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The interconnection between fiscal policy and foreign direct investment with R&D: Insights from East Asian countries

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Abstract. As a technological powerhouse, Asia should not be overlooked. The region has been responsible for 87% of patent filings, 43% of startup investment, 51% of expenditures on research and development, and 52% of the global growth in tech company revenues during the past ten years. Within this framework, the current paper investigates the impact of fiscal policy and FDI on research and development in East Asian countries during the last 20 years. It further analyses the direction and shocks of these impacts. The methodological framework included theories of public policy and R&D management, the concept of absorptive capacity, etc. The database includes fiscal policy, FDI, domestic credit, and R&D data for 2000–2020. As a result, the paper adopted Autoregressive Distributed Lag (ARDL) and Granger causality tests to capture the short-run and long-run dynamic relationship among the variables. Next, we utilized Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) models to capture the cointegration between fiscal policy, FDI, domestic credit, and R&D. In light of this, the research revealed that the region's fiscal policy and FDI outflows had a negative impact on the spending on R&D. Conversely, the results showed that FDI inflows and domestic loans provided to the private sector had a large favourable influence on research and development. It is also crucial to emphasize that the ARDL model produced results that were equivalent to the FMOLS and DOLS. Lastly, the Granger causality demonstrated a one-way causal relationship between fiscal policy and research and development. The study will help policymakers on how to promote R&D and enhance a country's competitiveness in the global economy by paying enough attention to their fiscal policy. It will also assist policymakers to develop strategies to attract FDI that can benefit their R&D sector.

Keywords: research and development (R&D); fiscal policy; foreign direct investment (FDI); domestic credit; East Asia.

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Развитие R&D в странах Восточной Азии: влияние фискальной политики и инвестиций

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Аннотация. В последние годы на долю стран Восточной Азии приходится 87 % патентов, 43 % инвестиций в стартапы, 51 % расходов на R&D и 52 % всех доходов технологических компаний. Сохранение статуса Восточно-Азиатского региона как одного из локомотивов мирового технологического развития тесно связано с государственной экономической политикой и инвестиционным климатом. Статья посвящена исследованию влияния фискальной политики и прямых иностранных инвестиций (ПИИ) на развитие сферы научно-исследовательских разработок (R&D) в странах Восточной Азии в 2000–2020 гг. Методологической основой исследования послужили теория государственного управления, R&D-менеджмента и др. Информационная база включает данные о фискальной политике, ПИИ, внутреннем кредитовании и R&D в Восточно-Азиатском регионе в период 2000–2020 гг. При обработке данных использовались методы регрессионного анализа и распределенного лага (ARDL), а также тест на причинно-следственные связи Грэнджера, что в совокупности позволило описать кратко- и долгосрочную динамическую связь между указанными переменными. Для выявления коинтеграции применялись модифицированный метод наименьших квадратов (FMOLS) и динамический метод наименьших квадратов (DOLS). Согласно результатам исследования, фискальная политика региона и отток ПИИ оказывают негативное влияние на уровень расходов на R&D. Среди факторов, имеющих значительное положительное влияние на R&D, – приток ПИИ и рост внутреннего кредитования предприятий частного сектора. При этом результаты модели ARDL эквивалентны результатам, полученным с помощью методов FMOLS и DOLS. Тест Грэнджера показал наличие однонаправленной причинно-следственной связи между фискальной политикой и R&D, что свидетельствует о решающем влиянии данного фактора на развитие научных исследований. Полученные результаты могут использоваться органами государственной власти при формулировании стратегий продвижения R&D и повышения конкурентоспособности стран на мировой арене посредством регулирования фискальной политики, а также при разработке стратегий привлечения ПИИ для финансирования научно-исследовательского сектора.

Ключевые слова: R&D; фискальная политика; прямые иностранные инвестиции (ПИИ); внутреннее кредитование; Восточная Азия.

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INTRODUCTION

Differences in wealth and economic growth between nations today are based on factors such as the availability of qualified workers, natural resources, and the phenomena of technological advancement [Smith, 1994]. Despite being at various stages of growth, countries share comparable macroeconomic objectives [Can, Doğan, Değer, 2017]. As a result, nations work to create novel strategies that will allow them to play a crucial role in international affairs and guarantee long-term economic success. Thus, world nations must encourage research and development efforts in order to meet their growth objectives and maintain sustainable economic growth. An important factor that is a crucial element with the potential to boost economic and globalization trends is investing in research and development (R&D) [Lychagin et al., 2016].

Many academics highlighted the significance of R&D investment. For instance, [Romer, 1990; Grossman, Helpman, 1991; Howitt, Aghion, 1998] claimed that a rise in the amount of money spent on R&D has a major impact on stabilizing economic growth. This implies that R&D and innovation efforts are the primary engines of economic growth in developed nations. It is obvious that nations that enhance and maintain their share of R&D spending might make substantial advances. For instance, it has been noted that East Asian nations known as the Asian Tigers can achieve sustainable prosperity when they prioritize R&D efforts. Investments in R&D have a variety of effects on development. These approaches include innovation, accumulating wealth, and raising the standard of human capital. Additionally, nations must change to keep up with the global competition. Investments in R&D are therefore closely tied to ensuring that countries achieve sustained growth [Arora, Belenzon, Patacconi, 2018].

