundamental transformation and assumed a bipolar structure. Two centers of power emerged on the global stage – the United States and the Soviet Union – while other states, as a rule, adopted policies of alignment with one of these poles. The Cold War period was characterized by a relatively flexible bipolar system. Naturally, both dominant powers sought to secure supremacy within the system and to establish unilateral hegemony. The American strategic perspective was rooted in the belief that any concession to the Soviet Union, much like the logic of the domino principle, would inevitably lead to a chain of further defeats. As a result, the strategy of containment emerged, aimed at restraining Soviet expansionism anywhere in the world where it sought to challenge the free and democratic order. The continuation of this policy was embodied in the Truman Doctrine, under which the United States provided substantial military and economic assistance to Greece and Turkey, thereby preventing their alignment with the socialist bloc.

In the initial phase of the Cold War, the United States further developed its strategy along two crucial directions. It established the North Atlantic Treaty Organization and introduced the Marshall Plan, which sought to facilitate the economic reconstruction of Europe and to further reduce dependence on the Soviet Union. These initiatives collectively reinforced the institutional and economic foundations of the Western bloc while consolidating the bipolar structure of the international system.

The end of the Cold War laid the groundwork for a new world order. The United States increasingly acted unilaterally across nearly all regions of the world, often without coordination with other major powers. Over time, however, the project of exporting democracy generated growing dissatisfaction among American citizens, while US interventions in Iraq and Libya resulted in a partial loss of trust among European allies. In 2008, the more isolationist orientation associated with the Obama administration replaced the rigid foreign policy approach of George W. Bush. As a consequence of this more restrained and inert posture, the United States failed to effectively counter Russia's annexation of Crimea and the conflict in eastern Ukraine. Moreover, it refrained from direct involvement in the Syrian civil war, thereby leaving a power vacuum that was subsequently filled by a revisionist Russia pursuing its own strategic ambitions.

Against this background, the decline of hegemonic dominance has become an observable reality. This development signifies the emergence of states on the global map capable of challenging US primacy. Among them, China and Russia stand out, driven by their own hegemonic aspirations and geostrategic interests, and actively seeking to reshape the balance of power within the contemporary international system.[11]

The term "new world order" denotes a new historical period that reflects dramatic changes in the global political landscape and a shifting balance of power within international relations. At the same time, adherents of conspiracy theories often interpret this concept in an entirely different manner, believing in the existence of a secret and malevolent elite allegedly seeking to impose a new world order in which sovereign states would cease to exist. According to such narratives, this imagined order would be characterized by a

10 Ahmed, R. (2018). From the ruins of unipolarity. *The Geopolitics*. https://thegeopolitics.com/from-the-ruins-of-unipolarity/

11 Allison, G. (2017). *Destined for War: Can America and China Escape Thucydides's Trap*. Houghton Mifflin Harcourt. p. 4.

single system of governance, a common currency, and the elimination of religious, national, and cultural distinctions, ultimately erasing all factors that differentiate human communities. In its most extreme formulations, this vision is portrayed as a precondition for the rise of the Antichrist on Earth, reflecting deep-seated fears rather than empirically grounded political analysis.

A systematic and contextual examination of the processes outlined above demonstrates that the new world order is not the product of a hidden or instantaneous design, but rather a long-term historical phenomenon that has evolved over several centuries alongside broader patterns of social development. Throughout different historical stages, it has undergone large-scale global transformations shaped by shifts in power, ideology, and institutional arrangements. During the Cold War, the intense and often critical geopolitical, economic, and ideological confrontation between the United States and the Soviet Union produced tangible structural outcomes, including the establishment of NATO and the Warsaw Pact. This period was further marked by major international crises, such as the Berlin Crisis of 1948-1949 and the subsequent creation of the German Democratic Republic and the Federal Republic of Germany in 1949, as well as conflicts and interventions in Korea, Vietnam, Hungary, Czechoslovakia, and elsewhere. In these contexts, the superpowers frequently engaged in large-scale confrontations aimed at preserving or expanding their regional dominance, reinforcing the dynamic and conflict-driven nature of the evolving international order.[12]

As is widely acknowledged, the global order of the twenty-first century represents, in many respects, a continuation of the Cold War, insofar as conflicts of interest between former superpowers persist today and are manifested through acute military confrontations, such as those in Syria, Libya, Yemen, and other regions. At the same time, regional powers including China, Turkey, Iran, and the oil-rich states of the Middle East are increasingly competing for regional dominance, a development that further intensifies the complexity and multilayered nature of the international system.

The occupation of Georgia's sovereign territories by the Russian Federation, followed by the annexation of the Crimean Peninsula and the subsequent Russia-Ukraine war, has underscored the extent to which leading international actors deliberately seek to demonstrate the use of force in pursuit of imperial ambitions and the establishment of a so-called new world order. These developments have once again compelled the international community to reflect on the true character of the twenty-first-century global order, which remains in the process of formation and is expected to assume its definitive contours in the aftermath of the Russia-Ukraine war.

DISINFORMATION AS AN INSTRUMENT OF RUSSIAN GOVERNANCE

When the international community speaks of Russian disinformation, a full understanding of the scale and function of this mechanism requires a careful examination of Russia itself. For the Kremlin, disinformation is not merely an export-oriented product designed to destabilize adversaries abroad. It constitutes a central pillar of domestic political governance. It functions as a foundational instrument through which reality is constructed for millions of citizens and through which regime survival is secured.[13]

This section examines how the Russian state has directed information warfare inward, against its own population, by constructing a hermetically sealed informational ecosystem in which the war in Ukraine is framed not as an act of aggression, but as an act of salvation and necessity.

In order to maintain control over a nation of approximately 144 million people without resorting to the mass repressions characteristic of the Stalinist era, the contemporary Russian state relies primarily on informational dominance. Over the past two decades, the Kremlin has systematically dismantled independent media outlets, creating an informational vacuum that was rapidly filled by state-controlled narratives. Television, which remains the primary source of news for older demographic groups,

12 Kipiani, V. (2020). Regional interconnections – an additional opportunity for greater national security and a stronger economy. *Interpressnews*, Tbilisi.

13 Pomerantsev, P. (2019). *This Is Not Propaganda: Adventures in the War Against Reality*. PublicAffairs.

has been transformed into a megaphone of the state.

A critical analysis of primary source materials exposes the structural machinery behind this narrative control. For instance, a systematic evaluation of official Russian presidential decrees—specifically *Decree No. 250 on Additional Measures to Ensure the Information Security of the Russian Federation*—reveals a legal architecture explicitly engineered to criminalize objective reporting and mandate alignment with state narratives. Furthermore, direct research into Russian state media materials demonstrates how these mandates are executed operationally. In a baseline broadcast analysis of Rossiya-1's flagship program *Vesti Nedeli* with Dmitry Kiselyov, the invasion is consistently structured through a tightly regulated lexical framework. The term "war" (*voina*) is strictly prohibited, replaced uniformly by the sterile, bureaucratized construct "special military operation" (*spetsialnaya voennaya operatsiya*). This controlled linguistic output reveals a calculated effort to insulate the domestic population from the geopolitical realities of state aggression, altering language to regulate collective psychological and emotional behavior.

Within this carefully curated reality, the invasion of Ukraine has never been presented as a war. By controlling language, the state controls emotional response. Narrative engineers on channels such as Rossiya-1 and Channel One do not merely report events; they dramatize them. They construct a storyline in which Russia is not the aggressor, but the victim – a besieged fortress defending itself against a decadent and hostile West that allegedly uses Ukraine as a battering ram.

This narrative architecture performs a crucial function. It preemptively neutralizes moral responsibility. If a Russian citizen believes that their country is fighting "Nazis" or preventing an inevitable NATO attack, the moral burden of war is effectively erased. In this context, disinformation operates as a form of psychological anesthesia for the population.

When a missile strikes a civilian building in Ukraine, Russian state media may simultaneously assert that:

- "The building was empty."
- "It was a Ukrainian missile that malfunctioned."
- "It was a military base rather than a civilian target."
- "The entire incident was staged with actors."

Such contradictory explanations generate a condition of learned helplessness. By eroding the very concept of objective truth, the state ensures that the population remains politically paralyzed. If nothing is definitively true, then no action appears meaningful, and it becomes safer to delegate political responsibility to the so-called professionals in the Kremlin. This structural strategy illustrates how modern information monopolies weaponize digital ecosystems to generate persistent internal conformity[14].

Domestic disinformation relies heavily on emotional resonance, particularly through the instrumentalization of history. The most powerful element in this arsenal is the memory of the Second World War, referred to in Russia as the Great Patriotic War. The Kremlin has effectively anchored the current conflict to the sacred legacy of the fight against Hitler.

By labeling Ukraine's leadership as "neo-Nazis," despite the fact that Ukraine's president is Jewish, the Russian leadership exploits deep intergenerational trauma. This is not mere propaganda; it is identity politics. Questioning the "special military operation" becomes symbolically equivalent to questioning the sacrifices of one's grandparents. Political dissent is thus reframed as a form of cultural betrayal.

This historical revisionism produces a rally-around-the-flag effect. It transforms geopolitical territorial expansion into a sacred war of survival. The disinformation apparatus continually reinforces the idea that Russia represents the last bastion of traditional values – faith, family, and order – standing against a chaotic and morally corrupt liberal world. This binary worldview renders compromise impossible and justifies extreme measures, including censorship and the imprisonment of dissenters.

In Russia, major media outlets are state-con-

14 Galeotti, M. (2022). The weaponisation of everything: A field guide to the new century of conflict. *Europe-Asia Studies*, 74(5), 844–861.

trolled, enabling the government to dictate narratives to the public. News coverage frequently emphasizes victimhood, historical claims to Ukrainian territory, and the portrayal of Ukraine as an existential threat. At the same time, the Kremlin actively exploits social media platforms to disseminate false narratives and amplify societal divisions.

Bots and troll networks spread disinformation with the aim of influencing specific demographic groups and sowing discord. The Russian government frequently employs historical revisionism to legitimize its actions. By framing the conflict in Ukraine as the reunification of "historically Russian lands," the narrative appeals to national pride and collective memory, thereby reinforcing public support for military operations.

The Russian government presents its military intervention in Ukraine as a "special operation" undertaken to protect Russian-speaking populations. This framing recasts Russia as a defender rather than an aggressor, resonates with nationalist sentiment, and strengthens public backing for the war. Furthermore, disinformation campaigns portray Ukraine and its allies as fascists or neo-Nazis, thereby undermining their legitimacy. This framing provides a moral justification for military action and presents it as a necessary measure to protect Russian citizens and preserve national identity.[15]

By portraying external threats, such as NATO expansion, the Kremlin cultivates an atmosphere of fear, suggesting that swift and decisive action is necessary to safeguard national security. This manufactured sense of urgency strengthens public support for the war effort and encourages citizens to rally more closely around the government's narrative, reinforcing collective alignment with state objectives. Recent academic findings indicate that this systematic orchestration of internal fear functions as an essential, defensive regime safeguard during periods of external military overextension.[16]

The societal impact of this disinformation strategy is significantly deeper. Many Russian citizens are compelled to endorse the government's narrative, while dissenting views are increasingly perceived as unpatriotic or illegitimate. This dynamic of enforced conformity is further entrenched by state propaganda, which suppresses independent thought and obstructs critical engagement with alternative perspectives. The pervasive nature of disinformation undermines critical thinking, making it progressively more difficult for individuals to distinguish factual reality from manipulated or false information.[17]

Moreover, disinformation actively contributes to societal polarization and internal division. Citizens may become increasingly fragmented along ideological lines, a process that fuels social tension and ultimately consolidates governmental control. As public opinion grows more fragmented, the space for constructive dialogue diminishes, weakening the foundations of pluralism and reducing the capacity of society to engage in meaningful debate.

THE IMPACT OF RUSSIAN DISINFORMATION IN UKRAINE

Russia's invasion of Ukraine began long before the first tank crossed the border in February 2022. For years, Ukraine served as the primary testing ground for Russian information warfare. The objective was not merely to mislead, but to dismantle Ukrainian identity both internally and externally by exploiting linguistic differences, regional histories, and political grievances until the state itself would collapse.

Prior to the full-scale invasion, the Kremlin's disinformation strategy in Ukraine was highly surgical in nature. It sought to widen existing social fractures into insurmountable divisions. Through pro-Russian television channels and extensive networks of social media bots, narratives were carefully tailored to specific regions.

