Received 20 October 2023
Revised 3 October 2024
15 December 2024
Accepted 27 December 2024

Unveiling the factors shaping innovation: a comparative analysis of emerging and advanced Asian economies

Shreya Pal and Mantu Kumar Mahalik
Department of Humanities and Social Sciences, Indian Institute of Technology Kharagpur, Kharagpur, India, and

Hrushikesh Mallick
Centre for Development Studies, Thiruvananthapuram, India

Abstract

Purpose – This study examines the role of monetary and fiscal policies in shaping innovation for a balanced panel sample of seven emerging and five advanced Asian economies.

Design/methodology/approach – Using the Driscoll–Kraay estimator as a baseline technique and panel-corrected standard errors and kernel-based regularised least squares as robust methods, this study explores the factors that influence innovation in both emerging and advanced Asian economies from 1990 to 2021. Based on the Morgan Stanley Capital International categorisation, this study has used a sample of seven emerging and five advanced Asian nations to empirically understand the factors shaping innovation.

Findings – The findings indicate that broad money and economic growth have positive effects on innovation, whereas tax revenue, governance quality and economic globalisation indicate negative effects in emerging Asia. The findings further indicate that tax revenue, economic growth, governance quality and economic globalisation favour innovation in advanced Asia. The authors also find an adverse impact of broad money on total innovation in advanced Asia.

Originality/value – These findings are quite helpful for the stakeholders and policymakers looking for efficient and long-lasting innovation initiatives.

Keywords Monetary policy, Fiscal policy, Innovation, Emerging Asian economies, Advanced Asian economies, Panel data

Paper type Research paper

1. Introduction

Innovation is now a crucial factor in economic growth, technical advancement and enhanced global competitiveness for both developing and developed nations. Promoting innovation and aiding in the creation of new products, concepts and technologies has grown in

JEL classification – C33, E52, E62, N10, O32

This work also took place at Indian Institute of Plantation Management Bengaluru, India due to the affiliation of first author.

Asia Pacific Journal of Innovation and Entrepreneurship
Vol. 19 No. 4, 2025
pp. 278-298
Emerald Publishing Limited
e-ISSN: 2398-7812
p-ISSN: 2071-1395
DOI 10.1108/APJIE-10-2023-0200

importance as nations strive to guarantee a wealthy and sustainable future. As legal tools for preserving intellectual property, patents are essential for encouraging research and development (R&D) spending and securing the results of creative endeavours. The idea that fiscal and monetary policies have an impact on innovation is viewed by economists, politicians and academics; in this quickly changing information age, patents receive special attention.

Monetary and fiscal policies are viewed by governments and central banks as powerful tools for influencing the economy and achieving macroeconomic and financial goals. An increasing body of scholarly literature and empirical data demonstrates the significance of these policies in shaping innovation and driving technical advancements. This further implies that fiscal and monetary policies may have a significant impact on innovation activities in both developed and developing nations is supported by existing studies (Feldman *et al.*, 2012; Moser, 2013; Hausmann *et al.*, 2021; Muñoz, 2021).

Monetary policy decisions made by central banks have an impact on the money supply, interest rates and credit availability. Lowering interest rates, for example, might encourage corporations to borrow money at reduced costs, which in turn encourages investment in R&D and innovation-driven activities. More patenting activity is positively correlated with technological development and supportive monetary policies, according to a recent study by Moser (2013). Changes in currency rates, which are often influenced by monetary policy, can also have an impact on technology transfer and international collaboration. Advantageous exchange rates for developing nations have the potential to attract foreign direct investment in R&D and promote technology spillovers, so bolstering innovation activities (Feldman *et al.*, 2012). Monetary policy refers to a range of measures (i.e. interest rates and credit conditions) implemented by central banks to regulate the money supply in an economy. The way businesses make decisions, how much money they invest and how the economy is doing overall are all likely to be significantly impacted by the decisions made by central banks. Lower interest rates, for example, may make borrowing less expensive, which incentivises businesses to spend money on R&D and start new projects. Recent studies have shown that accommodative monetary policies are positively correlated with increased innovation activities, particularly patenting (Muñoz, 2021).

To boost economic recovery and encourage investment in the wake of the recent COVID-19 pandemic, central banks throughout the world have implemented unorthodox monetary policy measures in line with the agenda of their corresponding governments, including targeted lending programmes and quantitative easing. Such monetary policy actions have the potential to encourage innovation-driven responses to the problems that surfaced during the pandemic while promoting the agenda of economic development as Organisation for Economic Co-operation and Development (OECD) indicated in 2021. Exchange rate variations that are driven by monetary policy can also affect the competitiveness of domestic companies and cross-border R&D partnerships. A favourable exchange rate might entice foreign investment in initiatives focused on innovation, resulting in knowledge transfers and technological spillovers (Keller, 2010; Marin and Bell, 2006). The panorama of entrepreneurial activity in innovation enterprises may also be shaped by monetary policy, which can also affect the availability of venture capital and funding for start-ups and innovative firms (Gompers *et al.*, 2020).

Similarly, fiscal policy, which is governed by government taxing and spending decisions, plays an integral role in supporting innovation efforts. Governments throughout the world have recognised the value of R&D investments and have implemented a variety of tax breaks to promote private sector engagement in creative activities. In this regards, R&D tax credits and deductions are useful tools for boosting patenting and fostering technical developments

(Czarnitzki *et al.*, 2020). Furthermore, public investment in research and technology-related initiatives can foster conditions conducive to collaborations among academics, industry and research institutions. According to the most recent statistics, greater public investment in R&D has resulted in breakthrough discoveries and developments in cutting-edge technology, fostering innovation in a variety of sectors (Coccia, 2018).

Fiscal policy shapes the innovation landscape of economies by allocating resources, providing incentives and creating an enabling environment for R&D activities. Recent statistics and insights emphasise the importance of fiscal policies in promoting innovation-driven growth. Thus, the International Monetary Fund (IMF) in 2022 has conducted research on the influence of fiscal stimulus packages on innovation during the COVID-19 epidemic. It suggests that the countries that have enacted targeted fiscal policies to encourage R&D expenditures and creative businesses have experienced more rapid economic recovery and technical advancement. In addition, Hausmann *et al.* (2021) research identified that higher R&D investment and patent applications occurred in reaction to government support, demonstrating the importance of tax incentives and R&D grants in promoting private-sector innovation. In this context, this study will unveil the complex interrelationship between fiscal policy and innovation, shining light on the policy implications for promoting innovation-led growth in emerging and advanced Asian economies, using recent statistics and empirical evidence.

Innovation is crucial for both emerging and advanced Asian economies because it drives economic growth, enhances competitiveness and fosters technological progress. In recent times, this importance has been particularly evident in both emerging and advanced economies due to the rapid pace of technological advancements and global economic shifts. According to a report by the World Intellectual Property Organisation, emerging economies like China and India have significantly increased their investment in R&D, leading to a rise in patent applications and technological breakthroughs. In 2020, China became the first country to file over a million patent applications in a single year, showcasing its growing commitment to innovation. Similarly, India has been fostering innovation through initiatives like "Make in India in 2014" and "Startup India in 2016", which have led to the emergence of a vibrant start-up ecosystem and a rise in technological innovation. This surge in innovation has propelled these countries to become major players in global trade and technology markets.

On the other hand, in advanced Asian economies, innovation is essential to maintaining their competitive edge in the global market. Countries like Germany and Japan have a long history of innovation-driven growth. They continue to invest heavily in R&D and foster a conducive environment for start-ups and technological advancements. For instance, the Global Innovation Index ranks countries based on their innovation capabilities and many advanced economies consistently rank high on this index due to their strong emphasis on innovation. In addition, "Germany's emphasis on research and engineering has enabled it to be at the forefront of innovation in industries such as manufacturing and automotive. "Japan's commitment to R&D is evident through its consistent presence among the world's top patent filers, whereas South Korea's advancements" in technology and electronics contribute significantly to its innovation landscape. Australia, known for its strong research institutions, has been focusing on innovation-driven sectors such as renewable energy. These trends are reflected in the innovative prowess of Singapore, a global hub for tech start-ups and research. New Zealand, despite its smaller size, has been leveraging innovation to drive advancements in agriculture and biotechnology, contributing to its overall economic growth.