Technological advancement is one of the essential strategies for attaining "clever, balanced, and inclusive growth," according to the Europe futuristic strategy. It emphasizes the need to increase R&D spending in the European Union to 3% of GDP and views research as a prerequisite for innovation. The EU is anticipated to be better positioned to address significant long-term concerns associated with growth, competitiveness, and ecological sustainability with more investment opportunities in R&D and innovation. Additionally, the Union views that greater expenditures in R&D will aid in managing Europe's urgent and short-term issues brought on by the global financial crisis [Kokko, Tingvall, Videnord, 2015].

Only a few of the factors discussed in the literature include the calibre of formal schooling, labour market effectiveness, entrepreneurial intention, trade openness, accessibility to venture capital, and availability of infrastructure, particularly in Europe and the USA. Consequently, not enough light is shed on the East Asian region because it has only recently experienced a new wave of digitalization and technological advancement in comparison with Western countries consisting of the majority of the OECD nations. In addition, previous studies have not considered the role of fiscal policy in promoting research and development as well the role of domestic credit allocated to private enterprises in order to encourage R&D.

Accordingly, the current study is relevant for several reasons. Firstly, East Asian countries have been experiencing a rapid economic growth, which is partly attributed to foreign direct investment (FDI) and research and development. However, the relationship between fiscal policy and FDI in R&D is complex and multifaceted, and there is a need for a deeper understanding of how these factors interact. Secondly, fiscal policy plays a crucial role in attracting FDI and promoting R&D. The study will provide insights into how fiscal policy can be used to facilitate foreign direct investment and promote research and development in the East Asian region. Thirdly, understanding the interconnection between fiscal policy, FDI and R&D is important for policymakers in East Asian countries as they seek to promote sustainable economic growth and development. By identifying the aspects that facilitate or hinder the interconnection between these factors, policymakers can develop effective policies that promote foreign direct investment and research and development. Last, while previous studies have examined each of the three factors individually, the current study provides a holistic view and, using the evidence from East Asian economies, analyses how these factors interact with each other.

The study addresses national and regional levels of policy-making. The findings can be used to inform the development of national policies that promote FDI and R&D in East Asia. Additionally, the study can also inform regional policies that promote cross-border investments and collaborations in research and development in the region.

From this perspective, one of the most significant variables influencing the spread of cross-border technology can be viewed as domestic finance provided to enterprises with a focus on R&D, FDI, as well as allocating a specific portion of the national budget to technological improvement. Nevertheless, many countries' FDI activities in R&D require a variety of prerequisites, namely human resources, infrastructure, the availability of high-quality institutions, intellectual property rights, etc. In this regard, industrialized nations are in a far better position compared to others.

In this context, the purpose of this study is to establish the way, in which FDI and fiscal policy affect R&D. To that end, we examine the link between R&D expenditure, domestic credit provided to the private sector, fiscal policy, and FDI inflows and outflows related to a data set of East Asian nations for the past 20 years, which are the finest representation in terms of technological advancement.

The remaining sections of the article are structured as follows. In Part 2, the pertinent literature on the relationship between fiscal policy, FDI, and research and development are reviewed. Part 3 discusses the resources and conceptual framework. The results are displayed in Section 4. Lastly, Part 5 presents the debate, policy implications, and conclusion.

LITERATURE REVIEW

Innovation and technological progress continue to be important drivers of economic growth. Interestingly enough that a key metric used by nations to evaluate the pace of their economic expansion and market dominance is through investing in research and development. Oftentimes, investments have an impact on sustainable economic growth via research, accumulation of capital, and human capital [Maradana et al., 2017]. Research and development is a unique scientific effort done to advance the boundaries of knowledge, including man's understanding, social knowledge, and civilization, and the utilization of this pool of expertise to invent new things or boost production and efficiency [Solomon, van Klyton, 2020].

Foreign direct investment has significantly increased in East Asian countries over the past few years, which has been essential to the region's economic growth. Yet, a number of variables, such as the political climate in the host nations, affect how FDI affects economic growth and technological advancement. Particularly when it comes to fiscal policy, FDI's effects on innovation and economic development may be significantly shaped [Razzaq, An, Delpachitra, 2021].

A number of East Asian nations have put in place measures to encourage investment and innovation. For instance, Singapore has adopted a number of tax breaks and grants to promote R&D spending and innovation in important industries. Similar measures have been taken by South Korea, notably tax breaks for R&D investment and assistance for university-industry partnerships to encourage knowledge transfer and improve the absorptive potential of indigenous businesses [Hammar, Belarbi, 2021].

The policy climate still has a lot of room for improvement, which might restrict the influence of FDI on research and economic development. For instance, many East Asian nations still struggle to provide the institutional framework required to encourage innovation, such as strong safeguards for intellectual property and easy entry to capital for start-up businesses. In order to encourage information transmission and technology transfer, there is also a need for better cooperation and coordination between government organizations, academic institutions, and the commercial sector [Cai, Boateng, Guney, 2019].