In the Russian-speaking eastern and southern regions, the dominant message was fear: "Kyiv will ban your language" or "the West wants to turn your factories into scrap". In western Ukraine, the

15 Presl, D. (2024). Russia is winning the global information war. *RUSI*.

16 Stent, A. (2024). The Putin regime and the weaponization of history. *Survival*, 66(1), 45–62.

17 Momtaz, R. (2024). Taking the pulse: Are information operations Russia's most potent weapon against Europe? *Strategic Europe*.

narrative shifted, portraying the eastern regions as a "dead weight" dragging the country back into its Soviet past. The aim was to paralyze the state through polarization, to cultivate a sense of internal exhaustion, and to present Moscow's "strong hand" as the only viable source of stability[18]. This operational deployment proves that targeted digital operations are systematically designed to break civic cohesion prior to formal military interventions[19].

Within this narrative framework, Ukraine was depicted not as a sovereign nation, but as a "failed state" or "Project Ukraine" – an artificial construct allegedly controlled by Western puppeteers. By persistently questioning the legitimacy of the Ukrainian government, the disinformation apparatus anticipated that, once the invasion began, Ukrainians would be unwilling to fight for a state they had been conditioned to distrust and resent.

When the invasion commenced on 24 February 2022, the disinformation strategy shifted immediately from sowing discord to inducing panic and capitulation. Alongside the physical battle for Kyiv, a digital battle was launched for the minds of Ukrainians.

The most striking example of this effort was the deepfake incident involving President Volodymyr Zelensky. A manipulated video circulated online showing the president standing at a podium and urging Ukrainian soldiers to lay down their arms and surrender. Simultaneously, Russian bot networks flooded Telegram channels with claims that the government had fled, the army had collapsed, and resistance was futile.

This constituted a "decapitation strike" aimed at national morale. The logic was straightforward: if the population believed that its leader had abandoned them, the will to resist would evaporate. This represented a twenty-first-century siege tactic – instead of cutting off food and water, the objective was to sever hope itself. This rapid convergence of synthetic media manipulation with frontline combat operations marks an evolutionary milestone in structural information warfare[20].

However, the Kremlin fundamentally miscalculated the resilience of Ukraine's information space. Rather than collapsing, Ukrainian society unified with a speed that surprised external observers.

Several factors contributed to this resilience.

- **Immunization:** Following eight years of hybrid warfare in Donbas since 2014, Ukrainians developed a form of "herd immunity" to Russian narratives. They had been exposed to the rhetoric of a "failed state" for too long to accept it at face value.
- **Horizontal communication:** Unlike the top-down Russian model, Ukrainian resistance was network-based. Citizens used messaging applications not only to share news, but also to organize logistics and verify information locally. When Russian media declared that a city had fallen, residents could simply look out of their windows, take photographs, and refute the falsehood in real time.
- **Humor as a shield:** Ukrainians transformed humor into a weapon. Memes depicting tractors towing tanks or stories from Snake Island became digital rallying cries. Humor rendered the terrifying image of the "invincible Russian army" manageable and, at times, even absurd.

The Zelensky deepfake was swiftly neutralized by the president himself, who released simple, handheld videos filmed on the streets of Kyiv, declaring, "I am here. We are all here". The contrast between the rigid artificiality of the deepfake and the tangible reality of a president standing in the streets dismantled the Russian narrative of abandonment.

When the Russian disinformation apparatus realized that it could not persuade the Ukrainian population to accept Russian forces as liberators, it entered a darker phase, one defined by terror.

The narrative shifted from "we are here to save you from Nazis" to messaging aimed at breaking the psychological will of the civilian population. This included spreading rumors of imminent chemical attacks, exaggerating the threat of nuclear strikes, and asserting that specific cities

18 McGlynn, J. (2023). *Memory Makers: The Politics of the Past in Putin's Russia*. Bloomsbury Academic.

19 Pamment, J. (2022). The protocol of disinformation: How state actors deploy strategic deception. *Journal of Communication*, 72(1), 89–107.

20 Yablokov, I. (2022). Digital media and state propaganda in contemporary Russia. *Media, Culture & Society*, 44(6), 1102–1119.

would be “wiped off the map” in order to provoke mass evacuation and chaos[21]. This operational pivot from persuasion to intimidation underlines how disinformation is dynamically adapted when encountering robust social resistance.[22]

In the occupied territories, this strategy generated a profound informational vacuum. Russian forces frequently destroyed Ukraine’s internet and mobile infrastructure, replacing it with Russian-controlled networks that blocked access to external news sources. Within these so-called informational ghettos, propaganda vehicles disseminated claims that Kyiv had already surrendered or that Ukraine was bombing its own population. This form of disinformation functioned as an instrument of occupation – isolating individuals from their lived reality in order to make them feel abandoned, disconnected, and forgotten.

The impact of Russian disinformation on Ukraine has been deep and far-reaching, shaping public perception and altering the narrative surrounding the ongoing conflict. As the war continued, the Kremlin employed a variety of information manipulation tactics aimed at generating confusion and sowing discord among Ukrainians. This disinformation campaign has not merely served as a weapon of war, but has evolved into a central strategy for undermining Ukraine’s sovereignty and societal resilience.

One of the most significant aspects of Russian disinformation lies in its ability to exploit existing divisions within Ukrainian society. By promoting narratives that emphasize ethnic and linguistic differences, the Kremlin seeks to deepen social fragmentation. This strategy has proven particularly effective in regions with substantial Russian-speaking populations, where it draws upon grievances and historical ties. By portraying itself as a protector of these regions, Russia attempts to legitimize its actions, secure public support, and simultaneously discredit the Ukrainian government[23]. Recent empirical research verifies that these regional efforts were designed to destroy localized civil trust and degrade state-level resistance networks.[24]

Moreover, Russia’s disinformation efforts extend beyond conventional propaganda and encompass tactical disinformation. In the early stages of the conflict, the Kremlin circulated false information regarding Ukraine’s military capabilities and intentions, suggesting that the country was on the verge of collapse. This narrative was designed to demoralize both the Ukrainian population and its armed forces by fostering an atmosphere of despair and uncertainty. By undermining trust in Ukraine’s defensive capacity, Russia hoped to facilitate a rapid and decisive victory.[25]

Social media played a decisive role in amplifying these disinformation efforts. Platforms such as Facebook and Twitter have been saturated with misleading narratives and so-called "fake news," often disseminated by bots and troll networks that create the illusion of widespread support for Russian claims. These information flows significantly complicate the ability of ordinary citizens to distinguish verified facts from fabricated content, thereby increasing confusion and susceptibility to manipulation. This widespread digital pollution demonstrates how modern communication networks can be exploited to weaken institutional integrity during active crises.[26]

The consequences of this disinformation campaign extend far beyond immediate military objectives. They also entail long-term strategic effects. By fostering skepticism toward governments and legitimate media outlets, Russian disinformation undermines public trust in democratic institutions. This erosion of trust can generate civic apathy, reduce public participation in civic life, and facilitate the entrenchment of Russian narratives within both domestic and international audiences.[27]

21 Giles, K. (2022). *Russia’s War on Everybody: And What It Means for You*. Bloomsbury Academic.

22 Kuzio, T. (2023). Imperial nationalism and disinformation in Russia’s war against Ukraine. *Post-Soviet Affairs*, 39(2), 115–134.

23 Walker, C., & Ludwig, J. (2017). The meaning of sharp power: How authoritarian states project influence. *Foreign Affairs*.

24 Lutsevych, O. (2023). Civil society and resilience in Ukraine: Countering authoritarian influence. *International Affairs*, 99(3), 895–912.

25 Global Rights Compliance. (2025). New report exposes Russia’s strategic disinformation warfare.

26 Wagnsson, C., & Barzanje, C. (2021). A pioneer of information warfare: Deconstructing Russian narrative strategies. *Defense & Security Analysis*, 37(2), 187–205.

27 Topor, L., & Tabachnik, A. (2021). *Russian Cyber In-*

Despite these challenges, Ukraine has demonstrated notable resilience in countering disinformation. The government has launched initiatives aimed at promoting media literacy, equipping citizens with the skills necessary to identify and reject false narratives. In parallel, Ukrainian civil society has mobilized to establish fact-checking organizations and independent media outlets that actively counter Russian propaganda and provide credible information. This collaborative civil-state mobilization offers a critical blueprint for democratic preservation against persistent authoritarian informational attack.[28]

In conclusion, Russia's use of disinformation as an instrument of governance within the context of the war in Ukraine illustrates the profound societal impact of information manipulation. Through narrative control, the demonization of opposition, and the framing of the conflict in terms of national identity, the Kremlin effectively legitimizes its actions both domestically and on the international stage. Recognizing and confronting disinformation is therefore essential for fostering a more informed and resilient society capable of navigating the complexities of contemporary geopolitics.[29]

At the same time, the impact of Russian disinformation in Ukraine remains a complex and evolving challenge. By exploiting social divisions, disseminating false narratives, and weakening trust in democratic institutions, Russia seeks to advance its strategic objectives. Nevertheless, Ukraine's sustained response, characterized by media literacy initiatives and robust civil society engagement, underscores the critical importance of countering disinformation and safeguarding democratic integrity. As the conflict continues, the struggle against disinformation will remain a key front in the defense of Ukraine's sovereignty and future.

CONCLUSION

The Russia-Ukraine war constitutes a severe stress test for the international system. It has demonstrated that existing mechanisms of protection are insufficient when confronted with a major power willing to violate established rules, particularly when that power employs disinformation to fracture and delay global responses.

The world now finds itself in a post-collapse phase of the international system. For societies seeking to move forward, the challenge lies not only in halting armed conflict on the ground, but also in determining how to restore a shared sense of law and truth in a world that has learned how easily both can be undermined.

Through a comprehensive examination, this research has firmly established that Russian disinformation operates not as an auxiliary tool of military power, but as a central mechanism of authoritarian governance and systematic international destabilization. Empirically, the study demonstrates that while strategic deception effectively enforces internal conformity and generates learned helplessness domestically, its capacity to alter outcomes diminishes significantly when confronted by the physical realities of kinetic warfare and structured societal resilience.

The primary analytical results indicate that the resilience of an information space depends directly on decentralized, horizontal communication networks and early state-civil society synchronization. The main academic contribution of this paper to the ongoing global debate is the presentation of an integrated, two-way analytical model showing how domestic regime protection and external hybrid aggression are inextricably linked. It offers a framework for assessing information operations not merely as misleading communication, but as structural threats to state sovereignty.

In contemporary Russia, disinformation is not a side effect of governance; it is governance itself. The regime maintains power not solely through coercive force, but through the management of collective imagination. By constructing a parallel reality in which Russia is always righteous and perpetually under threat, the Kremlin creates a closed informational loop that is extraordinarily difficult to penetrate from within.

formation Warfare: International Distribution and Domestic Control. Marine Corps University.

28 Fedchenko, O. (2022). Fact-checking as a weapon against hybrid threats: The Ukrainian experience. *Journal of Slavic Military Studies*, 35(3), 412–429.

29 Plokhy, S. (2023). *The Russo-Ukrainian War: The Return of History*. W. W. Norton & Company.

However, reliance on total informational control also generates structural vulnerability. A government that governs through falsehood ultimately fears truth more than military force. As the war prolongs and the gap between televised narratives and everyday economic reality widens, the durability of this artificial world faces its most serious test.

The impact of Russian disinformation on Ukraine serves as a critical case study for examining the limits of propaganda. Although it successfully sowed confusion in the years preceding the war, it failed its ultimate test. When missiles began to fall, the Kremlin's abstract narratives collided with the concrete realities of invasion and destruction.

Ukraine's experience suggests that while disinformation can weaken societies in times of peace, it can also strengthen resistance in times of war when falsehoods stand in stark contradiction to lived experience.

Ultimately, this study brings a transformative interpretation to the global scholarly discussion by demonstrating that the modern crisis of international order is fundamentally an epistemic one. It argues that hybrid warfare cannot be neutralized solely through conventional military deterrence or economic sanctions; it requires the active defense of objective truth.