However, the consequences of fiscal and monetary policy on innovation are nuanced and varied across many economic circumstances. While traditionally established countries have

depended on innovation to keep a competitive advantage, emerging economies are increasingly investing in R&D to enhance their technical capabilities and catch up with the world's innovative power centres. This study attempts to give a thorough and fact-based examination of how monetary and fiscal policies affect innovation in both developing and advanced economies, with an emphasis on patents. This analysis aims to shed light on the effectiveness of various policy approaches in stimulating innovation and fuelling economic growth in the modern world by reviewing recent statistics, empirical research and policy experiences of different countries. In addition, it will examine how emerging and advanced countries might pursue technological advancement while addressing difficulties and possibilities, as well as how patents can influence innovation ecosystems.

However, the ultimate goal of this study is to advance knowledge of how monetary and fiscal policies may be used by decision makers to encourage innovation, support patenting activities and advance their ideas in emerging and advanced Asian economies. One can also raise a research question of whether both monetary and fiscal policies influence total innovation equally in emerging and advanced Asian economies. What are the impacts of control variables (i.e. economic growth, economic globalisation and governance quality) on total innovation in emerging and advanced Asian economies? These research questions are essentially important to understand because countries in a global knowledge economy are competing with each other and thriving to achieve sustainable growth and development with the help of both monetary and fiscal policies-led innovation. Given this significance, these research questions are not yet addressed in existing studies and therefore motivate us to empirically examine the relative influence of monetary policy and fiscal policy on total innovation in emerging and advanced Asian economies by controlling economic growth, governance quality and economic globalisation in innovation function.

The following five reasons are the basis of our novelty that differentiates this study from the existing other studies. Firstly, this study offers a comprehensive analysis of how monetary and fiscal policies drive innovation with a focus on patents. As per our knowledge, this is the first study where we examine both emerging and advanced Asian economies while highlighting the significant impact of these policies on technological advancement. Secondly, this study used better-suited models (i.e. Driscoll–Kraay standard errors [DKSE] and panels-corrected standard errors [PCSEs]) to examine the stated objective. Thirdly, this research contrasts the innovation ecosystems of emerging economies like China and India with advanced economies like Germany and Japan, revealing key differences in how policy interventions influence R&D and patenting activities across different stages of economic development. Fourthly, this study incorporates up-to-date empirical data, grounding its analysis in recent research findings. This ensures the relevance of its conclusions to current economic conditions, making it a valuable resource for contemporary policy discussions, which are not yet discussed in the existing literature. Fifthly, the study offers practical recommendations for policymakers, emphasising the importance of targeted fiscal measures and accommodative monetary policies in promoting innovation-led growth, particularly in the context of a long balanced panel sample period from 1990 to 2021.

The remaining sections of this study are as follows. The existing studies are discussed in Section 2. Section 3 includes the data sources, theoretical framework and model specifications. Section 4 elaborates the related methodology used in the current analysis. Section 5 discusses the key results of this study. Section 6 also discusses the main findings and their underlying policy implications. Finally, conclusion is also highlighted in Section 7.

2. Literature review

As we know innovation is the key to sustainable economic growth in developing and developed countries of the world. For example, the producers producing any commodity require new ideas or re-skilling the workforce to expand the production capacity. The increasing production capacity is also contingent upon increasing the productivity of skilled labour forces (i.e. endogenous innovation) or increasing adoption of new cost-minimising technological practices (i.e. exogenous innovation). This shows the shifting production capacity due to the innovation of two types. Besides, innovation can be the cause of sustainable economic growth without substituting the workforce for capital in developing countries. For example, an unemployment crisis in the labour market of a country can occur if technology or machines are injected into the production process while replacing the workforce. Such an unemployment crisis can be avoided if workforces are re-skilled and trained, which can easily equip the technological innovation happening in the production process. As a result, output level can increase with an increasing skillset of workforces along with technological innovation.

Innovation, particularly in the context of financial services, also plays a critical role in shaping economic dynamics, especially when viewed through the lens of open, disruptive and incremental innovation. Fasnacht (2018) highlights that open innovation in financial services complements monetary policy by enhancing efficiency, improving financial inclusion and fostering economic growth. As financial institutions adapt to disruptive trends and embrace collaboration, they contribute to supporting credit availability and stability, which aligns with key monetary policy objectives.

Moreover, Nonyane (2024) underscores the profound impact that fintechs and mobile lending platforms have on monetary policy, particularly in emerging markets like Zambia and Kenya. These innovations are reshaping the credit landscape by expanding access to credit, influencing money demand and even affecting inflation dynamics. As mobile lending grows, it challenges traditional monetary transmission mechanisms, placing additional pressure on central banks to adapt their policies. The rise of fintech and mobile platforms presents a new frontier for monetary policy, which must balance the benefits of innovation with the need to maintain financial stability.

The relationship between innovation and monetary policy is further explored in the work of Davis and Tomoda (2018), who argue that monetary tool, such as interest rates, directly influence the pace and type of innovation in the economy. By adjusting interest rates, central banks can either encourage or dampen investment in both incremental and breakthrough innovations. For instance, lower interest rates make financing more accessible, which can spur investments in new technologies and support economic development.

In this context, monetary policy plays a crucial role in shaping the innovation landscape. It can either foster or inhibit investments in innovative technologies, which in turn impacts product cycles, economic growth and long-term welfare. While fostering innovation is essential for economic progress, it is equally important to review existing studies to understand how these innovations interact with monetary policy, ensuring that their benefits are maximised while mitigating potential risks to economic stability.

Arestis (2015) noted that monetary policy and other government financial regulation actions in the area of financial stability were closely coordinated, making fiscal policy an effective weapon for macroeconomic stabilisation and innovation building. Budgetary expenditures on research and education were found by Simionescu *et al.* (2017) to be generally connected with the real gross domestic product (GDP) growth rate, however, their significance varied according to the specifics of each ’country’s financial policies. Afonso

and Furceri (2010) conducted an empirical investigation of the effects of fiscal tools on economic processes. They came to the conclusion that the real GDP per capita of the OECD nations decreased concurrently with a rise in the percentage of government revenues in GDP. Chugunov *et al.* (2019) investigated the effects of fiscal policy tools on social advancement and economic expansion. The authors discovered that expansionary budgetary adjustments based on a combination of increases in government spending and revenue reductions were more successful than those based just on spending increases. A major part of fiscal consolidation is the decrease of government primary spending.

According to Mishchenko and Lon (2017), creating certain monetary preconditions is the primary responsibility for advancing economic growth. The preconditions were low levels of public debt, macroeconomic stability, the confidence of the financial system, the balance of the general budget and modest and generally steady inflation. Annicchiarico and Rossi (2013) emphasised that the central bank decreased overall uncertainty and ultimately aided in economic growth by using an inflation-targeting strategy. A sample of 22 advanced and 33 developing market economies were examined by Mollick *et al.* (2011). They demonstrated that the adoption of full-fledged inflation targeting resulted in an acceleration in the rise of real GDP per capita. According to Reynard (2007), concentrating on low inflation aims while ignoring pertinent monetary aggregate targets may result in excessive monetary constraints that reduce the possibility for real GDP development. Ahrorjon and Gafurov (2023) demonstrated that the natural anti-inflationary bias of fiscal and monetary policy coordination should promote economic expansion. They emphasised that the primary goal of government economic policy should be to lower the volatility of the key indicators of economic development. Lukianenko and Dadashova (2016) examined the relationships between the National Bank and the 'government's economic regulation, identifying seven stages in the relationships between monetary and fiscal policy. Further research is required to determine how regulatory financial structures affect innovation in real circumstances. Enhancing the institutional framework for the interplay of monetary and fiscal policy is necessary to provide long-term macroeconomic stability and the essential conditions for achieving long-term sustainable economic growth.