The role of fiscal policy in fostering innovation and economic growth in East Asia has been underlined in recent research. For instance, Nguyen and Chang [2020] discovered that financial advantages for R&D investment in Vietnam had a favourable effect on firm-level innovation. Likewise, Liang et al. [2021] found that tax breaks for high-tech companies had a positive impact on innovation in China. These results suggested that fiscal policy may significantly influence economic innovation and expansion in East Asian nations.

The importance of FDI in encouraging the use of digital technology in East Asia has also been emphasized in recent research. For instance, according to Hong et al. [2021], FDI had a beneficial effect on the use of digital technology by enterprises in China. Similar findings were made by Driffield et al. [2021], who revealed that FDI had a favourable effect on the deployment of Industry 4.0 technology in South Korean businesses.

The procedure for enhancing economic growth and productivity rates depends heavily on innovation. R&D efforts in general are the essential driver of technological advancement [Howitt, Aghion, 1998]. R&D initiatives, however, confront financial limitations in an underdeveloped capital market, and many businesses view the absence of external financial backing as the primary impediment to R&D efforts [David, Hall, Toole, 2000].

The more rapidly a country's economy is growing, the better the conditions for it to invest in R&D, promote innovation and foster wealth and expansion. Alene [2010] discovered indications that higher R&D spending helped African agriculture expand and become more productive, but it did not look at the inverse relationship that economic growth drives up R&D spending. Economic development was cited as a key predictor of R&D investment by Wang [2010], who examined factors influencing R&D spending in 26 OECD nations. The study looked at the income growth rate as a factor in determining R&D spending, but its conclusions could not be applied to the ASEAN countries. Bozkurt [2015] also identified a unidirectional association between economic development and R&D spending in Turkey, but did not offer any evidence that this relationship existed across other nations.

Another example is the Chinese government, which, among other current policies, provides tax discounts for renewable energy production, VAT rebates, commercial tax reductions, and R&D tax credits. Reduction in taxes benefits businesses since it lowers the cost of expenditure and improves informal investment sources, increasing their working capital alternatives. Cash flows, which allow sustainable energy firms to control their resource flows, are a prerequisite for discretionary finance. When a business uses tax benefits to support its green energy initiatives, it has easier access to cash, which increases the efficiency of renewable energy technologies and frees up funds [Sun et al., 2020]. So, one significant result of applying for subsidies is that it will reinforce the technological monopolies of renewable energy firms, encourage them to invest in R&D and technology, and therefore increase performance and unanticipated profits [Baloch et al., 2020].

Most lately, Bhattacharya et al. [2017] revealed that invention production (evaluated by patent-based indicators; a surrogate for policy uncertainty) declined considerably across 43 nations a year following elections. They claimed that political uncertainty reduces companies' incentives to develop and that this effect is more pronounced for companies operating in technology industries. There are also claims that certain UK pharmaceutical companies have been looking to hire bright researchers and healthcare experts due to uncertainty about the direction of policies following the Brexit decision [Golding, Waring, 2018]. Research from a significant UK government poll of SMEs revealed that bigger, creative, export-focused, and service-focused SMEs saw Brexit as the biggest barrier to the success of their company [Brown, Liñares-Zegarra, Wilson, 2018].

The efficiency of R&D tax incentives has already been supported by data for the UK [Guceri, 2017] and Italy [Cantabene, Nascia, 2014]. According to research by Bozio et al. [2015], R&D government subsidies have a favourable influence on company R&D in France. However, the anticipated growth in R&D expenditures is less than the lost tax income resulting from the policy's adoption [Mulkay, Mairesse, 2013]. Spain has inconsistent performance. According to the first group of research, R&D government subsidies only have a somewhat favourable influence on small businesses [Corchuelo, Martnez-Ros, 2010] or are useless for increasing business R&D [Romero-Jordán et al., 2014]. More lately, Labeaga, Martinez-Ros and Mohnen [2014] have demonstrated that changes in R&D fiscal measures have a notable negative impact on Spanish SMEs. R&D tax breaks are more beneficial for SMEs than big enterprises in Canada [Baghana, Mohnen 2009].

Using a representative sample of small and medium-sized privately listed firms, Tong and Chen [2016] investigated the influence of government subsidies on R&D investment in corporate entities from the standpoint of political ties. The findings demonstrate a strong correlation between government subsidies received by private businesses and the presence or absence of a political tie. Regardless of one's political orientation, securing government funding increases investment in research and development.

Additionally, Griffith, Redding and Reenen [2004] asserted that there are two stages of research and development: the first stage involves fostering innovation, and the second process involves integrating prior discoveries. Employing panel data of industries from 12 OECD nations, this link was investigated, and it was established that R&D was crucial in technological catch-up and innovation statistically and economically. Additionally, Wakelin [2001] examined the relationship between increased productivity and R&D spending using data from 170 organizations and discovered that they were favourably associated. To investigate the nature of the relationship between R&D and economic growth at the national level, Sadraoui and Zina [2009] used a generalized method of moments and panel data survey of 23 nations during a 13-year period (1992–2004). For the countries studied, they discovered a strong and positive correlation between R&D and economic growth. In order to evaluate the relationship between expenditure in research and development and economic expansion, Genc and Atasoy [2010] also utilized the granger-causality technique on yearly data for 34 countries from 1997 to 2008. Their results showed that there was simply one significant unidirectional influence of R&D activities on economic progress.