This paper shows that the systematic deconstruction of factual reality by authoritarian states acts as a direct precursor to territorial expansion and institutional paralysis. For contemporary international relations, this insight is critical. It moves the academic focus beyond technical media literacy and establishes information security as a core element of state sovereignty and global collective security in the twenty-first century.

REFERENCES

Bjola, C., & Pamment, J. (2021). Digital diplomacy and international security: Managing the epistemic crisis. *International Affairs*, 97(4), 1023–1041.

Fedchenko, O. (2022). Fact-checking as a weapon against hybrid threats: The Ukrainian experience. *Journal of Slavic Military Studies*, 35(3), 412–429.

Galeotti, M. (2022). The weaponisation of everything: A field guide to the new century of conflict. *Europe-Asia Studies*, 74(5), 844–861.

Giles, K. (2023). Russia's information warfare: Mechanisms, targets, and responses. *International Politics Review*, 11(2), 145–163.

Hamilton, Daniel S., and Kristina Spohr. *Exiting the Cold War, Entering a New World.* Global Affairs, Johns Hopkins University SAIS, 2019.

Global Rights Compliance. *New Report Exposes Russia's Strategic Disinformation Warfare.* 2025.

Kuzio, T. (2023). Imperial nationalism and disinformation in Russia's war against Ukraine. *Post-Soviet Affairs*, 39(2), 115–134.

Lutsevych, O. (2023). Civil society and resilience in Ukraine: Countering authoritarian influence. *International Affairs*, 99(3), 895–912.

McGlynn, Jade. *Memory Makers: The Politics of the Past in Putin's Russia.* London: Bloomsbury Academic, 2023.

Mearsheimer, J. J. (2022). Why the Ukraine crisis is the West's fault: The liberal delusions that provoked Putin. *International Security*, 47(1), 7–48.

Molander, Roger C., Andrew Riddile, and Peter A. Wilson. *Strategic Information Warfare: A New Face of War.* Santa Monica, CA: RAND Corporation, 1996.

Momtaz, Rym. *Taking the Pulse: Are Information Operations Russia's Most Potent Weapon Against Europe?* Strategic Europe, 2024.

Odarchenko, Kateryna, and Elena Davlikanova. *Russia's Evolving Information War Poses a Growing Threat to the West.* UkraineAlert, 2024.

Pamment, J. (2022). The protocol of disinformation: How state actors deploy strategic deception. *Journal of Communication*, 72(1), 89–107.

Plokhy, Serhii. *The Russo-Ukrainian War: The Return of History.* New York: W. W. Norton & Company, 2023.

Pomerantsev, Peter. *This Is Not Propaganda: Adventures in the War Against Reality.* New York: PublicAffairs, 2019.

Presl, Dominik. *Russia Is Winning the Global Information War.* Royal United Services Institute (RUSI), 2024.

Rid, Thomas. *Active Measures: The Secret History of Disinformation and Political Warfare.* New York: Farrar, Straus and Giroux, 2020.

Stent, A. (2024). The Putin regime and the weaponization of history. *Survival*, 66(1), 45–62.

Topor, Lev, and Alexander Tabachnik. *Russian Cyber Information Warfare: International Distribution and Domestic Control.* Marine Corps University, 2021.

Wagnsson, C., & Barzanje, C. (2021). A pioneer of information warfare: Deconstructing Russian narrative strategies. *Defense & Security Analysis*, 37(2), 187–205.

Walker, Christopher, and Jessica Ludwig. *The Meaning of Sharp Power: How Authoritarian States Project Influence.* Foreign Affairs, 2017.

Yablokov, I. (2022). Digital media and state propaganda in contemporary Russia. *Media, Culture & Society*, 44(6), 1102–1119.

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ARTICLE

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WHEN DEBT OVERTAKES SPENDING: A PARTIAL WAVELET COHERENCE ANALYSIS OF FISCAL POLICY AND ECONOMIC GROWTH IN FRANCE (1990–2024)

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Abstract. *This study investigates the dynamic relationships among public expenditure, public debt, and economic growth in France over the 1990–2024 period using wavelet coherence (WTC), partial wavelet coherence (PWC), and Granger causality analysis. This multi-method approach allows fiscal-macroeconomic linkages to be assessed simultaneously across time and frequency, capturing structural shifts that conventional econometric methods cannot detect. Results show that fiscal-macroeconomic associations operate predominantly at business cycle frequencies and strengthen markedly following eurozone integration and the 2008 financial crisis. Sub-period analysis reveals a clear structural transformation in France's fiscal regime. Before EMU, public spending maintained a stronger conditional association with growth than public debt, consistent with expenditure-led stabilization under monetary sovereignty. After 1999, this pattern reverses. Post-2008, the divergence widens further as debt levels exceed 110% of GDP. Granger causality tests confirm bidirectional feedback between fiscal instruments and growth, alongside strong unidirectional causality running from expenditure to debt. These findings suggest that France has transitioned from a fiscal regime driven by public spending to one increasingly constrained by accumulated debt, with direct implications for consolidation strategy and medium-term budgetary design within the eurozone framework.*

KEYWORDS: WAVELET PARTIAL ANALYSIS, FISCAL POLICY, PUBLIC DEBT, PUBLIC EXPENDITURE, FRANCE.

Jel Classification: E62, H63, O40, E43, C32.

INTRODUCTION

The relationship between fiscal policy and economic growth is one of the most persistent debates in macroeconomics, traditionally opposing Keynesian and neoclassical perspectives. While the Keynesian approach emphasizes the effectiveness of public spending in stimulating aggregate demand, particularly during recessions, the neoclassical approach highlights the negative effects of public debt accumulation via fiscal expectations, sovereign risk premiums, and the crowding out of private investment. However, most of the existing empirical literature treats these two dimensions of fiscal policy separately, neglecting their complex interactions and potentially distinct transmission mechanisms. Over the past three decades, France has experienced persistent fiscal imbalances, with public spending among the highest in the OECD, around 55–58% of GDP,[1] and debt levels exceeding 100% of GDP after the COVID-19 crisis, 113% in the fourth quarter of 2024.[2] In addition, membership in the European Monetary Union eliminates national monetary policy autonomy, which further complicates the management of France's fiscal policy. This has reignited debates about the growth impact of fiscal expansion and the risks of excessive indebtedness. Yet, the channels through which fiscal policy influences growth, directly through public investment and consumption, or indirectly through debt accumulation and financial constraints, remain complex. Traditional econometric methods often fail to disentangle these dynamic interactions across time and frequency. By employing wavelet coherence and partial wavelet coherence, this study offers a nuanced exploration of how fiscal instruments transmit their effects on growth at both short-term and long-term horizons. Such an approach provides valuable insights for policymakers seeking to balance fiscal discipline with economic stimulus and to ensure the long-term sustainability of France's public finances while supporting economic performance.

This research offers both a methodological and empirical contribution by systematically examining the time-varying and frequency-dependent co-movement between fiscal policy variables and economic growth through an innovative approach that combines Wavelet Total Coherence (WTC), Partial Wavelet Coherence (PWC), and Granger causality analysis. This methodology addresses three fundamental questions often ignored in the conventional literature: First, to what extent does public debt co-move with economic growth independently of public expenditure dynamics? Second, do public expenditures exhibit distinct co-movement with growth beyond the debt accumulation they generate? Third, is the observed relationship between public debt and government expenditure mainly driven by underlying structural fiscal constraints, or does it reflect a shared response to fluctuations in economic growth? By applying this methodology to France over the period 1990–2024, we obtain a particularly relevant case study. This context allows for an examination of fiscal transmission co-movements in a setting where fiscal policy serves as the main instrument of macroeconomic stabilization, while being constrained by European rules (the Maastricht criteria and the Stability and Growth Pact). The article is organized as follows: Section 1 presents the literature review and theoretical positioning. Section 2 describes the classical and partial wavelet coherence methodology. Section 3 presents the data and empirical specifications. Section 4 presents the main results. Section 5 discusses the theoretical and policy implications. Section 6 highlights the research limitations, followed by the conclusion.

1. LITERATURE REVIEW

1.1. Public debt and growth: The theoretical debate

The relationship between public debt and economic growth has generated abundant and controversial literature. The neo-Ricardian perspective, initiated by Barro,[3] posits that ratio-

1 OECD. (2024). OECD Economic Surveys: France. OECD Publishing. <https://doi.org/10.1787/bd96e2ed-en>.

2 Insee. <https://www.insee.fr/fr/statistiques/8540821?sommaire=8540823>.

3 Barro, R. J. (1974). Are government bonds net wealth? Journal of Political Economy, 82(6), 1095-1117. <https://doi.org/10.1086/260266>.

nal economic agents anticipate that public debt accumulation will require future tax increases, leading them to increase precautionary savings and reduce current consumption, thus neutralizing the expansionary effects of debt-financed spending. Although strict Ricardian equivalence is largely rejected empirically, it underscores the importance of expectations and intertemporal constraints in fiscal policy transmission. Recent empirical work has identified several channels through which high levels of public debt can negatively affect growth. Reinhart and Rogoff[4] published their influential paper "Growth in a Time of Debt" in The American Economic Review, arguing that when government debt exceeds 90% of GDP, average growth falls considerably. Their analysis was based on data from 44 countries spanning about 200 years. However, Herndon et al. [5]published a critique identifying coding errors, selective exclusion of available data, and unconventional weighting of summary statistics. After correcting these errors, they found that countries with public debt/GDP ratios above 90% averaged 2.2% real annual GDP growth, not -0.1% as originally published. More robustly, Checherita-Westphal and Rother[6] identify a negative impact of debt on growth beyond 90-100% of GDP for European countries, operating through three main channels: increasing long-term interest rates, crowding out private investment, and reducing total factor productivity. Égert[7] confirms these non-linear effects while emphasizing their dependence on the economy's cyclical position. Corsetti et al.[8] analyze the confidence channel during the European sovereign debt crisis, showing how loss of confidence in fiscal sustainability can trigger self-fulfilling prophecies and multiple equilibria. Afonso and de Sá Fortes Leitão Rodrigues[9] examined the relationship between public debt, governance, and economic growth. Their study of 44 developing countries from 1990-2000 shows that public debt impedes economic growth in all quantiles. However, in the presence of good governance, public debt promotes economic growth in the medium to higher quantiles. The empirical findings confirm that governance is far more important in promoting economic growth.

1.2. Public expenditure and growth: Keynesian effectiveness

The literature on public expenditure effects on growth has developed considerably since the 2008 financial crisis, renewing interest in Keynesian fiscal multipliers. Blanchard and Perotti[10] established a benchmark methodology using impulse response functions in a structural VAR framework, estimating public expenditure multipliers around 1.5 after four quarters for the United States. A major recent development concerns the cyclical dependence of fiscal multipliers. Auerbach and Gorodnichenko[11] demonstrate that multipliers can be two to three times higher during recessions than in expansion periods, a result confirmed by Batini et al.[12] for a panel of advanced countries.

4 Reinhart, C. M., Rogoff, K. S. (2010). Growth in a time of debt. American Economic Review, 100(2), 573-578. <https://doi.org/10.1257/aer.100.2.573>.

5 Herndon, T., Ash, M., Pollin, R. (2014). Does high public debt consistently stifle economic growth? A critique of Reinhart and Rogoff. Cambridge Journal of Economics, 38(2), 257-279. <https://doi.org/10.1093/cje/bet075>.

6 Checherita-Westphal, C., Rother, P. (2012). The impact of high government debt on economic growth and its channels: An empirical investigation for the euro area. European Economic Review, 56(7), 1392-1405. <https://doi.org/10.1016/j.euroecorev.2012.06.007>.

7 Égert, B. (2015). Public debt, economic growth and nonlinear effects: Myth or reality? Journal of Macroeconomics, 43, 226-238. <https://doi.org/10.1016/j.jmacro.2014.11.006>.

8 Corsetti, G., Kuester, K., Meier, A., Müller, G. J. (2013). Sovereign risk, fiscal policy, and macroeconomic stability. Economic Journal, 123(566), 99-132. <https://doi.org/10.5089/9781463933180.001>.

9 Afonso, A., de Sá Fortes Leitão Rodrigues, E. (2022) Corruption and economic growth: does the size of the government matter? Econ Change Restruct 55(2):543–576. <https://doi.org/10.1007/s10644-021-09338-4>.

10 Blanchard, O., Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. Quarterly Journal of Economics, 117(4), 1329-1368. <https://doi.org/10.1162/003355302320935043>.