3. Data, theoretical framework and models specifications

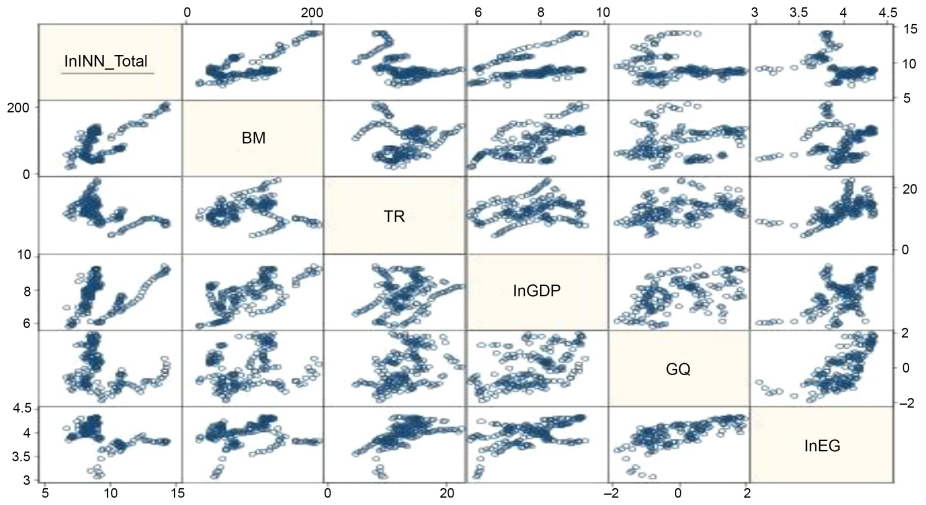
3.1 Data sources

The primary objective of our research is to investigate the factors influencing innovation in emerging and advanced Asian countries. For this, we have critically chosen seven emerging and five advanced Asian countries based on the Morgan Stanley Capital International (MSCI) classification and data availability [1]. To analyse the determinants of innovation types, the dependent variable that we have collected and added reliable data on patent applications by residents and non-residents from the World Bank. The independent variables are broad money (BM) (% of GDP), tax revenue (TR) (% of GDP), GDP per capita (current US$) and GQ, which we have extracted from the World Development Indicators database of the World Bank. The EG index is also collected from the KOF Swiss Economic Institute. Besides, the GQ index has been created by using principal component analysis, which is a combination of voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law and control of corruption. To ensure the availability of sufficient data, we have selected the period from 1990 to 2021. In Table 1, we present descriptive statistics and a correlation matrix of the underlying variables, whereas Figures 1 and 2 display the scatter plot. These visual representations aid in understanding the relationships between the variables and provide valuable preliminary insights into the dynamics of innovation and its determinants in emerging and advanced Asian economies.

Table 1. Data details with summary statistics and correlation

Data details	Patent applications, total	Broad money (% of GDP)	Tax revenue (% of GDP)	GDP per capita (current US$)	Governance quality index	Economic globalisation index
Data sources	World development indicators (WDI), the World Bank	World development indicators (WDI), the World Bank	World development indicators (WDI), the World Bank	World development indicators (WDI), the World Bank	World development indicators (WDI), the World Bank	KOF Swiss Economic Institute
	INN	BM	TR	GDP	GQ	EG
Emerging Asian economies						
Mean	88,866.230	95.775	12.820	3400.164	0.000	55.401
Median	6,257.000	90.473	12.892	2446.807	−0.152	55.521
Maximum	1,542,002.000	211.892	22.481	12,617.500	1.968	76.731
Minimum	854.000	20.710	4.585	329.001	−1.875	21.110
SD	283,837.700	44.300	3.355	2,952.038	1.000	12.111
Jarque–Bera	0.142	0.923	0.178	0.550	0.482	0.349
Observations	182	182	182	182	182	182
INN	1.000					
BM	0.615	1.000				
TR	−0.324	0.044	1.000			
GDP	0.452	0.652	0.102	1.000		
GQ	−0.097	0.188	0.397	0.507	1.000	
EG	−0.250	0.189	0.621	0.478	0.743	1.000
Advanced Asian economies						
Mean	114,072.100	127.655	18.535	35,423.740	0.000	67.784
Median	25,741.000	112.866	14.934	34,979.210	0.317	66.570
Maximum	439,175.000	283.486	31.986	77,710.070	1.542	94.922
Minimum	5,700.000	36.327	11.577	8,281.700	−2.325	36.373
SD	142,770.700	54.324	5.942	14,861.740	1.000	14.399
Jarque–Bera	0.572	0.818	0.341	0.856	0.962	0.202
Observations	130	130	130	130	130	130
INN	1.000					
BM	0.830	1.000				
TR	−0.477	−0.457	1.000			
GDP	−0.032	0.320	−0.017	1.000		
GQ	−0.687	−0.291	0.419	0.482	1.000	
EG	−0.574	−0.163	−0.069	0.368	0.802	1.000

Source: Authors' own calculation by using E-views 12



Source: Authors' own calculation by using STATA 17

Figure 1. Scatter plot of the variables for emerging Asian economies

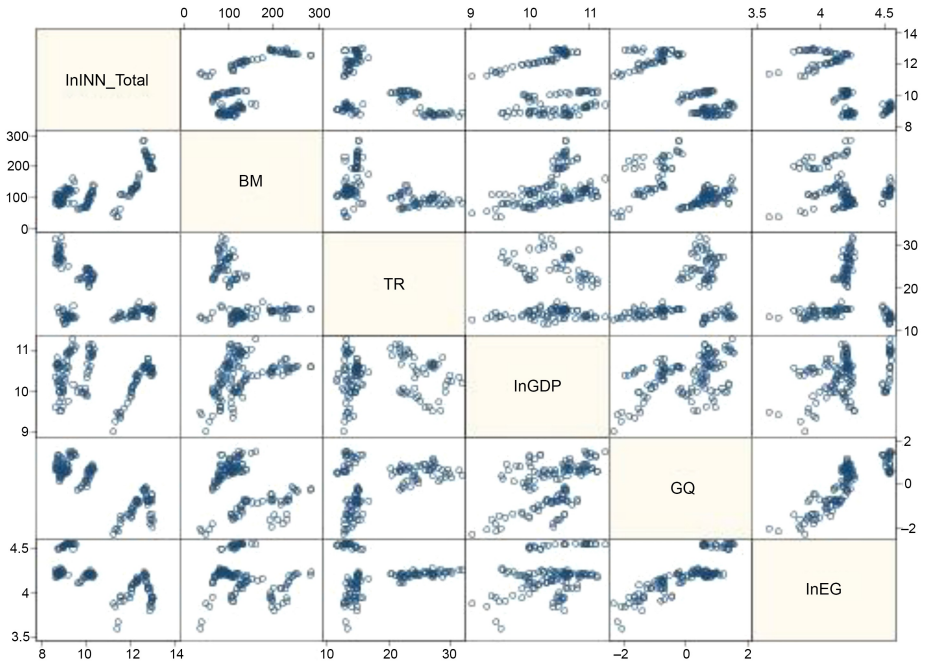
3.2 Theoretical framework and models specifications

Before moving into the model specification, it is important to hypothesise the theoretical connection between innovation and its determinants. The monetary policy (i.e. BM supply as a % of GDP) drives innovation if low interest rates via excessive money supply can enable producers and consumers to invest money in making innovation (Muñoz, 2021). Similarly, fiscal policy (i.e. TR as a % of GDP) also impedes innovation if higher tax is imposed on producers. The producers can reduce investment in innovation if they pay more taxes to the governments. Better governance quality stimulates innovation. This becomes possible when the governments incentivise the business firms involved in making better governance of corporate social and environmental responsibilities, thereby driving innovation. The higher economic growth (i.e. GDP) induces innovation. This is true because investing on innovation requires income level. Finally, economic globalisation also drives innovation. This becomes true when economies are open to trade and capital flows through which new ideas or new technology can be increased. To evaluate the effects of fiscal policy and monetary policy on innovation, this study specifies the following model for the empirical estimation by controlling other key determinants of innovations, such as economic growth, governance quality and economic globalisation:

$$\text{lnINN}_{it} = f(BM_{it}, TR_{it}, ln\text{GDP}_{it}, GQ_{it}, lnEG_{it}) \leftarrow \quad (1)$$

lnINN stands for the natural logarithm [2] of total innovation, BM for broad money, TR for tax revenue, lnGDP for economic growth, GQ for governance quality index [3] and lnEG for economic globalisation index in equation (1).