Maneejuk and Yamaka [2020], looking at both developing and developed nations, noted that innovation is a significant source of new technologies and a driving force behind economic progress. Additionally, relying on the Granger causality test applied to distinct economic circumstances, Tuna, Kayacan and Bektaş [2015] claim that there does not appear to be a dynamic connection between R&D expenditures and economic growth over the long run. The reason could be that certain nations are still in the early stages of development; therefore, R&D expenses will be greater and are rising. In light of this, R&D operations do take a longer period of time to produce results. The time frame may last for two or three decades. Consequently, it is stated that nations seeking to invest in R&D activities ought to accomplish this from a long-term perspective while taking into account equally quality and quantity requirements [Edquist, Henrekson, 2017]. Generally, developed economies gain the greatest advantage from R&D activities due to their ability to afford and spend more money on them. Additionally, these nations have high incomes. Technological advancements are connected to research and development efforts in such a manner that they promote economic development. R&D evolves in the context of emerging nations (such as Turkey) from being a beneficiary of funds to a crucial component of economic sustainability [Xiong et al., 2020]. R&D operations must, therefore, improve. Technological ad-

vancement is the result of R&D, which also increases productivity and competitiveness. In this situation, spending on research and development would enable a nation to become independent economically and create its very own technology [Mehmood, Askari, Saleem, 2022].

There has been significant progress in earlier studies on the factors that influence research and development. Yet it has also raised a number of significant issues that remain unaddressed. To substantially contribute to the growing body of knowledge, these elements are incorporated in the current study. First, while there is a significant body of literature on the impact of fiscal policy and FDI on R&D, there is a limited focus on East Asian countries. Most of the existing literature focuses on developed economies, such as the US and European countries, with only a few studies specifically examining the East Asian region. Second, none of the preceding studies used different models such as ARDL, sensitivity models, and Granger causality in one paper to determine the relationship between the selected variables. Third, the selected variables such as FDI and fiscal policy in proportion to R&D were never used together before in the same model, hence, eliminating the possibility of unbiased results. Fourth, the paper extends the results by carrying out an impulse response function (IRF), which will provide us with concrete evidence of how the shocks of independent variables affect research and development.

METHODOLOGY AND DATA

The paper employs annual time series data varying from 2000 to 2020 with the regard to East Asian countries as a focus region. The reason behind selecting this territory is that many East Asian nations have been successful in promoting R&D through technology transfer, which involves acquiring technology from foreign firms and adapting it to local needs. The theoretical framework for examining the relationship between technology transfer and R&D could be based on the concept of absorptive capacity, which suggests that firms may need to have the ability to absorb and utilize new technologies effectively in order to benefit from technology transfer. What is more, many East Asian countries have employed state intervention in promoting R&D through policies such as direct funding, tax incentives, and industrial policies. The theoretical framework for examining the relationship between state intervention and R&D could be based on the concept of market failure, which suggests that the private sector may underinvest in R&D due to externalities or other market imperfections, and therefore may require government intervention to ensure adequate funding and support. With that in mind, the measured variable is the research and development expenditure (% of GDP), which serves as a proxy for measuring technological advancement. The progress of technological advancement hypothesis is supported by using fiscal policy as a proxy for final consumer expenditure (current US dollars), which represents the total amount of money East Asian countries allocate to their various sectors. Domestic credit is considered a proxy for the needed financial resources that are provided to the private sector. Additionally, foreign direct investment inflows and outflows were the relevant control variables. The theoretical framework for the selected variables in this study is derived from the fact that they have a direct link with R&D. For instance, FDI can be an important source of capital for R&D activities, particularly in emerging markets where domestic funding sources may be limited. The theoretical framework for examining the relationship between FDI and R&D could be based on the concept of knowledge spillovers, which suggests that FDI can lead to the transfer of knowledge, technology, and expertise from foreign firms to domestic firms, which can help to stimulate innovation and R&D activities [Erdal, Göçer, 2015]. Next, access to credit is a critical factor in promoting R&D, as it enables firms to invest in new technologies and innovation. The theoretical framework for examining the relationship between domestic credit to the private sector and R&D could be based on the concept of financial constraints, which suggests that firms may face barriers to accessing credit, particularly in emerging markets, which can limit their ability to invest in R&D [Lenihan et al., 2023]. Third, fiscal policy can be an important tool for promoting R&D, as it can provide funding and incentives for firms to invest in innovation. The theoretical framework for examining the relationship between fiscal policy and R&D could be based on the concept of public goods, which suggests that R&D is a public good that generates positive externalities for society, and therefore may require government intervention to ensure adequate funding and support [Huang, 2011]. To proceed with the study, the paper performed Autoregressive Distributed Lag (ARDL) and Granger causality test to capture the long-run and short-run dynamic relationship among the variables, as well as to determine the direction of these relationships. Next, we utilized Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) models to capture the cointegration between fiscal policy, FDI, domestic credit, and R&D. Rationally, if a long-run association is discovered among the variables, carrying out a cointegration to ascertain the robustness of the model is necessary [Olamide et al., 2022; Liu, Zhang, 2022; Sultana, Rahman, Khanam, 2022]. All information was gathered from the World Development Indicators (Table 1).