11 Auerbach, A. J., Gorodnichenko, Y. (2013). Fiscal multipliers in recession and expansion. In Fiscal Policy after the Financial Crisis (pp. 63-98). University of Chicago Press. <https://doi.org/10.7208/chicago/9780226018584.003.0003>.

12 Batini, N., Eyraud, L., Forni, L., Weber, A. (2014).

This asymmetry is explained by the presence of unused productive capacity during recessions, reducing crowding-out effects on private demand, and by the prevalence of credit constraints affecting households and firms during periods of financial stress. This methodological controversy illustrates the sensitivity of estimates to identification assumptions and measurement of fiscal shocks. The composition of public expenditure also appears crucial. Arestis et al. (2020)[13] provide empirical evidence on the linkage between government expenditure and output using the Keynesian view versus Wagner's law, demonstrating the importance of government expenditure in stimulating economic growth. Recent research using panel ARDL approaches for European Union countries shows that different categories of public expenditures have dissimilar long- and short-term effects on economic performance. Oyadeyi[14] found that in ECOWAS countries, government expenditure positively influences real GDP, with findings indicating that the response of economic growth to government spending shocks differs according to the nature of shocks. At the disaggregated level, Nguyen and Bui[15] collected data from 16 emerging and developing economies and showed that government expenditure negatively impacts economic growth in the long run. Their study suggests that public sector consumption does not promote economic growth, while several studies have found a positive correlation between economic growth and educational indicators or expenditures. France presents a particularly instructive case study for examining the composition and efficiency of public expenditure. Afonso et al.[16] examined public spending efficiency in France using historical data from 1870-2010 and found that the only functional component of expenditure that clearly contributes to the growth of French output is expenditure aimed at the protection of property rights. Public interventions in support of the economy, on the other hand, have no impact on growth. In the area of social spending, only health expenditure contributes to output growth, while education spending shows insignificant effects. These findings provide empirical support for Smith's minimal state hypothesis in the French context: the restriction of the size of the state and the delimitation to its essential functions tend to favor output growth. This contrasts with the more general findings in developing countries, where education expenditure typically shows positive growth effects.

1.3. Debt-expenditure interactions: A neglected dimension

Despite abundant literature on the separate effects of debt and expenditure, few studies systematically examine their interactions and the decomposition of their respective effects. Most studies control for one variable when analyzing the other, but without explicit decomposition of direct and indirect effects. Ilzetzki et al.[17] represent a notable exception, examining how public expenditure effectiveness varies according to pre-existing debt levels. They find that fiscal multipliers are significantly lower in countries with high debt-to-GDP ratios, suggesting a negative interaction between debt level and expenditure effectiveness. Huidrom et al.[18] confirm this result and show that this interaction operates primarily through the confidence channel and expectations

Fiscal multipliers: Size, determinants, and use in macroeconomic projections. IMF Technical Notes and Manuals, 2014/004. <https://doi.org/10.5089/9781498382458.005>.

13 Arestis, P., Şen, H., Kaya, A. (2020). On the linkage between government expenditure and output: Empirics of the Keynesian view versus Wagner's law. Economic Change and Restructuring, 54(2), 265-303. <https://doi.org/10.1007/s10644-020-09284-7>.

14 Oyadeyi, O. O. (2024). Effect of government expenditure on real economic growth in ECOWAS: Assessing the moderating role of corruption and conflict. Humanities and Social Sciences Communications, 11, 740. <https://doi.org/10.1057/s41599-024-03285-x>.

15 Nguyen, C. T., Bui, T. H. L. (2022). Government expenditure and economic growth: Does the role of corruption control matter? Heliyon, 8(10), e10822. <https://doi.org/10.1016/j.heliyon.2022.e10822>.

16 Op. cit.

17 Ilzetzki, E., Mendoza, E. G., Végh, C. A. (2013). How big (small?) are fiscal multipliers? Journal of Monetary Economics, 60(2), 239-254. <https://doi.10.1016/j.jmoneco.2012.10.011>.

18 Huidrom, R., Kose, M. A., Lim, J. J., Ohnsorge, F. L. (2020). Why do fiscal multipliers depend on fiscal positions? Journal of Monetary Economics, 114, 109-125. <https://doi.10.1016/j.jmoneco.2019.03.004>.

of fiscal sustainability. Nguyen and Trinh[19] examined fiscal standards using panel data from 92 countries from 2000 to 2021, showing that fiscal standards decrease the adverse effects of fiscal rules on output growth, demonstrating a trade-off between public debt sustainability and output growth. However, these works mainly treat debt level as a conditional variable moderating expenditure effect, rather than as exerting autonomous effects that must be analytically distinguished. Our partial wavelet coherence approach precisely enables this conditional co-movement analysis, revealing the time-frequency structure of fiscal relationships.

2. METHODOLOGY AND DATA

This section first outlines the wavelet analysis methodology applied in the study and then presents the dataset used for the empirical investigation

2.1. Analytical framework

This study employs wavelet-based time-frequency analysis to examine the dynamic relationships among economic growth and fiscal policy in France. Unlike conventional time-series methods that assume stationarity and time-invariant correlations, wavelet techniques decompose relationships across both time and frequency domains, revealing how co-movements evolve at different periodicities (short-term fluctuations vs. long-term trends) and across different historical episodes (crisis vs. stable periods). Our methodological approach proceeds in four stages: (1) preliminary stationarity testing and data transformation, (2) bivariate wavelet coherence (WTC) to identify pairwise co-movements, (3) partial wavelet coherence (PWC) to isolate conditional relationships from third-variable confounding, and (4) Granger causality tests to establish temporal precedence. This multi-method triangulation strengthens the empirical evidence beyond what any single technique can provide. Since our data are quarterly, each wavelet period corresponds to one quarter; thus, 2-4 periods represent 6 months to 1 year (short-run), 8-16 periods represent 2 to 4 years (medium-run), and 16-32 periods represent 4 to 8 years (long-run). These conversions are applied consistently throughout the interpretation of all wavelet coherence figures.

2.2. Wavelet coherence

The wavelet coherence framework, originally developed by Goupillaud et al.,[20] enables the examination of causal relationships between two variables simultaneously across both the time and frequency domains. Wavelet total coherence measures local correlation between two time series x(t) and y(t) in the time-frequency domain. It generalizes the concept of cross-correlation by allowing this correlation to vary both in time and according to the considered frequencies (or periods). The continuous wavelet transform (CWT) decomposes a time series into time-frequency space by convolving the data with scaled and translated versions of a mother wavelet function. For a discrete time series x(t) with uniform time steps δt and length N, the CWT is defined as:

$$W_x(a,b) = \sum_{t=1}^{N} x(t) \cdot \psi^* \left[\frac{(t-b) \cdot \delta t}{a} \right]$$

where:

- $W_x(a,b)$ denotes the wavelet coefficient at scale a and time position b
- $\psi(t)$ represents the mother wavelet function
- $\psi^*(t)$ is the complex conjugate of the mother wavelet
- a is the wavelet scale (inversely related to frequency)
- b is the translation parameter (time localization)

19 Nguyen, T. C., Trinh, L. T. (2021). The impact of fiscal policy on economic growth: Evidence from emerging and developing Asian countries. Economics and Business Letters, 10(3), 251-262. <https://doi.org/10.17811/ebl.10.3.2021.251-262>.

20 Goupillaud, P., Grossmann, A., Morlet, J. (1984). Cycle-octave and related transforms in seismic signal analysis. Geoexploration, 23(1), 85-102. <https://doi.org/10.1016/0016-7142(84)90025-5>.

This study employs the Morlet wavelet as the mother wavelet function, following the standard practice in economic and financial applications (Aguiar-Conraria & Soares, 2014; Rua & Nunes, 2009).[21] The Morlet wavelet is defined as:

$$\psi_\eta(t) = \pi^{-1/4} \cdot e^{i\eta t} \cdot e^{-t^2/2}$$

The Morlet wavelet is particularly advantageous for economic applications because: It provides excellent frequency resolution, crucial for distinguishing business cycle frequencies; Its Gaussian envelope ensures good time localization for identifying structural breaks; It is complex-valued, enabling extraction of both amplitude and phase information To examine the co-movement between two time series, we construct the cross-wavelet transform, which identifies regions in time-frequency space where the two series exhibit high common power. For two time series x(t) and y(t)with wavelet transforms $W_x(a,b)$ and $W_y(a,b)$, the cross-wavelet transform is defined as:

$$W_xy(a,b) = W_x(a,b)W_y^*(a,b)$$

where $W_y^*(a,b)$ denotes the complex conjugate of $W_y(a,b)$

The cross-wavelet power spectrum is then:

$$|W_xy(a,b)| = |W_x(a,b)W_y^*(a,b)|$$

This measure quantifies the local covariance between the two series at each time-frequency location. High cross-wavelet power indicates that both series exhibit large-amplitude oscillations at that particular scale and time, suggesting potential interaction or common driving forces. However, cross-wavelet power is influenced by the individual power spectra of each series; regions of high cross-wavelet power may simply reflect periods where both series have high variance, rather than genuine co-movement. To address the limitation of cross-wavelet power's dependence on individual variances, we employ wavelet coherence, which normalizes the cross-wavelet spectrum by the power spectra of the individual series. This normalization produces a measure analogous to the squared correlation coefficient, bounded between 0 and 1, facilitating interpretation.

The wavelet coherence between two time series x(t) and y(t) is defined as:

$$R_{xy}^2(a,b) = \frac{\left|S\left(W_{xy}(a,b)\right)\right|^2}{S(|W_x(a,b)|^2) \cdot S\left(|W_y(a,b)|^2\right)}$$

where S denotes a smoothing operator applied in both time and scale dimensions. The smoothing operator S is essential to obtain a consistent estimator of coherence. Without smoothing, the coherence would trivially equal unity at all time-frequency locations. Following Torrence and Compo,[22] we apply smoothing in both the time direction (along the time axis at each scale) and the scale direction (across adjacent scales at each time point).

2.3. Partial Wavelet Coherence (PWC)

Partial wavelet coherence extends the bivariate coherence framework to account for the confounding influence of a third variable, enabling the isolation of conditional co-movement from third-variable confounding. This multivariate extension is crucial for disentangling the complex co-movement patterns among fiscal policy variables. The concept of partial wavelet coherence is analogous to partial correlation in classical statistics but is implemented in the time-frequency domain. For three time series x(t), y(t), and z(t), the partial coherence between x and y controlling for z measures the strength of the conditional x-y relationship after removing the components of their co-movement attributable to their mutual relationships with z. Following Mihanović et al.[23]

21 Aguiar-Conraria, L., Soares, M. J. (2014). The continuous wavelet transforms: Moving beyond uni-and bivariate analysis. Journal of Economic Surveys, 28(2), 344-375. <https://doi.org/10.1111/joes.12012>; Rua, A., Nunes, L. C. (2009). International co-movement of stock market returns: A wavelet analysis. Journal of Empirical Finance, 16(4), 632-639. <https://doi.org/10.1016/j.jempfin.2009.02.002>;

22 Torrence, C., Compo, G. P. (1998). A Practical Guide to Wavelet Analysis. Bulletin of the American Meteorological Society, 79, 61-78.

23 Mihanović, H., Orlić, M., Pasarić, Z. (2009). Diurnal thermocline oscillations driven by tidal flow around

and Ng & Chan,[24] the squared partial wavelet coherence is computed in the frequency domain to preserve time-frequency localization:

$$\rho_{xy|z}^2(a,b)=\frac{\left|R_{xy}(a,b)-R_{xz}(a,b)\cdot R_{zy}^*(a,b)/R_{zz}(a,b)\right|^2}{\left[1-\frac{|R_{xz}(a,b)|^2}{R_{xx}(a,b)R_{zz}(a,b)}\right]\cdot\left[1-\frac{|R_{yz}(a,b)|^2}{R_{yy}(a,b)R_{zz}(a,b)}\right]}$$

Equivalently, this can be expressed in terms of the normalized coherence measures:

$$\rho_{xy|z}^2(a,b)=\frac{\left|R_{xy}(a,b)-R_{xz}(a,b)\cdot R_{zy}^*(a,b)\right|^2}{(1-|R_{xz}(a,b)|^2)\left(1-\left|R_{zy}(a,b)\right|^2\right)}$$

where:

- $R_{xy}(a,b)$, $R_{xz}(a,b)$, $R_{yz}(a,b)$ are the smoothed wavelet coherence measures between pairs of variables
- $R_{zy}^*(a,b)$ is the complex conjugate of $R_{zy}(a,b)$
- All coherence measures are computed at the same scale a and time position b.