In line with the underlying discussion and theoretical concept, we evaluate the causal interaction between underlying variables using a single multivariate framework. Therefore, we hypothesised that:



Source: Authors' own calculation by using STATA 17

Figure 2. Scatter plot of the variables for advanced Asian economies

H0. Broad money, tax revenue, economic growth, governance quality and economic globalisation have a negative impact on total patent applications (i.e. innovation).

The following empirical model is described as:

$$\mathrm{INN}_{it} = \beta_0 + \beta_1 BM_{it} + \beta_2 TR_{it} + \beta_3 GDP_{it} + \beta_4 GQ_{it} + \beta_5 EG_{it} + \varepsilon_{it} \quad (2)$$

To lessen the sharpness of the data and eliminate the possibility of autocorrelation and heteroscedasticity, we additionally transformed all the data into semi-natural logarithms [4]. We establish our empirical equation in log-linear form as follows:

$$\mathrm{lnINN}_{it} = \beta_0 + \beta_1 BM_{it} + \beta_2 TR_{it} + \beta_3 lnGDP_{it} + \beta_4 GQ_{it} + \beta_5 lnEG_{it} + \varepsilon_{it} \quad (3)$$

where β_0 is the constant value, β_1, β_2, β_3, β_4 and β_5 are the long-run elasticities of the independent variables, t specifies the period, $t = 1, 2, \ldots. n$ and ε_{it} represents the error terms.

4. Related methodology

4.1 Pre-estimation methodological steps

In recent years, there has been an increasing recognition of the significance of spatial or spillover effects in various research areas. However, the development of panel unit root

and cointegration tests in the 1990s did not adequately account for these factors, leading to substantial size distortions in the results. To address this concern, researchers have explored various methodologies to incorporate cross-sectional dependence into their analyses. These approaches encompass techniques such as using panel-specific unit roots, using unit root tests with heterogeneous intercepts and slopes, and using dynamic panel data models with both individual and time effects. Furthermore, estimation strategies like the generalised method of moments and the system generalised method of moments have been adopted to better accommodate cross-sectional dependence. These strategies allow researchers to better capture the inherent heterogeneity present in panel data, thereby enhancing the accuracy of their findings. Individual-specific effects can arise when working with panel data characterised by a large cross-sectional unit paired with a limited time dimension. Pesaran (2004) introduced the cross-sectional dependence (CD) test as an alternative to the scaled lagrange multiplier (LM) test in this context, providing a valuable tool for researchers to address individual-specific effects in equation (4):

$$CD_{\rho} = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T_{ij}\widehat{\rho}_{ij} \rightarrow N(0, 1) \leftarrow \tag{4}$$

where $T_{ij} = \neq (T_i \cap T_j)$

In the context of unit root testing, the non-stationarity assumptions frequently violated in macroeconomic time series analysis necessitate careful consideration. To accurately analyse such time series, it is essential to examine the stationarity of the time series variable. Unit roots, a form of autocorrelation, signify that the distribution shape remains consistent over time. Detecting unit roots is pivotal and tests like the IPS unit root test are often used for this purpose. Identifying unit roots signifies a nonstationary time series, requiring transformation for statistical inference to be meaningful. The deterministic nature of time series is an implicit assumption when conducting unit root tests shown in equations (5) and (6):

$$[y_t]_{t-1}^{T} \tag{5}$$

Can be written as:

$$y_t = D_t + Z_t + \varepsilon_t \tag{6}$$

However, this study uses the cross-sectionally augmented Im, Pesaran, Shin (IPS) (CIPS) test introduced by Pesaran (2004), which represents second-generation panel unit root tests. As the cross-sectional dependency does not accommodate the first-generation unit root test, therefore using the second-generation unit root test enhances the authenticity of the results of this study. The choice of unit root test may vary based on the specific research context and objectives:

$$\widehat{CIPS} = \frac{1}{N} \sum_{i=1}^{n} CDF_i \tag{7}$$

And:

$$CIPS(N, T) \Leftarrow N^{-1} \sum_{i=1}^{N} t_i(N, T) \leftarrow \tag{8}$$

While:

$$\Delta CA_{it} = \varphi_{it} + \varphi_{it} Z_{it-1} + \varphi_{it} \overline{CA_{t-1}} + \sum_{l-0}^{p} \varphi_{it} \Delta \overline{CA_{t-1}} + \sum_{l-0}^{p} \varphi_{il} \Delta \overline{CA_{t-1}} + \mu_{it} \quad (9)$$

where $\overline{CA_{t-1}}$ and $\Delta \overline{CA_{t-1}}$ are the cross-sectional averages.

4.2 Driscoll–Kraay robust standard errors and panel-corrected standard errors

The DKSE estimator, created by Driscoll and Kraay (1998), is used in the context of pooled ordinary least squares (OLS) regression to estimate long-run coefficients. To take into consideration any cross-sectional or temporal dependencies, this estimator modifies the standard errors of the pooled OLS models. It does this by applying the Newey–West adjustment to a collection of moment condition cross-sectional averages. This dynamic non-parametric method is especially useful as the time dimension grows because it evaluates the linear relationship between panel data without being restricted by the number of panel cross-sections.

The Driscoll–Kraay covariance matrix technique has several benefits. It talks about things like cross-country dependency, autocorrelation and heteroscedasticity. This flexible approach handles missing values well for balanced and unbalanced panel data sets. The linear model using the pooled OLS DKSE is formulated as follows:

$$y_{it} = x_{it}'\beta + \varepsilon_{it} \quad (10)$$

In this equation, the explanatory variables (BM, TR, lnGDP, GQ and EG) are designated as x_{it}, whereas the dependent variable (lnINN) is represented by y_{it}. Additional techniques are used in this study to increase robustness and confirm the outcomes produced by the DKSE methodology. In particular, the estimate of PCSEs by Bailey and Katz is applied. By adjusting for cross-section dependence, heteroscedasticity and serial correlation within panels, these methods increase the validity of the long-term estimates.

4.3 Kernel-based regularised least squares

This study, in addition, uses the kernel-based regularised least squares (KRLS) model to evaluate the validity of the findings. This machine learning approach is a useful analytical tool since it incorporates point-to-point derivatives. The study by Hainmueller and Hazlett (2014) describes the procedural framework involving KRLS. It corrects erroneous regression preconditions inside a linear model system, as suggested by Brambor *et al.* (2006), to investigate the notion of "short-coattails". Due to recurrent words of association, questions frequently emerge regarding the linear differentiation of marginal efficacy in langrage-multipliers. The smooth correction of marginal effects is skilfully facilitated by KRLS, enabling more accurate analysis (Hainmueller and Hazlett, 2014). This thorough technique guarantees a thorough assessment of the KRLS model and adds to the reliability and validity of the analytical results.

5. Estimated result

5.1 Summary statistics and correlation

Let's begin by explaining the benchmark statistics. A summary of the mean values and standard deviations of the relevant variables is given in Table 1 of summary statistics. The summary statistics table provides information on the medians and ranges of these variables. We provide the correlation matrix in Table 1 to explore the connections between variables.

We can understand the relationships between various variables according to this matrix. The findings of our correlation show strong relationships with innovation, broad money (BM), tax revenue (TR), economic growth (GDP), governance quality (GQ) and economic globalisation (EG) in both the cases of emerging and advanced Asian economies. Figures 1 and 2 also demonstrate similar observations. The Jarque and Bera test (Jarque and Bera, 1980) is one of the most well-known tests for the normality of regression residuals and is widely used by econometricians. The theoretical values of Jarque and Bera under normalcy are 0 and 3, respectively, which evidenced that the variables are normal.