ECONOMETRIC MODEL

For an empirical analysis of cointegration, we use the ARDL technique. One of its advantages is that it does not demand the same level of integration for each variable. It does not really matter whether a factor has a variable order of integration, order zero integration, or order one integration. This feature makes ARDL superior to conventional cointegration techniques. Because the test's capac-

Table 1 – Variables' description
Таблица 1 – Описательные характеристики переменных

Variables	Definition	Source
RD	Research and development expenditure (% of GDP)	All the data were extracted from the World Development Indicators
FP	Final consumption expenditure (current US dollars)	
DC	Domestic credit to the private sector (% of GDP)	The study focuses on East Asian countries
FDI	Foreign direct investment, net inflows (current US dollars)	
FDO	Foreign direct investment, net outflows (current US dollars)	The period is 20 years (2000–2020)

ity to detect cointegration is diminished when there is a mixed order of integration, standard cointegration procedures become unstable. Our model's general functional form is as follows:

$$RD = \int(FP,DC,FDI,FDO), \quad (1)$$

where RD is the research and development, FP is the fiscal policy, DC is domestic credit to private sector, FDI and FDO are foreign direct investment inflow and outflow, respectively. Once equation (1) is log-linearized, the below equation is generated:

$$RD_t = \beta_0 + \beta_1 FP_t + \beta_2 DC_t + \beta_3 FDI_t + \beta_4 FDO_t + \varepsilon_t. \quad (2)$$

In this equation, β_0 is the constant, and ε_t is regarded as the equation's error term. The parameters of β_1 through β_4 are the coefficients utilized to calculate the research and development. Additionally, it is possible to compute both the short-run and long-run coefficients simultaneously. The preceding model was developed in order to establish ARDL bounds:

$$\Delta RD_t = \propto_0 + \sum_{i=t}^{p} \propto_1 \Delta RD_{t-1} + \sum_{i=t}^{p} \propto_2 \Delta FP_{t-1} + \sum_{i=t}^{p} \propto_3 \Delta DC_{t-1} +$$
$$+ \sum_{i=t}^{p} \propto_4 \Delta FDI_{t-1} + \sum_{i=t}^{p} \propto_5 \Delta FDO_{t-1} + \lambda_1 RD_{t-1} + \lambda_2 FP_{t-1} +$$
$$+ \lambda_3 DC_{t-1} + \lambda_4 FDI_{t-1} + \lambda_5 FDO_{t-1} + \varepsilon. \quad (3)$$

The ∝ parameters in the equation denote the short-term relationship. On the other hand, the λ symbol represents long-term relationships. Consequently, this approach tests the null hypothesis of no cointegration ($\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$) or the alternative hypothesis of cointegration ($\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq 0$) based on the F-test. Additionally, the F-test was developed based on the relevance of the lower and upper bound values, which were primarily expressed by [Pesaran, Shin, Smith, 2001]. As a result, this method aids in providing pertinent information regarding whether the elements are cointegrated. Thus, if over a long period of time, the variables are cointegrated, an error correction model is used to estimate each variable's coefficient. The formula is shown below.

$$\Delta RD_t = \gamma_0 + \sum_{i=t}^{p} \delta_i \Delta RD_{t-1} + \sum_{i=t}^{p} \varphi_i \Delta FP_{t-1} + \sum_{i=t}^{p} \varphi_i \Delta DC_{t-1} +$$
$$+ \sum_{i=t}^{p} \varphi_i \Delta FDI_{t-1} + \sum_{i=t}^{p} \varphi_i \Delta FDO_{t-1} + \mu\, ECT_{t-1} + \upsilon_t. \quad (4)$$

In this model, the parameters μ reflect the speed of adjustment, and ECT stands for the error correction term.

Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS). The DOLS uses a parametric approach to estimate a long-term connection in a model, where the variables are still cointegrated but are incorporated in a distinct order [Stock, Watson, 1993]. This model incorporates leads and lags to account for simultaneous bias and small sample bias. Less-squares estimates can be used to derive the DOLS estimators, which are asymptotically accurate and unbiased even when the endogenous problem is present. Additionally, the parameters take into account potential autocorrelation and residual non-normality [Herzer, Nowak-Lehmann, 2006]. Moreover, fully modified OLS (FMOLS) is used in this study to confirm the reliability of the DOLS results. Hansen and Phillips [1990] invented the FMOLS regression to maintain the top cointegrating estimates. The FMOLS method helps to take into consideration for the effects of serial correlation as well as the endogeneity in the predictor factors caused on by cointegrating. The equations for both models are expressed as follows:

$$yt = a + bX_t + \sum_{i=-k}^{i=k} \varnothing\, \Delta X_{t+i} + \varepsilon_t; \quad (5)$$

$$\delta_{FME} = \left(\sum_{i=t}^{p} Z_t\, Y_t'\right)\left(\sum_{i=t}^{p} Z_t\, Y_t^{+}\right) - T\,[\Lambda_{12}^{+}]. \quad (6)$$

In equation (5), b stands for the long-run elasticity. The descriptor ∅ is the "coefficient" and refers to the distinction between the leads and lags of I (1) regressors. The above coefficients are used to account for residuals that may be endogenous, autocorrelative, or non-normal. They are regarded as nuisance parameters. Furthermore, in equation (6) we perceive that Y_t^+, Z_t^* and Λ^+_{12} terms eliminate the autocorrelation problem and unobserved heterogeneity. Standard Wald tests can be performed using the FMOLS estimator because it is monotonically impartial and employ a stable mixture-normal asymptotic distribution.