The partial wavelet coherence $\rho_{xy|z}^2(a,b)$ ranges from 0 to 1, with the same interpretation as classical wavelet coherence: Values near 0: No conditional co-movement between x and y after controlling for z. Values near 1: Strong conditional co-movement independent of z. The frequency-domain formulation employed here removes the influence of z separately at each time-frequency location, allowing the confounding effect to vary across both time and frequency. This is essential for fiscal policy analysis, where the role of control variables (e.g., debt dynamics) may be negligible at high frequencies (short-term fluctuations) but dominant at low frequencies (long-term trends), and these patterns may shift over time as policy regimes change. We compute partial wavelet coherence using the pwtc() function from the biwavelet package (version 0.20.21) in R,[25] which implements the frequency-domain methodology described above. Statistical significance is assessed using Monte Carlo simulations with 1000 randomized surrogates, analogous to the procedure for classical wavelet coherence.

3. DATA AND EMPIRICAL SPECIFICATIONS

We use French quarterly data from 1990Q1 to 2024Q4, totaling 140 observations. This period covers several major economic cycles and macroeconomic shocks: the early 1990s recession, preparation for European monetary union (1992-1998), the global financial crisis (2008-2009), the European sovereign debt crisis (2010-2012), and the COVID-19 pandemic (2020-2021) (See Table 1, 2, 3, 4).

an island in the Middle Adriatic. Journal of Marine Systems, 78, S157-S168. <https://doi.org/10.1016/j.jmarsys.2009.01.021>.

24 Ng, E. K., Chan, J. C. (2012). Geophysical applications of partial wavelet coherence and multiple wavelet coherence. Journal of Atmospheric and Oceanic Technology, 29(12), 1845-1853. <https://doi.org/10.1175/JTECH-D-12-00056.1>.

25 Gouhier, T. C., Grinsted, A., Jevrejeva, S. (2021). Biwavelet: Conduct Univariate and Bivariate Wavelet Analyses. R package version 0.20.21.

Table 1. Data source and description

Variable	Unit	Source
GDP growth	Quarterly GDP growth in percentage	INSEE: https://www.insee.fr/fr/statistiques/2830547
Public debt	Public debt in the Maastricht sense as percentage of GDP.	INSEE: Quarterly national accounts, base year 2020. https://www.insee.fr/fr/statistiques/8540821?sommaire=8540823
Public expenditure	Total public spending as percentage of GDP.	INSEE: https://www.insee.fr/fr/statistiques/2381414

Table 2. Descriptive statistics

	GDP growth	Debt	Expenditure
Mean	0.387	77.240	55.928
Median	0.409	67.581	56.030
Maximum	15.355	117.772	61.699
Minimum	-12.194	36.800	51.612
Std. Dev.	1.800	22.870	2.130
Skewness	1.485	0.140	0.130
Kurtosis	52.564	1.808	2.297
Jarque-Bera	14382.02	8.746	3.276
Probability	0.000	0.012	0.194
Sum	54.275	10813.73	7829.934
Sum Sq. Dev.	450.603	72704.97	630.963
Observations	140	140	140

Table 3. Correlation matrix

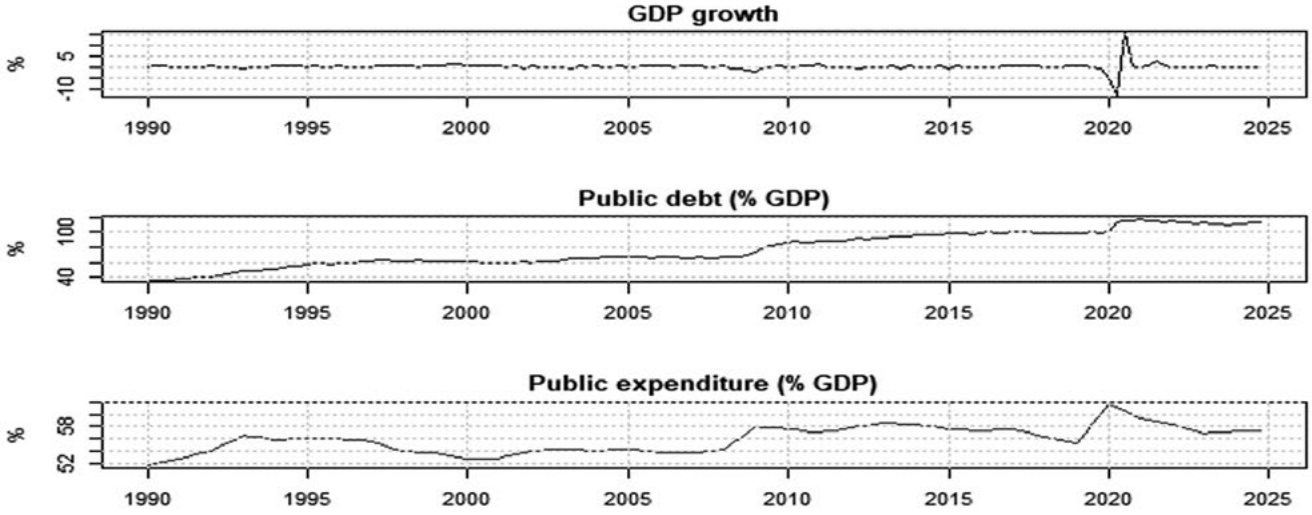
	GDP growth	Debt	Expenditure
GDP growth	1		
Debt	-0.009	1	
Expenditure	-0.115	0.789	1

Table 5. Stationarity tests

Variable	Transformation	ADF Statistic (p-value)	KPSS Statistic (p-value)	PP Statistic (p-value)	Stationarity Decision	Order of Integration
Public Expenditure	Level	−3.158 (0.098)	1.696 (0.01)	−12.701 (0.384)	Non-stationary	I(1)
Public Debt	Level	−2.745 (0.266)	2.782 (0.01)	−10.638 (0.503)	Non-stationary	I(1)
GDP Growth	Level	−6.064 (0.01)	0.083 (0.10)	−153.62 (0.01)	Stationary	I(0)
Public Expenditure	First Difference	−4.303 (0.01)	0.079 (0.10)	−43.212 (0.01)	Stationary	-
Public Debt	First Difference	−5.006 (0.01)	0.058 (0.10)	−117.24 (0.01)	Stationary	-

*Note: Significance. **p<0.05, ***p<0.01.*

Figure 2. Series evolution and trends



Descriptive statistics reveal that French GDP growth averaged 0.4% per quarter over 1990–2024, with high volatility and extreme leptokurtosis (kurtosis = 52.56), driven by unprecedented shocks such as the COVID-19 collapse in Q2 2020 (-12.19%) and its subsequent rebound (+15.36%) (See Fig.2). Public debt rose sharply from 36% to 117% of GDP, accelerating after 2008 and again during the pandemic, while public expenditure remained relatively stable around 55% of GDP - a divergence that points to a chronic structural deficit where revenues persistently fall short of spending. Simple linear correlations between GDP growth and either debt (-0.009) or expenditure (-0.11) are negligible, whereas the strong debt-expenditure correlation (0.79) reflects the government budget constraint; these weak pairwise correlations motivate the use of wavelet analysis, which is better suited to capturing the non-linear and non-stationary relationships that classical methods cannot detect. Finally, Variance Inflation Factors of 2.65 for both debt and expenditure confirm the absence of problematic multicollinearity, validating the reliability of the subsequent partial coherence analysis.

4. EMPIRICAL RESULTS

4.1. Stationarity tests results

The following table indicates the stationarity test results. The three tests: ADF, PP, and KPSS results are highlighted in Table 5.

The unit root tests indicate that public expenditure and public debt are non-stationary in levels but become stationary after first differencing, implying that both variables are integrated of order one, I(1). In contrast, GDP growth is stationary in levels, suggesting an I(0) process. Figure 3 indicates the trends of the two variables after the first-difference transformation.

4.2. Wavelet analysis results

4.2.1. Debt – GDP growth relationship

4.2.1.1 Total coherence (WTC)

Figure 4 shows that wavelet coherence between public debt and GDP growth is largely concentrated at medium- to long-run horizons (8–32 periods), with persistently strong co-movement emerging especially from the mid-sample onward, while short-run coherence (2–4 periods) remains sporadic. Phase arrows in significant long-run regions predominantly point left and slightly downward, suggesting that rises in public debt tend to precede declines in GDP growth, consistent with debt overhang and crowding-out hypotheses, while some medium-run intervals show left-upward arrows, indicating episodes of countercyclical fiscal responses where growth slowdowns lead to debt increases. Overall, the debt-growth nexus appears time-varying and frequency-dependent,