5.2 Unit root test

The results of the IPS and CIPS panel unit root testing are shown in detail in Tables 2 and 3. These results suggest that when evaluating the level series, the unit root null hypothesis (*H0*) cannot be disproved in the case of some variables. However, once the first differencing has been applied, all the variables show stationarity. These observed findings give the cointegration analysis, which is the essential basis to move on, indicating that all the variables under study follow an I (0) and I (1) process integrated with order zero and one, for both the emerging and advanced Asian economies.

5.3 Cointegration test and cross-sectional dependency test

Given that the *p*-value is greater than the threshold for significance, the results of the Pedroni panel cointegration tests and Westerlund error correction model panel cointegration tests

Table 2. IPS unit root test

	Emerging Asian economies		Advanced Asian economies	
Variables	Level	First difference	Level	First difference
lnINN	−0.380	−8.895***	−4.662***	
BM	0.821	−5.415***	−0.543	−7.300***
TR	−0.959	−13.911***	−16.566***	
lnGDP	−0.234	−6.236***	−0.117	−6.647***
GQ	0.913	−8.743***	0.094	−8.885***
lnEG	−3.361***		−1.589*	

Notes: ***; * are significant at 1, and 10% levels, respectively
Source: Authors' own calculation by using E-views 12

Table 3. CIPS unit root test results

	Emerging Asian economies		Advanced Asia economies	
Variables	Level	First difference	Level	First difference
lnINN	−2.372	−5.330***	−4.742***	
BM	−0.986	−4.274***	−2.338	−5.500***
TR	−2.422	−4.281***	−3.337***	
lnGDP	−3.877***		−2.967**	
GQ	−2.873**		−2.275	−4.904***
lnEG	−2.689	−4.845***	−3.522***	

Notes: ***; ** are significant at 1, and 5%, levels, respectively
Source: Authors' own calculation by using STATA 17

Table 4. Panel cointegration test results (Pedroni panel cointegration tests and Westerlund ECM panel cointegration tests)

	lnINN = f (BM, TR, lnGDP, GQ, lnEG)				
Statistics	Emerging Asian economies	Advanced Asian economies	Statistics	Emerging Asian economies	Advanced Asian economies
Panel v-statistic	−2.875	−1.269	Gt	−2.815***	−2.652***
Panel rho-statistic	1.989	−0.589	Ga	−13.937***	−26.331***
Panel PP-statistic	−3.305***	−4.334***	Pt	−6.136***	−4.729***
Panel ADF-statistic	−4.150***	−1.802**	Pa	−13.528***	−13.383***
Group rho-statistic	2.945	−0.309			
Group PP-statistic	−4.325***	−5.671***			
Group ADF-statistic	−2.629***	−1.497*			

Notes: ***; **; * are significant at 1, 5 and 10% levels, respectively
Source: Authors' own calculation by using E-views 12 and STATA 17

presented in Table 4 show that the null hypothesis (*H0*) of cointegration among the specified variables cannot be ruled out. The conclusion that there is a long-lasting equilibrium linkage between the dependent variables (lnINN) and the investigated independent variables (BM, TR, lnGDP, GQ and lnEG) is strongly supported by the observed cointegration. On the other hand, we use a cross-sectional dependency test, the results of which are shown in Table 5, to evaluate cross-sectional dependence within our series. These results support the idea that cross-sectional dependence exists in our series.

5.4 Long-run results

Subsequently, the DKSE approach is used as a long-term estimator of the fundamental variables of the model, building upon the foundational panel data analysis (Table 6). These techniques enable reliable estimations when heteroscedasticity and autocorrelation are present in the regression models, and they are especially well suited to handle the cross-sectional dependency in the series.

One uniqueness of our modelling strategy is that broad money, tax revenue, economic growth, governance quality and economic globalisation are used in our estimation method for both emerging and advanced Asian economies. The model for emerging Asian economies relates the response of innovation to broad money, tax revenue, economic growth, governance quality and economic globalisation. The findings show a positive impact of BM and economic growth, whereas a negative relationship is observed for tax revenue,

Table 5. Cross-sectional dependence (CD) test results

	lnINN = f (BM, TR, lnGDP, GQ, lnEG)	
Statistics	Emerging Asian economies	Advanced Asian economies
Breusch–Pagan LM	167.588***	47.680***
Pesaran scaled LM	22.619***	8.425***
Δ	5.526***	7.725***
Δadj	6.464***	9.037***

Note: *** is significant at 1% level
Source: Authors' own calculation by using E-views 12

Table 6. Baseline regression results of Driscoll–Kraay standard errors (DKSE)

	Dependent variable: innovation			
	Emerging Asian economies		Advanced Asian economies	
Variables	Coefficient	Std. err.	Coefficient	Std. err.
BM	0.016***	0.001	−0.010***	0.000
TR	−0.184***	0.037	0.012**	−0.004
lnGDP	1.280***	0.051	0.866***	0.120
GQ	−0.956***	0.133	1.297***	0.048
lnEG	−1.502*	0.843	0.122**	0.289

Notes: ***; **; * are significant at 1, 5 and 10% levels, respectively
Source: Authors' own calculation by using STATA 17

governance quality and economic globalisation in emerging Asian economies. On the other hand, the results also indicate a direct impact on tax revenue, economic growth, governance quality and economic globalisation, but a negative relationship between broad money and total innovation holds for the advanced economies.

5.5 Robust long-run results

This study also uses PCSEs estimation and KRLS estimation approaches to ensure the reliability of the Driscoll–Kraay test results. The Driscoll–Kraay regression results are consistent with the long-term coefficient estimates derived using KRLS and PCSEs, as shown in Tables 7 and 8. The above results are validated with Figures 3 and 4 of pointwise derivatives of KRLS estimation approaches. Notably, the empirical findings show that all the explanatory factors have consistent, statistically significant associations with the dependent variable, validating our main results obtained from Driscoll-Kraay's estimates.

6. Discussion of the estimated key results and policy implications

The influence of monetary policy on innovation differs significantly across emerging and advanced Asian economies, which reflects the complex dynamics of various economic environments. Innovation often benefits from accommodative monetary policies in emerging Asian countries, which are characterised by lower interest rates and more liquidity. By

Table 7. Correlated panels corrected standard errors (PCSEs) method-based robust results

	Dependent variable: innovation			
	Emerging Asian economies		Advanced Asian economies	
Variables	Coefficient	Std. err.	Coefficient	Std. err.
BM	0.022***	0.001	−0.011***	0.001
TR	−0.147***	0.014	0.054***	0.009
lnGDP	0.476***	0.071	0.358***	0.104
GQ	−0.098**	0.064	0.606***	0.116
lnEG	−2.899***	0.507	2.442***	0.466

Notes: ***; ** are significant at 1 and 5% levels, respectively
Source: Authors' own calculation by using STATA 17

Table 8. Kernel-based regularized least squares (KRLS) method-based robust results