Pairwise Granger test. The purpose was to show the factors' causal linkages. To ascertain if there is a meaningful relationship between the indicators, the Granger causality test proposed by Granger [1969] was carried out. The strategy is explained in further context below:

$$X_t = \sum_{l=1}^{p} (a_{11,1} X_{t-1} + a_{12,1} Y_{t-1}) + \mu_t, \quad (7)$$

$$Y_t = \sum_{l=1}^{p} (a_{21,1} X_{t-1} + a_{22,1} Y_{t-1}) + \varepsilon_t. \quad (8)$$

As illustrated in equations 7 and 8, p implies the order of the model, $a_{ij,1}$ (i,j = 1,2) denotes the coefficients expressed in the model, while μ_t and ε_t denote the residuals. A causation linkage between X and Y may be established using F-tests, and the parameters can be computed using simple least squares.

EMPIRICAL FINDINGS

The descriptive statistics enabled regulators to undertake an extensive analysis of the variables that affected the dependent variables in addition to guiding their trend analysis over the course of the period. Table 2 displays the descriptive statistics for the variables. The percentage of total spending that goes into research and development ranges from 2.234 to 2.632, with an average of 2.339. With a kurtosis of 5.044 and a standard deviation of 0.092%, the distribution is positively skewed. In East Asian nations, fiscal policy has an average value of 13.004% and an upper limit of 13.229%. Since the standard deviation is smaller than 1, the maximum amount of total government spending cannot be increased by more than 0.175% through fiscal policy. The findings reveal a negatively skewed distribution for fiscal policy and both for FDI inflows and outflows. The greater standard deviation value in DC demonstrates the wide variability of domestic credit offered to the private sector and implies that in East Asian countries more credit is required for the private sector.

Another crucial method for getting assumptions between variables before they are approached is the correlation matrix. In Table 3, the results indicate a negative correlation of –0.040 between domestic credit offered to the private sector and fiscal policy. In addition, both the foreign direct investment inflows and outflows presented a negative correlation with the domestic credit offered to the private sector. This implies that FDI inflows and outflows cannot support increasing the amount of credit offered to the private sector. Nevertheless, we perceive a positive association between all the factors to research and development, particularly, fiscal policy and FDI inflows appear strongly correlated with research and development in East Asian countries.

Table 4 shows the results of the DF-GLS, PP, and ADF tests. All factors that are not stationary at level become stationary at I (1) after initial differencing. This implies that none of the variables under investigation are I (2) and are instead all either I (0). Structure breaks are not taken into account by the traditional unit root tests that are discussed below. Hence, the testing strategy adopted in this study would account for one structural breakdown in the factors. Hence, Dickey–Fuller's unit root test with one structural break is used in the study, and the results are displayed

Table 2 – Descriptive statistics
Таблица 2 – Описательная статистика

Indicator	RD	FP	DC	FDI	FDO
Mean	2.356028	13.00486	143.3089	11.54526	11.44281
Median	2.339509	13.03642	143.7335	11.69638	11.55825
Maximum	2.632895	13.22969	171.4803	11.80024	11.75573
Minimum	2.234790	12.73721	127.6140	11.05287	10.87735
Std. Dev.	0.092132	0.175058	12.37595	0.260241	0.300849
Skewness	1.297730	–0.234253	0.787770	–0.728614	–0.605598
Kurtosis	5.044563	1.531345	3.025202	1.998132	1.878587
Jarque-Bera	9.552070	2.079390	2.172593	2.736344	2.383990
Probability	0.008429	0.353562	0.337464	0.254572	0.303615
Observations	21	21	21	21	21

Table 3 – Correlation matrix results
Таблица 3 – Результаты построения корреляционной матрицы

Variables	RD	FP	DC	FDI	FDO
RD	1.000	–	–	–	–
FP	0.498	1.000	–	–	–
DC	0.098	–0.040	1.000	–	–
FDI	0.469	0.938	–0.248	1.000	–
FDO	0.422	0.949	–0.138	0.976	1.000

Table 4 – Unit root analysis results
Таблица 4 – Результаты проверки наличия единичного корня

Variables	ADF	PP	DF-GLS	KPSS	DF-Break Unit root test	
Level					T.stat	Break-Year
RD	–0.529	–0.528	–3.285***	0.451**	–4.992***	2019
FP	–3.137**	–3.189**	–1.316	0.613**	–2.318	2007
DC	0.658	–1.590	–0.411	0.184	–2.727	2015
FDI	–1.029	–0.916	–0.841	0.543**	–3.650	2009
FDO	–0.877	–0.816	–0.749	0.559**	–4.610	2006
First difference						
RD	–3.319**	–3.323**	–1.801*	0.180	–11.916***	2019
FP	–8.697***	–8.435***	–2.558**	0.149	–4.559**	2011
DC	–3.027*	–3.027*	–2.231**	0.814***	–4.707**	2019
FDI	–4.700***	–4.891***	–4.146***	0.152	–5.155***	2009
FDO	–4.892***	–5.032***	–4.402***	0.132	–5.205***	2005

Note: (*), (**), and (***) denote 1%, 5%, and 10% level of significance, respectively.

in Table 4. After a structural change in the data has been allowed, the all-time series of the factors are stationary at the initial difference. Yet for each series, these fundamental changes take place at various times. Additionally, only RD demonstrated stationarity at both levels, and the first difference after the break unit root was carried.