Figure 3. Series trend after transformation

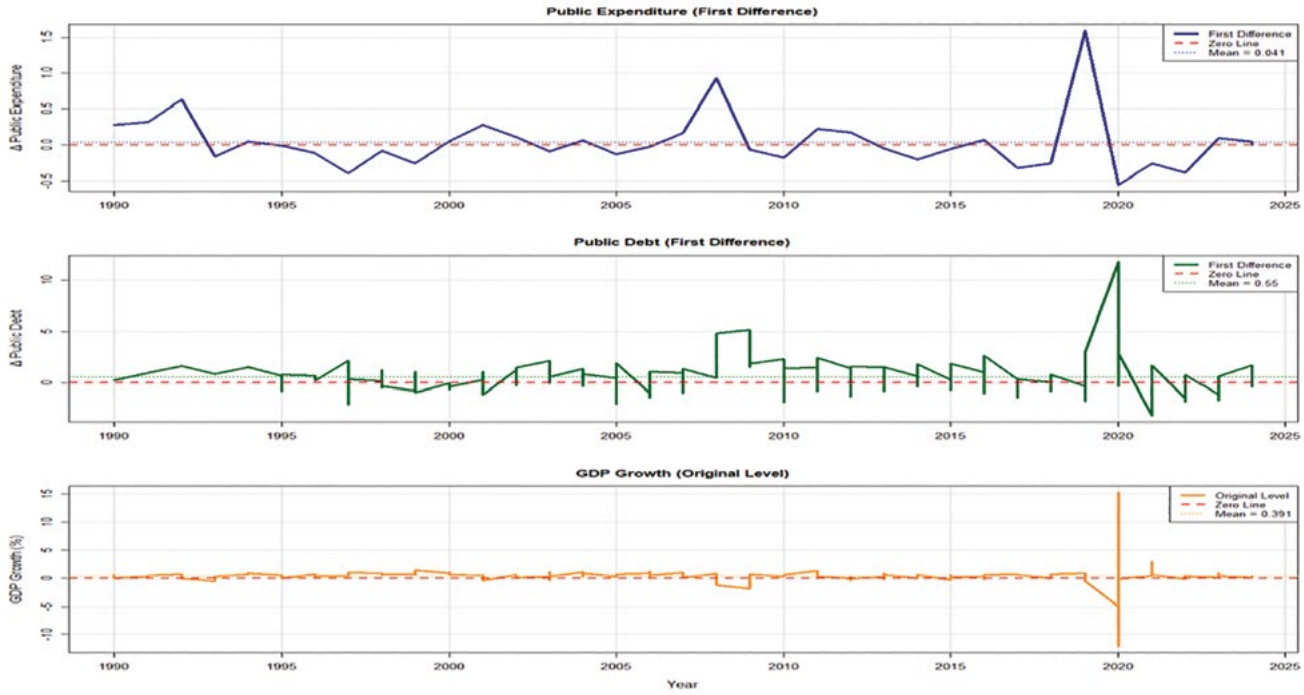


Figure 4. Wavelet Coherence: Public debt vs GDP growth

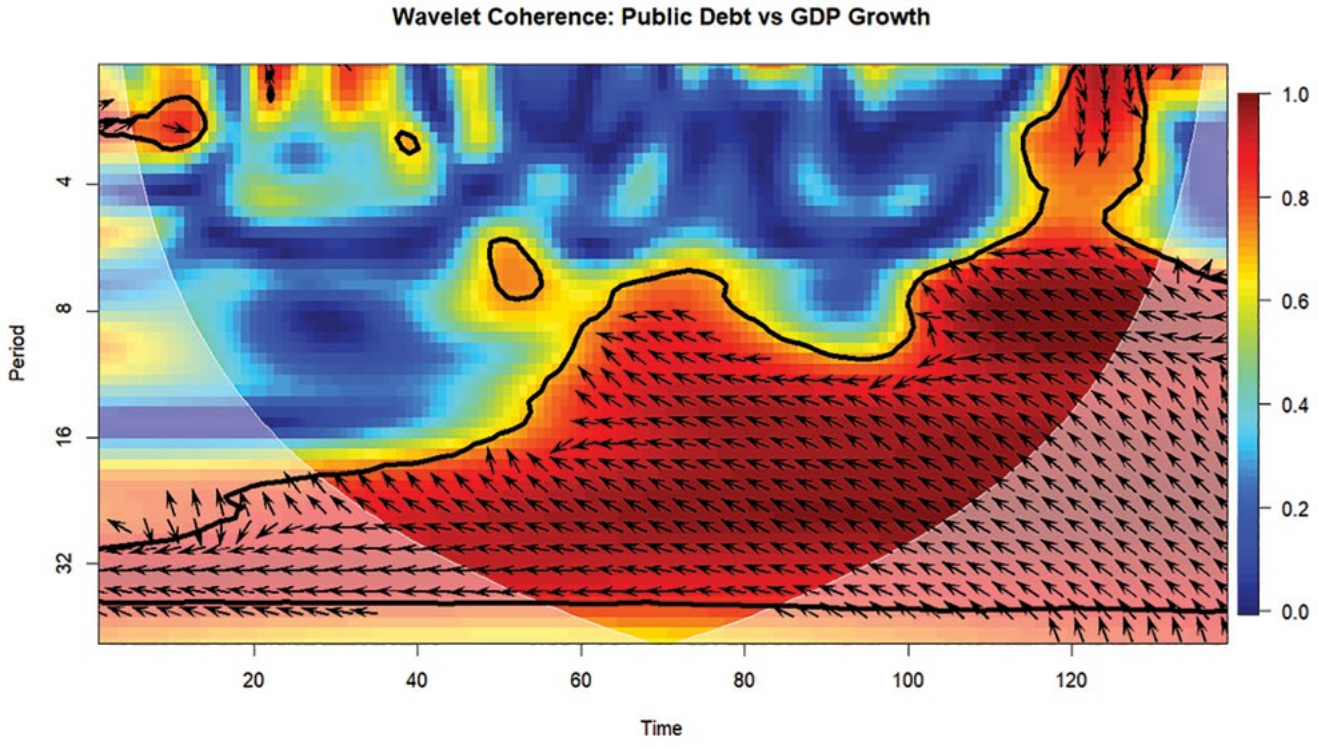
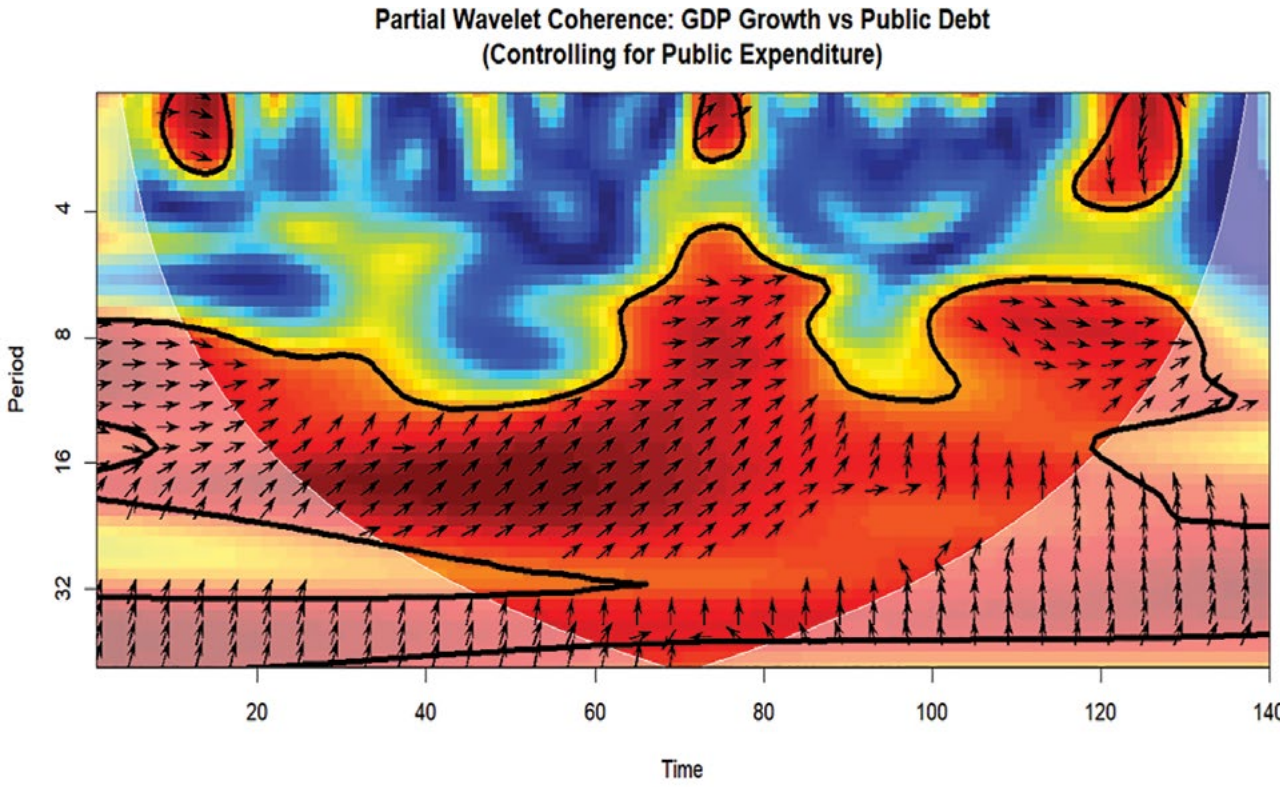


Figure 5. PWC GDP vs Debt growth/ Expenditure



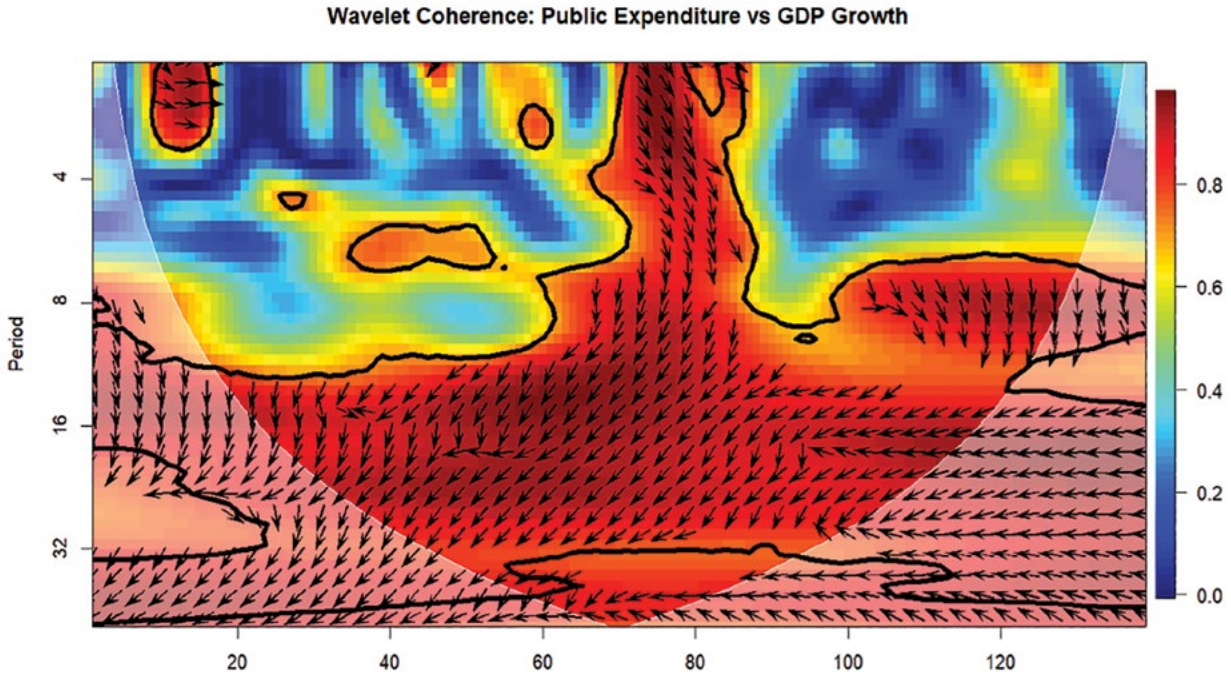
with debt leading growth at lower frequencies during much of the post-2000 period, though these patterns are suggestive rather than formally conclusive of a structural causal relationship.

4.2.1.2. Partial coherence (PWC) controlling for expenditure

The Partial Wavelet Coherence (PWC) between GDP growth and public debt, after controlling for public expenditure, reveals *interesting results (See Fig 5)*.

This partial wavelet coherence analysis isolates the direct relationship between French GDP growth and public debt while controlling for public expenditure effects. The analysis reveals significant coherence concentrated primarily in the medium to long-term frequency bands (8-32 periods) between approximately time points 60-120. This region of high coherence (red-orange zones with values approaching 0.8-1.0) indicates that during this critical period-roughly corresponding to France's eurozone consolidation and crisis years- public debt and GDP growth exhibited strong co-movement at business cycle frequencies. The phase arrows point predominantly rightward and slightly upward, suggesting a positive relationship where debt dynamics and growth are synchronized, though with potential lead-lag effects. For France specifically, this pattern reflects the country's challenging fiscal trajectory within the eurozone framework. The strong coherence in the 60–120-time window likely captures France's experience during the European sovereign debt crisis and subsequent recovery, when rising French public debt (climbing from around 65% to over 100% of GDP) became increasingly intertwined with growth outcomes through confidence channels, sovereign risk premia, and constraints on policy flexibility. The isolated eras of coherence at shorter periods (4-8 range) around time points 10-30 suggest episodes during France's early EMU years when debt and growth synchronized at higher frequencies, possibly reflecting adjustment dynamics as France adapted to single currency constraints and Stability and Growth Pact requirements. The relatively weak coherence at very short periods indicates that quarterly fluctuations in French debt and growth do not strongly correlate, while diminishing coherence at very long periods suggests secular trends may diverge.

Figure 6. Wavelet Coherence: Public Expenditure vs GDP Growth



The concentration of coherence at business cycle frequencies has important implications for French fiscal policy: debt management strategies should focus on medium-term horizons (2-8 years) where the debt-growth nexus is strongest, rather than expecting immediate short-term effects or relying exclusively on long-term projections.