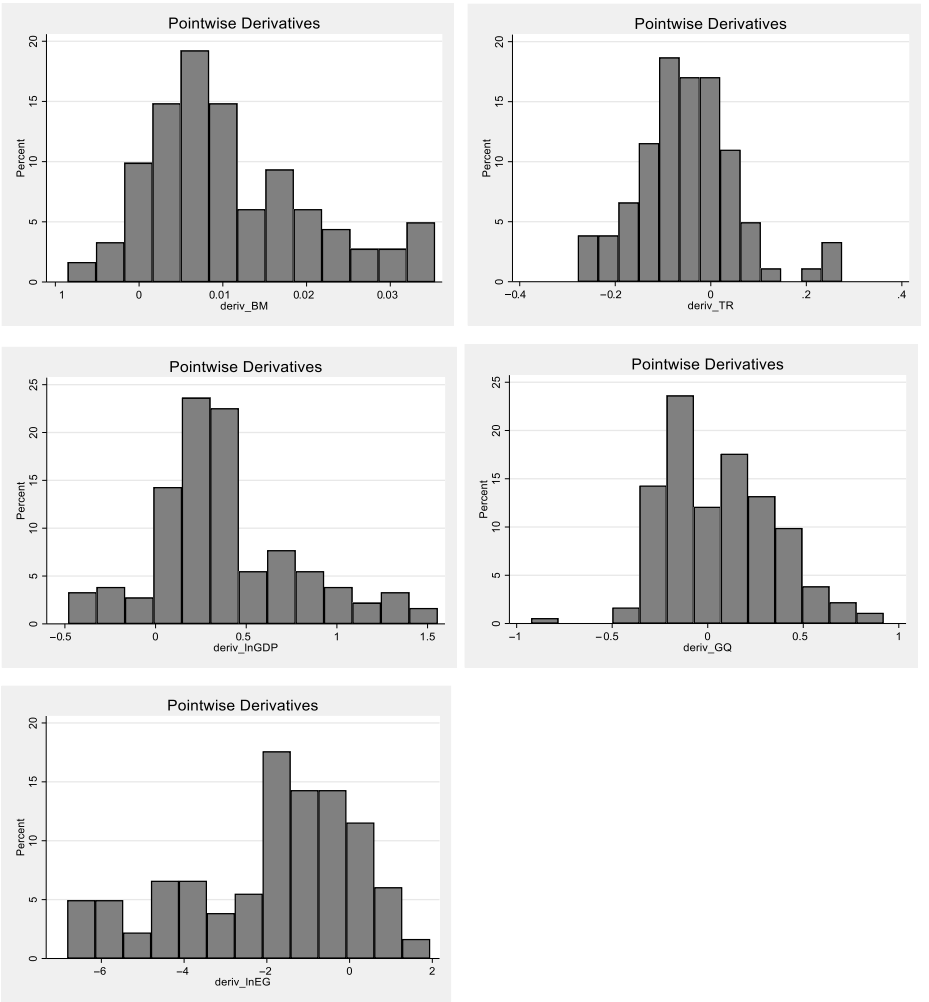
	Dependent variable: innovation									
	Emerging Asian economies					Advanced Asian economies				
Variables	Avg.	Std. err.	P25	P50	P75	Avg.	Std. err.	P25	P50	P75
BM	0.010***	0.001	0.003	0.008	0.016	−0.002***	0.000	−0.000	0.001	0.005
TR	−0.049***	0.011	−0.110	−0.055	0.002	0.051***	0.006	−0.121	−0.031	0.003
lnGDP	0.388***	0.038	0.153	0.321	0.579	0.297***	0.067	0.005	0.367	0.662
GQ	0.063*	0.034	−0.179	0.040	0.270	0.363***	0.041	−0.653	−0.375	−0.129
lnEG	−1.936***	0.194	−3.467	−1.470	−0.330	0.634	0.186	−1.813	−0.713	0.792
R^2	0.980					0.988				
Lambda	0.143					0.180				
Tolerance	0.182					0.130				

Notes: ***; * are significant at 1 and 10% levels, respectively
Source: Authors' own calculation by using STATA 17

encouraging borrowing and investment in R&D, these policies support initiatives that drive innovation. According to empirical studies like Yin *et al.* (2022), lower borrowing rates encourage businesses in developing nations to take on riskier and more creative ventures, which raises the degree of innovation overall. The situation is different for the advanced Asian economies, where a possible misallocation of resources might be the cause of the negative correlation between monetary policy and innovation. Low-interest rate strategies may cause capital to be diverted from profitable projects to speculative ones, which can stifle innovation efforts. This idea is supported by research by Bhowmik *et al.* (2023), which demonstrates how extended accommodating monetary policies in advanced countries may lead to zombie enterprises and cause a resource diversion from more creative and productive businesses to low return/productive projects. As a result, the complex interaction between monetary policy and innovation emphasises how important it is to take into account a variety of economic factors when creating policy plans.

Between emerging and advanced Asian economies, the association between fiscal policy and innovation shows an intriguing difference, which reflects the complex interaction between governmental intervention and innovation processes. Fiscal policy that prioritises increased taxes and reduced government expenditure appear to have a negative effect on innovation in emerging Asian economies. Such regulations may restrict expenditures made by the private sector in R&D, which would limit creative endeavours. According to the empirical studies like Chen and Wen's (2020), high taxes and a lack of financial support for activities connected to innovation may result in lower levels of inventive production in emerging countries. On the other hand, our study observes that fiscal policy and innovation are positively correlated in advanced Asian economies. The R&D grants, incentives and public–private partnerships are frequently funded by governments in industrialised countries to promote innovation. This idea is supported by Miguelez and Fink (2013), which shows that financial incentives for R&D have a favourable impact on innovation outcomes in the developed world. The disparate nature of these relationships emphasises the necessity for customised policy strategies that take into account the distinctive economic and developmental environments of emerging and advanced Asian economies.

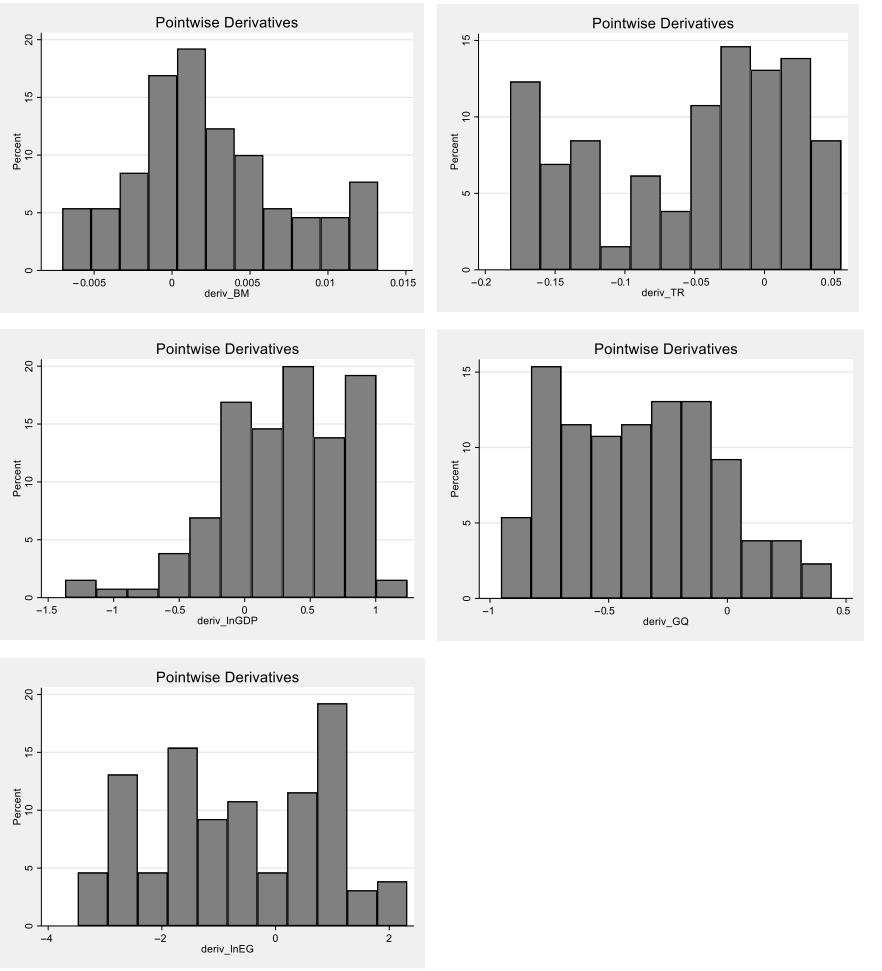
In both emerging and advanced Asian economies, the association between economic growth and innovation reveals a recurrent pattern of favourable effect, highlighting the crucial significance of vigorous economic expansion in encouraging inventive activity. A faster rate of economic growth in both the Asian economies can foster an atmosphere that is favourable for innovation by presenting more resources, market possibilities and better infrastructure.