In order to estimate parameters by using the ARDL bounds testing approach, the regression must possess a suitable lag. Table 5 displays the lag length selection. In order to determine parameters, the study used the AIC lag selection criterion, showing that roughly two lags should be used. Thus, to produce objective and fair results, the study considered two lags for the study.

To create effective policy interventions, the Autoregressive Distributed Lag test method will assist us in assessing the short-run and long-run elasticities between variables. With that in mind, the factors are serially correlated and exhibit long-run relationships, which are shown by the ARDL bounds prediction (Table 6). Accounting for causality and partial equilibrium correlations seen between variables, the F-statistics are noteworthy at the 1% level with a 10.98 value and fall underneath the I (1) upper limit. As a result, we will proceed with the error correction and long-run estimation.

Table 7 shows that the error correction term (called Adjustment) is statistically significant and negative

Table 5 – Lag length selection
Таблица 5 – Результаты выбора длины лага

Lag	LogL	LR	FPE	AIC	SC
0	16.32298	NA	2.09e-07	–1.191892	–0.943356
1	100.5002	115.1899	4.60e-10	–7.421073	–5.929854
2	156.8414	47.44519*	3.45e-11*	–10.72014*	–7.986241*

Note: (*) indicates the lag order selected by the criterion. LR is the sequential modified LR test statistic (each test at 5% level), FPE is the final prediction error, AIC is the Akaike information criterion, SC is the Schwarz information criterion, HQ is Hannan–Quinn information criterion.

Table 6 – ARDL model bounds testing estimates
Таблица 6 – Результаты тестирования границ модели ARDL

Test Statistic	Value	K
F-Statistic	10.98	4
Critical Value Bounds		
Significance, %	I (0) Bound	I (1) Bound
10	2.20	3.09
5	2.56	3.49
2.5	2.88	3.87
1	3.29	4.37

Table 7 – ARDL short-run and long-run estimation
Таблица 7 – Кратко- и долгосрочная оценка ARDL

Dependent variable: ln (RD)				
Selected model: ARDL (2, 2, 2, 2, 2)				
Short-run cointegrating form				
Variables	**Coefficients**	**St. Error**	**t-Statistics**	**Prob**
ΔRD (–1)	0.296876	0.120654	2.460546	0.0697
ΔFP	0.402116	0.275987	1.457008	0.2188
ΔFP (–1)	1.394202	0.224487	6.210625	0.0034
ΔDC	0.019202	0.001035	18.55792	0.0000
ΔDC (–1)	–0.002004	0.000860	–2.329651	0.0803
ΔFDI	1.856909	0.090814	20.44740	0.0000
ΔFDI (–1)	–1.316082	0.184591	–7.129724	0.0020
ΔFDO	–0.960207	0.067487	–14.22813	0.0001
ΔFDO (–1)	0.830509	0.128288	6.473782	0.0029
CointEq(–1)	–2.765256	0.227110	–12.17586	0.0003
Long-run coefficients				
Variables	**Coefficients**	**St. Error**	**t-Statistics**	**Prob**
FP	–0.523747	0.191301	–2.737812	0.0520
DC	0.006270	0.001071	5.856019	0.0042
FDI	1.653437	0.212770	7.771012	0.0015
FDO	–1.035795	0.179271	–5.777817	0.0045
Constant	1.010313	1.148046	0.880028	0.4285

(–2.76). This statement demonstrates the rate at which equilibrium is restored following a shock to the long-run causal relation. According to the short-run and long-run results, all the variables appear to have a significant association with research and development. Starting with the short-run outcomes of fiscal policy, the total government expenditure demonstrates a positive impact on R&D. This implies that a 1% increase in East Asian countries' total expenditure rises research and development by 1.39%. Additionally, domestic credit offered to the private sector and FDI inflows and FDI outflows have a diverse impact on research and development across the lags. Next, the long-run estimation exhibits that fiscal policy and FDI outflows have a negative influence on expenditure on research and development. For instance, a 1% increase in FP and FDO reduces –0.523% and –1.035% respectively the expenditure on research and development. On the other hand, the amount of domestic credit offered to the private sector and FDI inflows revealed to increase in the expenditure on research and development. We perceive that a 1% increase in DC and FDI causes to rise the RD by 0.006% and 1.65%, respectively.