4.2.2. Expenditure-GDP relationship

4.2.2.1. Wavelet total coherence (WTC)

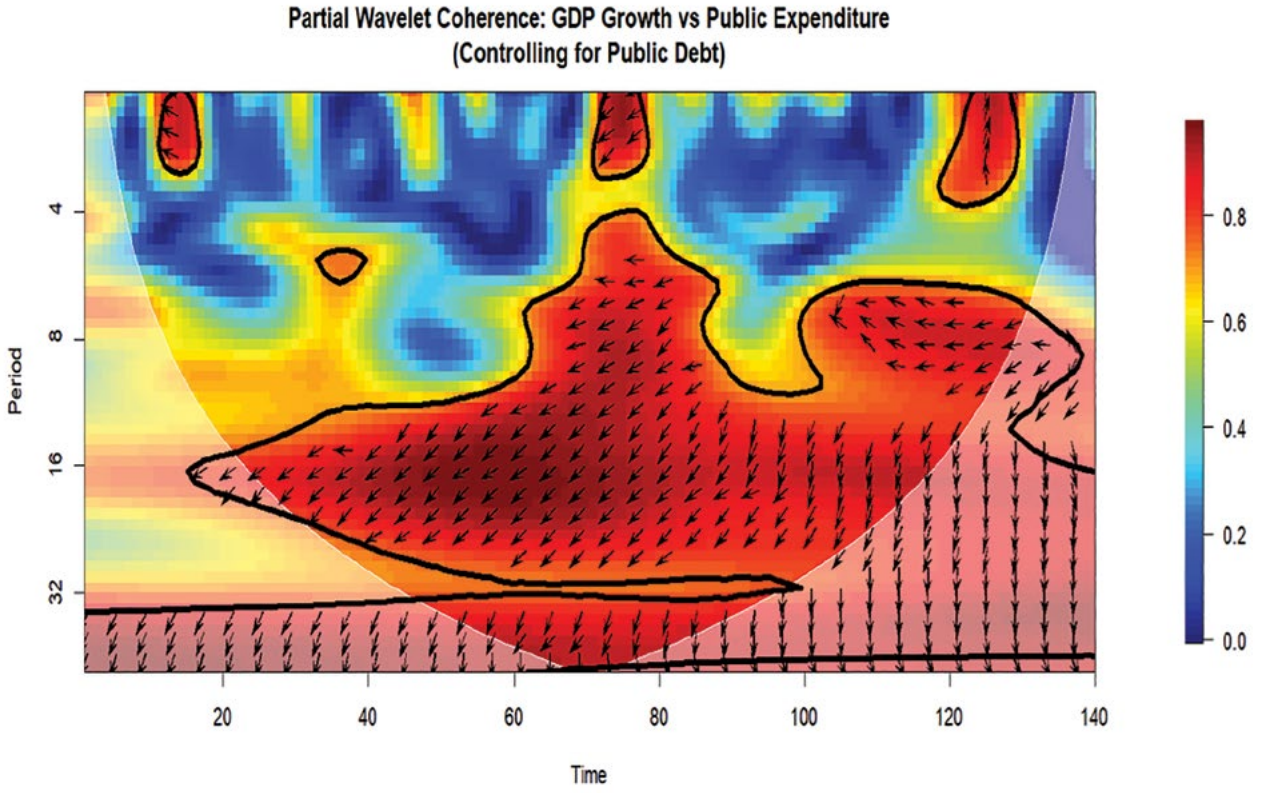
The following plot shows the time frequency dependency between GDP growth and public expenditure. Several consistent patterns emerge (See Fig 6).

The bivariate wavelet coherence (Figure 6) reveals substantial co-movement between public expenditure and GDP growth, particularly at medium- to long-term frequencies (8-32 years). The widespread red-orange regions, enclosed by thick black contours indicating statistical significance at the 5% level, demonstrate persistent high coherence throughout most of the sample period, especially in the 16-32-year frequency band. The phase arrows, predominantly pointing rightward and downward, suggest that public expenditure leads GDP growth by approximately one quarter of the cycle, indicating a pro-cyclical or potentially counter-cyclical fiscal stance depending on the specific time window. This strong bivariate relationship supports the conventional Keynesian view that fiscal policy exerts meaningful effects on economic activity across multiple time horizons.

4.2.2.2 Partial coherence (PWC) controlling for debt

Figure 7 examines the coherence between French GDP growth and public expenditure while controlling for debt effects. Strong coherence appears in the 8-32 period bands during the 60–120 time window, similar to the debt analysis, but with notable differences in spatial distribution and intensity. The high coherence region appears more concentrated around the 16-period band and extends with somewhat different temporal dynamics, suggesting that public expenditure's relationship with GDP growth operates through partially distinct frequency channels compared to debt. For France, this pattern reflects the country's historically strong reliance on public expenditure as an economic management tool. With government spending at approximately 57% of GDP, France maintains one of the world's largest public sectors. The coherence

Figure 7. PWC GDP growth vs Expenditure/ Debt



at business cycle frequencies confirms that French public spending, encompassing extensive social protection, public services, and state intervention, maintains significant synchronization with growth outcomes over medium-term horizons. The phase relationships show predominantly positive associations with more immediate effects compared to debt, consistent with expenditure having direct demand-side impacts through government consumption, investment, and transfers. However, the visual coherence patterns indicate that while expenditure and growth remain connected, the strength of this connection when controlling for debt has diminished, reflecting France's fiscal policy dilemma: high debt levels now constrain the effectiveness of the expenditure activism that historically defined French economic policy. The scattered islands of short-term coherence may correspond to specific fiscal interventions or crisis responses where spending had more immediate growth effects.

4.2.3. Expenditure-debt relationship

4.2.3.1 Wavelet Total Coherence (WTC)

Figure 8 shows that public expenditure and public debt are strongly and persistently synchronized at medium- to long-term horizons (8-32 periods), while their short-run relationship remains weak and intermittent. This means temporary spending fluctuations do not immediately affect debt, but sustained spending patterns are a key driver of debt accumulation over time. Phase arrows predominantly point right and upward, indicating that spending increases tend to precede and cause rises in public debt, consistent with standard deficit-financing logic. In some sub-periods, arrows tilt slightly downward, hinting at occasional feedback where high debt levels begin to constrain expenditure decisions, likely through consolidation pressures or rising debt-servicing costs.

4.2.3.2 Partial coherence (PWC) controlling for GDP

Figure 9 presents the partial wavelet coherence between public expenditure and public debt after controlling for GDP growth.

Figure 9 shows that French public debt and public expenditure have moved closely togeth-

Figure 8. Wavelet Coherence: Public Expenditure vs Public Debt

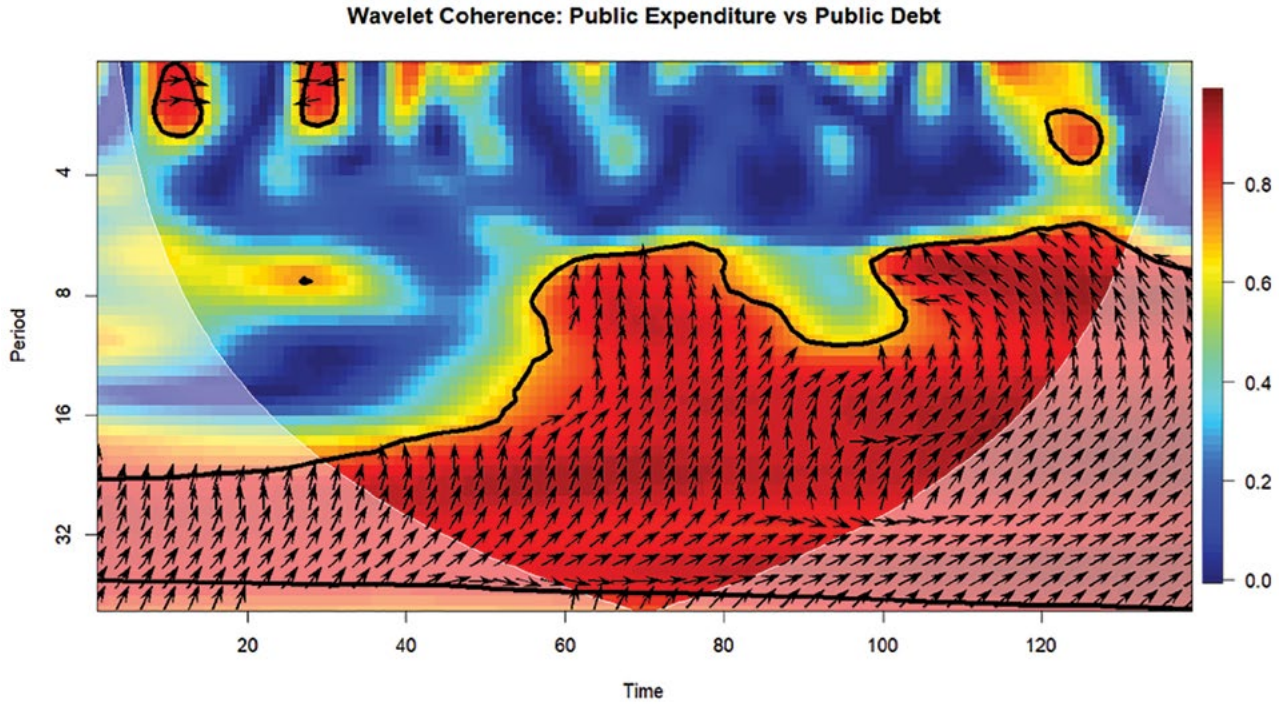
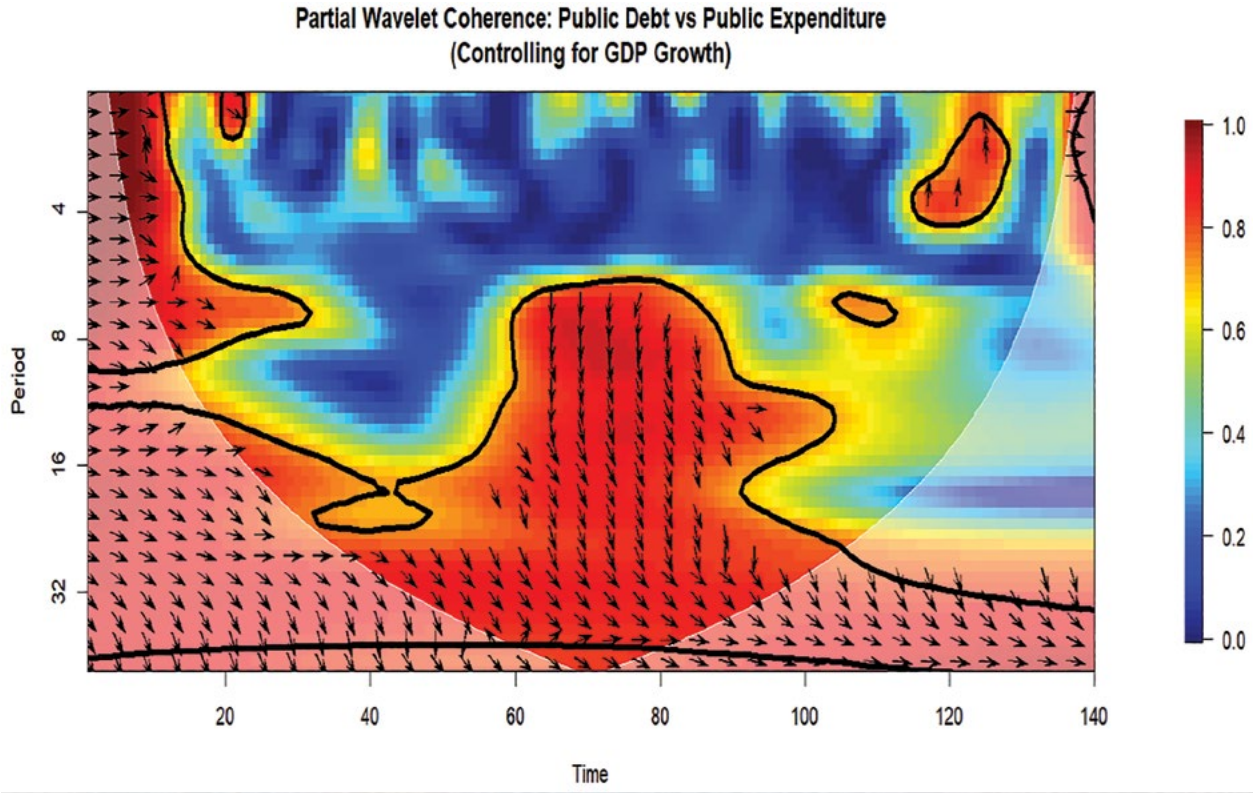


Figure 9. PWC Debt vs Expenditure/GDP growth



er across most time periods and frequencies, even after removing the influence of GDP growth. The strongest synchronization appears at medium-term horizons (8-32 periods), reflecting coordinated fiscal management where borrowing has consistently financed spending commitments, not just crisis-driven stimulus, but also France's structural social and public service obligations. Early in the sample, tight short-term coupling reflects the pressure of meeting Maastricht criteria, though France repeatedly fell short. Phase arrows indicate that debt tends to slightly lead expenditure, with both moving in the same direction. However, the relatively low post-crisis partial coherence value (0.21) reveals that much of this co-movement is actually driven by shared reactions to growth fluctuations rather than independent fiscal decisions, suggesting that France's fiscal policy has become more reactive than proactive in recent years.