Source: Authors' own calculation by using STATA 17

Figure 3. Pointwise derivatives of emerging Asian economies

According to Li *et al.* (2021)' study, a growing economy increases demand for cutting-edge goods and services, which forces businesses to increase their R&D spending to keep up with consumer demand. Similar to this, in industrialised economies, economic expansion spurs innovation by increasing investment capacity and driving up customer demand for new products. The study by Shahbaz *et al.* (2020) shows that increasing R&D spending and a supportive entrepreneurial ecosystem result from prolonged economic development, which raises the amount of innovation. This mutually reinforcing link between economic development and innovation is shown by a shared positive association, highlighting the significance of supporting economic development to encourage inventive endeavours.



Source: Authors' own calculation by using STATA 17

Figure 4. Pointwise derivatives of advanced Asian economies

An intriguing dichotomy between emerging and advanced Asian economies may be seen in the relationship between governance quality and innovation. Due to difficulties of enforcing intellectual property rights, administrative roadblocks and insufficient protection of inventive endeavours, weaker governance quality tends to hinder innovation in emerging Asian economies. Studies like those by Chakrabarti *et al.* (2020), which contend that poor governance might discourage investment in R&D and restrict innovation potential, lend credence to this idea. In contrast, better governance in advanced Asian economies drives innovation by providing open and transparent rules, effective protection of intellectual property rights and a favourable business climate. According to research by Hall and Jones (2019), improved governance increases the protection of intellectual property, lowers uncertainty and stimulates innovation. With well-

functioning governance institutions in place act to spur innovation in the advanced Asian economies while creating difficulties in emerging Asia. This contrasting influence highlights the crucial importance of governance quality in determining innovation dynamics.

The influence of economic globalisation on innovation demonstrates disparities between emerging and advanced Asian economies. Economic globalisation has a detrimental impact on innovation in emerging Asian economies for a variety of reasons. Increased competition from global players may lead to a preference for copying current technology rather than engaging in hazardous and costly creative activities. Furthermore, the unequal distribution of advantages from globalisation may worsen income inequality, restricting access to education and research possibilities for a major percentage of the population and thereby stifling innovation. According to Duan *et al.* (2021), globalisation may shift resources away from innovation-related investments in emerging Asian economies. In contrast, economic globalisation is frequently used as a driver of innovation in advanced Asian economies. It exposes businesses to a variety of markets, technology and concepts, encouraging knowledge transfer and international cooperation. In turn, this encourages innovation by increasing R&D spending and promoting the use of new technology. Economic globalisation boosts competitiveness and spurs innovation in technologically sophisticated industries, which results in improved productivity and economic development, according to research by Blanchard *et al.* (2017). Finally, it is important to note that some existing studies support our findings and others do not support it. This is largely due to the sample countries and methodological differences used in the existing studies.

However, both emerging and advanced Asian countries may benefit significantly from the implications of these results in terms of designing their policy. The fact that broad money and economic growth in emerging Asian economies are positively correlated, highlighting the need to preserve a stable and supportive monetary environment to promote economic growth and boost capacity for innovation. The apparent negative association may be reversed by efforts to simplify tax collection regulations and raise governance standards, creating an atmosphere that is favourable to innovation. In addition, given that the findings raise the possibility of a trade-off with innovation, economic globalisation should be approached with caution. Prioritising initiatives that support domestic innovation ecosystems and take advantage of economic globalisation would help uplift local innovation efforts rather than harming them.

The encouragingly favourable correlations between tax revenue, economic growth, governance quality and economic globalisation with innovation in advanced Asian economies provide a clear policy roadmap. To support innovation-led growth, governments should keep funding R&D projects, encourage economic expansion and enhance governance structures. The explored inverse association between total innovation and broad money indicates the requirement for a sensible monetary administration to avoid distortions that can obstruct innovation.

In the end, these policy ramifications highlight the complex interaction of numerous elements in stimulating innovation, needing a comprehensive and context-specific strategy adapted to specific systems or features of each economy. Both emerging and advanced Asian economies may use the power of innovation as a driver of sustainable and equitable economic growth by carefully coordinating monetary, fiscal and governance policies.

7. Conclusion

This study aims to offer insight into the factors that influence the innovation in both emerging and advanced Asian economies. Our study uses reliable methodologies, such as the Driscoll–Kraay estimator, PCSEs and KRLS, to carry out an extensive long-run empirical analysis with a carefully chosen sample of seven emerging and five advanced Asian countries based on MSCI classification and data accessibility over the time period from 1990 to 2021. The findings demonstrate an intricate relationship of different variables in affecting innovation

trends. Notably, broad money and economic growth exhibit a positive impact on innovation, whereas tax revenue, governance quality and economic globalisation reveal a negative relationship for emerging Asian economies. Our findings illustrate a complicated dynamic in advanced Asian economies where tax revenue, economic growth, governance quality and economic globalisation together boost innovation. Broad money and overall innovation, however, are associated negatively in advanced Asian economies. These findings highlight the subtle linkages of macro policy variables influencing innovation trends in both emerging and advanced Asian economies, providing insightful information for stakeholders and policymakers looking to support sustainable and effective innovation policies in the long run.

Notes

1. Emerging Asian economies: China, India, Indonesia, Malaysia, The Philippines, Thailand, Vietnam; Advanced Asian economies: Australia, Japan, Korea, New Zealand, Singapore. The International Monetary Fund (IMF) supported such economies' classifications.
2. The natural logarithm (ln) is used to reduce the heterogeneity in the data set.
3. The governance quality index has been made by using principal component analysis by combining variables like control of corruption, government effectiveness, political stability and absence of violence/terrorism, regulatory quality, rule of law, voice and accountability.
4. We have taken the natural logarithm (ln) of innovation, GDP per capita and economic globalisation; the rest of the variables are either in percentage form or negative, therefore, we are unable to take natural logarithm (ln).

References

Afonso, A. and Furceri, D. (2010), "Government size, composition, volatility and economic growth", *European Journal of Political Economy*, Vol. 26 No. 4, pp. 517-532.

Ahrorjon, A. and Gafurov, X. (2023), "IQTISODIY SIYOSATNING RIVOJLANISHIDA FISKAL VA PUL-KREDIT SIYOSATI", Qo 'qon universiteti xabarnomasi, pp. 310-313.

Annicchiarico, B. and Rossi, L. (2013), "Optimal monetary policy in a new Keynesian model with endogenous growth", *Journal of Macroeconomics*, Vol. 38, pp. 274-285.

Arestis, P. (2015), "Coordination of fiscal with monetary and financial stability policies can better cure unemployment", *Review of Keynesian Economics*, Vol. 3 No. 2, pp. 233-247.

Bhowmik, R., Durani, F., Sarfraz, M., Syed, Q.R. and Nasseif, G. (2023), "Does sectoral energy consumption depend on trade, monetary, and fiscal policy uncertainty? Policy recommendations using novel bootstrap ARDL approach", *Environmental Science and Pollution Research*, Vol. 30 No. 5, pp. 12916-12928.

Blanchard, O., García-Santana, M. and López-Salido, J.D. (2017), "International shocks and domestic prices: how large are strategic complementarities?" *The Quarterly Journal of Economics*, Vol. 132 No. 3.

Brambor, T., Clark, W.R. and Golder, M. (2006), "Society for political methodology", *Political Analysis*, Vol. 14 No. 1, pp. 63-82.

Chakrabarti, A.K., Gupta, N. and Kumar, R.R. (2020), "Governance quality, institutions, and innovative entrepreneurship", *Economic Modelling*, Vol. 93, pp. 374-387.

Chen, K.X.Z. and Wen, Y. (2020), "Tax policy and endogenous innovation: evidence from cross-country firm-level data", *Journal of Monetary Economics*, Vol. 116, p. 200-216.

Chugunov, I., Pasichnyi, M. and Nepytaliuk, A. (2019), "Macroeconomic effects of inflation targeting in advanced and emerging market economies", available at: https://ssrn.com/abstract=3606981

Coccia, M. (2018), "Optimization in R&D intensity and tax on corporate profits for supporting labor productivity of nations", *The Journal of Technology Transfer*, Vol. 43 No. 3, pp. 792-814.