4.3. Robustness checks (pre-EMU vs post-EMU; pre-2008 vs post-2008)

Table 6 reports the average Wavelet Coherence (WTC) and Partial Wavelet Coherence (PWC) estimates between GDP growth, public debt, and public expenditure across different institutional and macroeconomic regimes.

Table 6 reports wavelet coherence (WTC) and partial wavelet coherence (PWC) estimates for the three variable pairs: GDP growth, public debt, and public expenditure, across four sub-periods. **Full sample:** Over the entire 1990–2024 period, all three variable pairs display strong bivariate coherence: GDP-Expenditure leads at 0.677, followed by GDP-Debt (0.618) and Debt-Expenditure (0.601). These high values are unsurprising given France's large public sector, where government spending represents around 57% of GDP. Once the influence of the third variable is controlled for, however, partial coherence values fall to the 0.25, 0.29, 0.31 range, indicating that a substantial share of the observed pairwise associations reflects common exposure to fiscal dynamics rather than direct bilateral linkages. **Pre-EMU period (before 1999):** All coherence measures are at their weakest in this sub-period. The GDP-Expenditure association (0.501) exceeds that of GDP-Debt (0.431), in line with France's traditional reliance on public spending as its main macroeconomic instrument under full monetary sovereignty. Notably, the conditional expenditure-growth estimate (PWC GE|D = 0.393) remains relatively high, confirming that public spending exerted a meaningful independent influence on growth before the constraints of eurozone membership applied. This indicates that expenditure maintained strong conditional co-movement with growth when France had fiscal autonomy. **Post-EMU period (1999 onward):** Euro adoption is accompanied by a broad strengthening of all coherence measures: GDP-Debt rises to 0.668, GDP-Expenditure to 0.674, and Debt-Expenditure to 0.612. At the conditional level, the debt-growth estimate (PWC GD|E) increases to 0.442 while the expenditure-growth estimate (PWC GE|D) falls to 0.225. This shift suggests that, under

Table 6. Robustness analysis - Sub-period wavelet coherence

Period	N	WTC GDP-Debt	WTC GDP-Exp	WTC Debt-Exp	PWC GD|E	PWC GE|D	PWC DE|G
Full Sample	139	0,618	0,677	0,601	0,313	0,293	0,250
Pre-EMU (<1999)	39	0,431	0,501	0,388	0,297	0,393	0,253
Post-EMU (≥1999)	100	0,668	0,674	0,612	0,442	0,225	0,201
Pre-Crisis (<2008)	72	0,442	0,592	0,386	0,476	0,573	0,399
Post-Crisis (≥2008)	68	0,659	0,657	0,611	0,657	0,515	0,593

Note: WTC = Wavelet Coherence; PWC = Partial Wavelet Coherence. PWC GD|E reads "GDP-Debt controlling for Expenditure". All values represent the mean coherence across the time-frequency domain. N = number of quarterly observations.

Table 7. Granger causality test results

Direction	Optimal_Lag	F_statistic	P_value	Result
Expenditure → GDP	2	62,763	0.000	Strong causality
GDP → Expenditure	4	2,773	0,029	Significant causality
Debt → GDP	1	45,059	0.000	Strong causality
GDP → Debt	4	9,643	0.000	Strong causality
Expenditure → Debt	1	31,729	0.000	Strong causality
Debt → Expenditure	1	2,530	0,114	No causality

eurozone fiscal rules, debt accumulation gradually took over the role that public spending had previously played in driving growth fluctuations.

Pre-crisis period (before 2008): The WTC GDP-Debt measure (0.442) is lower in this sub-period than in either of the post-EMU or post-crisis windows, though the absolute minimum across all sub-periods belongs to the Pre-EMU era (0.431). More notable is the PWC GE|D, which reaches 0.573 - its highest value across all sub-periods. This suggests that French public spending maintained its closest association with growth during the relatively calm years of early eurozone membership, a finding that sits in stark contrast with France's repeated violations of Stability and Growth Pact deficit limits during the same period. **Post-crisis period (2008 onward):** All coherence measures reach their sample-period highs: WTC GDP-Debt at 0.659, WTC GDP-Expenditure at 0.657, and WTC Debt-Expenditure at 0.611. This broad tightening reflects France's large-scale fiscal response to the 2008 crisis and the subsequent build-up of public debt above 110% of GDP. At the conditional level, PWC GD|E rises to 0.657 while PWC GE|D declines to 0.515, down from its pre-crisis peak of 0.573. Taken together, these results point to a clear structural shift: as debt accumulated, its association with growth strengthened while the expenditure-growth link weakened. France appears to have moved from a fiscal regime in which public spending was the primary growth driver to one in which the level of accumulated debt defines the main constraint on macroeconomic performance.

4.4. GRANGER CAUSALITY TEST RESULTS

Granger causality tests complement our wavelet coherence analysis by identifying temporal precedence relationships. We find bidirectional causality between GDP and debt, confirming the dynamic feedback loop between the two variables. We notice from Table 7 a strong causality between Expenditure and GDP (p value=0.0000), the relationship between GDP and Expenditure is also significant, confirming the bidirectional causality between the two variables. Expenditure exhibits strong unidirectional causality toward debt. The absence of a debt-to- expenditure feedback mechanism represents a critical vulnerability in France's fiscal framework, as the budget constraint operates unidirectionally without self-correcting properties.

5. POLICY IMPLICATION

The wavelet analysis points to four practical lessons for French fiscal policy. First, public spending takes time to affect growth, so short-term budget tweaks are unlikely to work; longer-term planning is needed instead. Second, since the 2008 crisis, debt has become more damaging to growth while spending has become less effective at boosting it, largely because high debt raises borrowing costs and scares off private investment. Third, France's spending decisions have historically driven debt upward without any automatic correction mechanism, which is exactly the kind of imbalance the

EU's new fiscal rules are trying to fix. Fourth, public spending was a much more powerful growth tool when debt was below 70% of GDP, so reducing debt gradually is not just an external constraint; it is the only way to make fiscal policy effective again.

6. RESEARCH LIMITATION

The study has a few limitations worth noting. It only looks at France, leaving open the question of whether these findings apply elsewhere. The data themselves carry measurement uncertainty, and important factors like interest rates and monetary policy are not included in the model. The extreme COVID shock of 2020 also creates some technical noise near the edges of the wavelet analysis. Future work could consider robustness checks excluding the 2020–2021 period or employing adaptive wavelet methods designed to handle structural outliers.

CONCLUSION

This paper has applied a combination of Partial Wavelet Coherence and Granger causality tests to examine the complex frequency-dependent associations among fiscal policy variables and economic growth. Applied to French quarterly data spanning 1990-2024, our methodology reveals that France's fiscal co-movement patterns operate primarily at business cycle frequencies and have shifted notably following eurozone integration in 1999 and the 2008–2012 crisis period. The main finding of this study points to a clear shift in how fiscal policy operates in France. Before the euro, public spending was closely associated with economic growth, giving the government an effective lever to steer the economy. Today, this relationship has weakened, while the link between public debt and growth has grown stronger, meaning that the level of accumulated debt now shapes economic outcomes more than spending decisions themselves.

REFERENCES:

Afonso, A., de Sá Fortes Leitão Rodrigues, E. (2022) Corruption and economic growth: does the size of the government matter? Econ Change Restruct 55(2):543–576. <https://doi.org/10.1007/s10644-021-09338-4>;

Aguiar-Conraria, L., Soares, M. J. (2014). The continuous wavelet transforms: Moving beyond uni-and bivariate analysis. Journal of Economic Surveys, 28(2). <https://doi.org/10.1111/joes.12012>;

Arestis, P., Şen, H., Kaya, A. (2020). On the linkage between government expenditure and output: Empirics of the Keynesian view versus Wagner's law. Economic Change and Restructuring, 54(2). <https://doi.org/10.1007/s10644-020-09284-7>;

Auerbach, A. J., Gorodnichenko, Y. (2013). Fiscal multipliers in recession and expansion. In Fiscal Policy after the Financial Crisis (pp. 63-98). University of Chicago Press. <https://doi.org/10.7208/chicago/9780226018584.003.0003>;

Barro, R. J. (1974). Are government bonds net wealth? Journal of Political Economy, 82(6). <https://doi.org/10.1086/260266>;

Batini, N., Eyraud, L., Forni, L., Weber, A. (2014). Fiscal multipliers: Size, determinants, and use in macroeconomic projections. IMF Technical Notes and Manuals, 2014/004. <https://doi.org/10.5089/9781498382458.005>;

Blanchard, O., Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. Quarterly Journal of Economics, 117(4). <https://doi.org/10.1162/003355302320935043>;

Checherita-Westphal, C., Rother, P. (2012). The impact of high government debt on economic growth and its channels: An empirical investigation for the euro area. European Economic Review, 56(7). <https://doi.org/10.1016/j.euroecorev.2012.06.007>;

Corsetti, G., Kuester, K., Meier, A., Müller, G. J. (2013). Sovereign risk, fiscal policy, and macroeconomic stability. Economic Journal, 123(566). <https://doi.org/10.5089/9781463933180.001>;

Égert, B. (2015). Public debt, economic growth and nonlinear effects: Myth or reality? Journal of Macroeconomics, 43. <https://doi.org/10.1016/j.jmacro.2014.11.006>;

Gouhier, T. C., Grinsted, A., Jevrejeva, S. (2021). Biwavelet: Conduct Univariate and Bivariate Wavelet Analyses. R package version 0.20.21;

Goupillaud, P., Grossmann, A., Morlet, J. (1984). Cycle-octave and related transforms in seismic signal analysis. Geoexploration, 23(1). <https://doi.org/10.1016/0016-7142(84)90025-5>;

Herndon, T., Ash, M., Pollin, R. (2014). Does high public debt consistently stifle economic growth? A critique of Reinhart and Rogoff. Cambridge Journal of Economics, 38(2). <https://doi.org/10.1093/cje/bet075>;

Huidrom, R., Kose, M. A., Lim, J. J., Ohnsorge, F. L. (2020). Why do fiscal multipliers depend on fiscal positions? Journal of Monetary Economics, 114. <https://doi.10.1016/j.jmoneco.2019.03.004>;

Ilzetzki, E., Mendoza, E. G., Végh, C. A. (2013). How big (small?) are fiscal multipliers? Journal of Monetary Economics, 60(2). <https://doi.10.1016/j.jmoneco.2012.10.011>;

Insee. <https://www.insee.fr/fr/statistiques/ 8540821?sommaire=8540823>;

Mihanović, H., Orlić, M., Pasarić, Z. (2009). Diurnal thermocline oscillations driven by tidal flow around an island in the Middle Adriatic. Journal of Marine Systems, 78, S157-S168. <https://doi.org/10.1016/j.jmarsys.2009.01.021>;

Ng, E. K., Chan, J. C. (2012). Geophysical applications of partial wavelet coherence and multiple wavelet coherence. Journal of Atmospheric and Oceanic Technology, 29(12). <https://doi.org/10.1175/JTECH-D-12-00056.1>;

Nguyen, C. T., Bui, T. H. L. (2022). Government expenditure and economic growth: Does the role of corruption control matter? Heliyon, 8(10), e10822. <https://doi.org/10.1016/j.heliyon.2022.e10822>;

Nguyen, T. C., Trinh, L. T. (2021). The impact of fiscal policy on economic growth: Evidence from emerging and developing Asian countries. Economics and Business Letters, 10(3). <https://doi.org/10.17811/ebl.10.3.2021.251-262>;

OECD. (2024). OECD Economic Surveys: France. OECD Publishing. <https://doi.org/10.1787/bd96e2ed-en>;

Oyadeyi, O. O. (2024). Effect of government expenditure on real economic growth in ECOWAS: Assessing the moderating role of corruption and conflict. Humanities and Social Sciences Communications, 11. <https://doi.org/10.1057/s41599-024-03285-x>;

Reinhart, C. M., Rogoff, K. S. (2010). Growth in a time of debt. American Economic Review, 100(2). <https://doi.org/10.1257/aer.100.2.573>;

Rua, A., Nunes, L. C. (2009). International co-movement of stock market returns: A wavelet analysis. Journal of Empirical Finance, 16(4), 632-639. <https://doi.org/10.1016/j.jempfin.2009.02.002>;

Torrence, C., Compo, G. P. (1998). A Practical Guide to Wavelet Analysis. Bulletin of the American Meteorological Society, 79.

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