Czarnitzki, D., Hünermund, P. and Moshgbar, N. (2020), "Public procurement of innovation: evidence from a German legislative reform", *International Journal of Industrial Organization*, Vol. 71, p. 102620.

Davis, C. and Tomoda, Y. (2018), "Competing incremental and breakthrough innovation in a model of product evolution", *Journal of Economics*, Vol. 123 No. 3, pp. 225-247.

Driscoll, J.C. and Kraay, A.C. (1998), "Consistent covariance matrix estimation with spatially dependent panel data", *Review of Economics and Statistics*, Vol. 80 No. 4, pp. 549-560.

Duan, X., Gunay, S. and Wei, Z. (2021), "The impacts of economic globalization on technological innovation in emerging economies", *Technovation*, Vols 98/99, p. 102314.

Fasnacht, D. (2018), "Open innovation in the financial services", In *Open Innovation Ecosystems. Management for Professionals*, Springer, Cham, doi: 10.1007/978-3-319-76394-1_4.

Feldman, M.P., Link, A.N. and Siegel, D.S. (2012), *The Economics of Science and Technology: An Overview of Initiatives to Foster Innovation, Entrepreneurship, and Economic Growth*, Springer, New York, NY.

Gompers, P.A., Gornall, W., Kaplan, S.N. and Strebulaev, I.A. (2020), "How do venture capitalists make decisions?" *Journal of Financial Economics*, Vol. 135 No. 1, pp. 169-190.

Hainmueller, J. and Hazlett, C. (2014), "Kernel regularized least squares: reducing misspecification bias with a flexible and interpretable machine learning approach", *Political Analysis*, Vol. 22 No. 2, pp. 143-168.

Hall, R.E. and Jones, C.I. (2019), "The value of life and the rise in health spending", *The Quarterly Journal of Economics*, Vol. 134 No. 4, pp. 1717-1760.

Hausmann, R., Santos, M.Á., Tudela Pye, J., Li, Y. and Grisanti, A. (2021), "Loreto's hidden wealth: economic complexity analysis and productive diversification opportunities", CID Faculty Working Paper Series.

Jarque, C.M. and Bera, A.K. (1980), "Efficient tests for normality, homoscedasticity and serial independence of regression residuals", *Economics Letters*, Vol. 6 No. 3, pp. 255-259.

Keller, W. (2010), "International trade, foreign direct investment, and technology spillovers", In *Handbook of the Economics of Innovation*, North-Holland, Amsterdam, Vol. 2, pp. 793-829.

Li, L., Fan, Z., Xiong, K., Shen, H., Guo, Q., Dan, W. and Li, R. (2021), "Current situation and prospects of the studies of ecological industries and ecological products in eco-fragile areas", *Environmental Research*, Vol. 201, p. 111613.

Lukianenko, I. and Dadashova, P. (2016), "Monetary and fiscal policies interaction in Ukraine", available at: https://ekmair.ukma.edu.ua/handle/123456789/11721

Marin, A. and Bell, M. (2006), "Technology spillovers from foreign direct investment (FDI): the active role of MNC subsidiaries in Argentina in the 1990s", *The Journal of Development Studies*, Vol. 42 No. 4, pp. 678-697.

Miguelez, E. and Fink, C. (2013), "Foreign direct investment, fiscal incentives, and innovation in developing countries", *International Tax and Public Finance*, Vol. 20 No. 5, pp. 723-752.

Mishchenko, V.I. and Lon, I.M. (2017), "Rol monetarnoho rehuliuvannia u stymuliuvanni ekonomichnoho rozvytku [The role of monetary regulation in stimulating economic development]", *Finansy Ukrainy*, No. 4, pp. 75-93.

Mollick, A.V., Cabral, R. and Carneiro, F.G. (2011), "Does inflation targeting matter for output growth? Evidence from industrial and emerging economies", *Journal of Policy Modeling*, Vol. 33 No. 4, pp. 537-551.

Moser, P. (2013), "Patents and innovation: evidence from economic history", *Journal of Economic Perspectives*, Vol. 27 No. 1, pp. 23-44.

Muñoz, F.F. (2021), "Inventing ideas: patents, prizes, and the knowledge economy, by Zorina Khan Oxford University Press (2020), 462 pp. ISBN: 978-0190936075 (hb,£64.00); 978-0190936082 (pb, £19.99); Kindle ed.(£16.66)", available at: https://doi.org/10.1093/oso/9780190936075.001.0001

Nonyane, K.B. (2024), "Disruptive innovation and the long run impact of mobile lending on bank sustainability in Zambia and Kenya", available at: https://hdl.handle.net/10539/38828

Pesaran, M.H. (2004), "General diagnostic tests for cross section dependence in panels", *Cambridge Working Papers*, Economics, Vol. 1240 No. 1, p. 1.

Reynard, S. (2007), "Maintaining low inflation: money, interest rates, and policy stance", *Journal of Monetary Economics*, Vol. 54 No. 5, pp. 1441-1471.

Shahbaz, M., Nasir, M.A., Hille, E. and Mahalik, M.K. (2020), "UK's net-zero carbon emissions target: investigating the potential role of economic growth, financial development, and R&D expenditures based on historical data (1870–2017)", *Technological Forecasting and Social Change*, Vol. 161, p. 120255.

Simionescu, M., Lazányi, K., Sopková, G., Dobeš, K. and Adam, P.B. (2017), "Determinants of economic growth in V4 countries and Romania", *Journal of Competitiveness*, Vol. 9 No. 1, pp. 103-116.

Yin, H.T., Chang, C.P. and Wang, H. (2022), "The impact of monetary policy on green innovation: global evidence", *Technological and Economic Development of Economy*, Vol. 28 No. 6, pp. 1933-1953.

Further reading

Bailey, D. and Katz, J.N. (2011), "Implementing panel-corrected standard errors in R: the pcse package", *Journal of Statistical Software*, Vol. 42, pp. 1-11.

Bloom, N., Lemos, R., Sadun, R., Scur, D. and Van Reenen, J. (2016), "The new empirical economics of management", *Journal of the European Economic Association*, Vol. 14 No. 1, pp. 1-37.

Song, F. and Thakor, A.V. (2012), "Financial system architecture and the co-evolution of banks and capital markets", *Journal of Financial Intermediation*, Vol. 21 No. 4, pp. 437-470.

About the authors

Shreya Pal is currently an Assistant Professor at the Indian Institute of Plantation Management in Bengaluru, India. Her research area includes international trade and environment, international finance and macroeconomics. She has published papers in the *Journal of Public Affairs*, *Asia-Pacific Financial Markets* and the *International Journal of Economic Policy Studies*. Shreya Pal is the corresponding author and can be contacted at: share2shreya@gmail.com

Mantu Kumar Mahalik is currently an Associate Professor of economics at the Department of Humanities and Social Sciences, Indian Institute of Technology Kharagpur, West Bengal, India. He works in the fields of open economies, resources and energy economics and real estate economics. He has published papers in the *Journal of Real Estate Finance and Economics*, *Journal of Property Research*, *Asia-Pacific Financial Markets*, *Journal of Economic Policy Reforms*, *Applied Economics*, *Applied Economics Letters*, *Australian Economic Review*, *Technological Forecasting and Social Change*, *Journal of Economic Change and Restructuring*, *The Journal of International Trade & Economic Development*, *Economic Analysis and Policy*, *Renewable Energy-An International Journal*, *Journal of Cleaner Production*, *Energy Economics*, and *Energy Policy*.

Hrushikesh Mallick is currently a Professor of economics at the Centre for Development Studies, Thiruvananthapuram, India. He works in the fields of open economies, resources and energy economics and real estate economics. He has published papers in the *Journal of Economic Change and Restructuring*, *Applied Economics*, *Energy Economics*, *Technological Forecasting and Social Change*, and *Energy Policy*.