Upon acknowledging the association of the variables, the FMOLS and DOLS frameworks are used to examine how long-term trends in fiscal policy, FDI inflows and outflows, and domestic credit provided to the private sector in East Asian countries. Table 8 summarizes the models' outcomes. Starting with the FMOLS estimates, when all other variables are maintained constant, the anticipated long-run coefficients of DC and FDI are positive and significant at a 5% level, indicating that a 1% increase in credit offered to the private sector and FDI inflows will result in 0.005%, and 0.87% more research and development. This conclusion shows that long-term investment in R&D is influenced by the amount of foreign investment coming into the country and domestic loans to the private sector. Additionally, the estimated long-run of FP and FDO coefficients are negative and significant at 5% and 10% levels, demonstrating that a 1% increment in fiscal policy and FDI outflow in East Asian countries is closely linked to a reduction in research and development by 0.001% and 0.60%, respectively, over the long term. This reveals that the fiscal policy and FDI outflows of East Asia nations are not favourably supporting a technological transition. Simultaneously, the DOLS model reveals identical outcomes with the FMOLS and ARDL models. For instance, the model validates that credit offered to the private sector and FDI inflows are favourable determinants of research and development, while the fiscal policy and FDO outflows in East Asian countries uncovered detrimental influence on R&D. Furthermore, it is remarkable that the computed coefficients' values are accurate in both theory and practice. In the present study, a diagnostic test was used to assess the derived model's correctness of fit. We may conclude that the developed regression framework performs extremely well based on the R2 estimates of 0.4323 and 0.9971, for both models correspondingly. As a result, 44% and 98% of the fluctuation in the shift of the outcome variable can be explained by independent factors.

Table 8 – FMOLS and DOLS estimates
Таблица 8 – Результаты анализа FMOLS и DOLS

Variables	FMOLS			DOLS		
	Coeff.	Std. error	t.stat	Coeff.	Std. error	t.stat
FP	–0.0011	0.3524	–0.0032	–4.536**	0.2845	–15.944
DC	0.0050**	0.0019	2.5779	0.0314**	0.0017	17.588
FDI	0.8712**	0.3173	2.7449	7.1682**	0.4113	17.426
FDO	–0.609**	0.2381	–2.5581	–3.352**	0.2813	–11.914
C	–1.4243	2.0694	–0.6882	12.420*	1.3904	8.9326
R-squared		0.432376		0.997174		
Adjusted R-squared		0.281009		0.951965		
Long-run variance		0.003544		5.55E-05		
Mean dependent var		2.362090		2.351580		
S.D. dependent var		0.090127		0.065236		
Sum squared resid		0.087604		0.000204		

Note: (*), (**) and (***) denotes 1%, 5%, and 10% level of significance, respectively.

To determine the causation between the variables and whether it exists, one can use the F-statistic, which assesses the Pairwise Granger causality. Table 9 summarizes the causality association between the indicators as well as the orientation of connection, such as one-way or two-way causality. Generally, the results of the test demonstrate a one-way causal association between fiscal policy and research and development. To put it differently, we observe a causality running from fiscal policy to research and development. The rest of the variables indicates no prominent causality with R&D.

Table 9 – Pairwise Granger causality test results
Таблица 9 – Результаты теста Грэнджера

Variables	F-Statistic	Prob.	Note
FP ≠> RD	5.07067**	0.0378	Unidirectional
RD ≠> FP	0.06677	0.7992	
DC ≠> RD	0.00114	0.9735	No causality
RD ≠> DC	2.12800	0.1629	
FDI ≠> RD	2.68581	0.1196	No causality
RD ≠> FDI	1.31625	0.2672	
FDO ≠> RD	2.08026	0.1674	No causality
RD ≠> FDO	1.11328	0.3061	

Note: (**) denotes a 5% level of significance.

The impulse response function (IRF) displays how a variable responds to a shock (such as a stress of one standard deviation, a stimulus of one unit, etc.) over a specific period of time. A variable's impact on another factor cannot be determined using the Granger causality or the variance decomposition. To ascertain an impact's route, the IRF evaluation is crucial. The horizontal axis depicts time, while the vertical axis indicates the size of a variable's responses to a shock. The red dotted line substitutes for the confidence bands at 5% significance, while the blue line represents the IRF. Figure 1 shows the responses of RD, FDI, FDO, FP, and DC to one standard deviation shock of RD. Within this scope, we witness that RD's reaction to the shock varies greatly throughout the course of each time interval. Nevertheless, the shock turned positive and statistically substantial after period 6. Moreover, the private sector's access to domestic finance and FDI inflows react favourably to the shock of R&D. In period seven, these favourable responses are quite consistent. It is important to highlight that FDI and DC often exhibit a positive, composed response to RD fluctuations; this finding is consistent with our ARDL long-run results. Consequently, even if the 7th period for FDI inflows indicates a negative reaction towards R&D, an increase in FDI inflows and credit provided to the private sector will enhance research and development. The chart also shows that fiscal policy and FDO outflows have reacted negatively to R&D spending.

In order to ensure the integrity and dependability of our chosen model, the study makes extensive use of analytic statistical tests, the observations are provided in Table 10. The results suggest that the framework is accurate since it met all diagnostic tests. The model is shown to be unaffected by serial correlation or autocorrelation problems using the Breusch-Godfrey LM test. The Ramsey RESET test has demonstrated that the model is not misspecified. The heteroscedasticity of the model is assessed using the Breusch-Pagan-Godfrey test and the ARCH test. The empirical findings show that heteroscedasticity is minor and unimportant. The findings of the Jarque-Bera test also show that the residuals of the model have a normal distribution. Additionally, the CUSUM and CUSUMSQ plot demonstrates that the model is stable because the graph is contained inside the 5% level of significance limits (see Fig. 2).

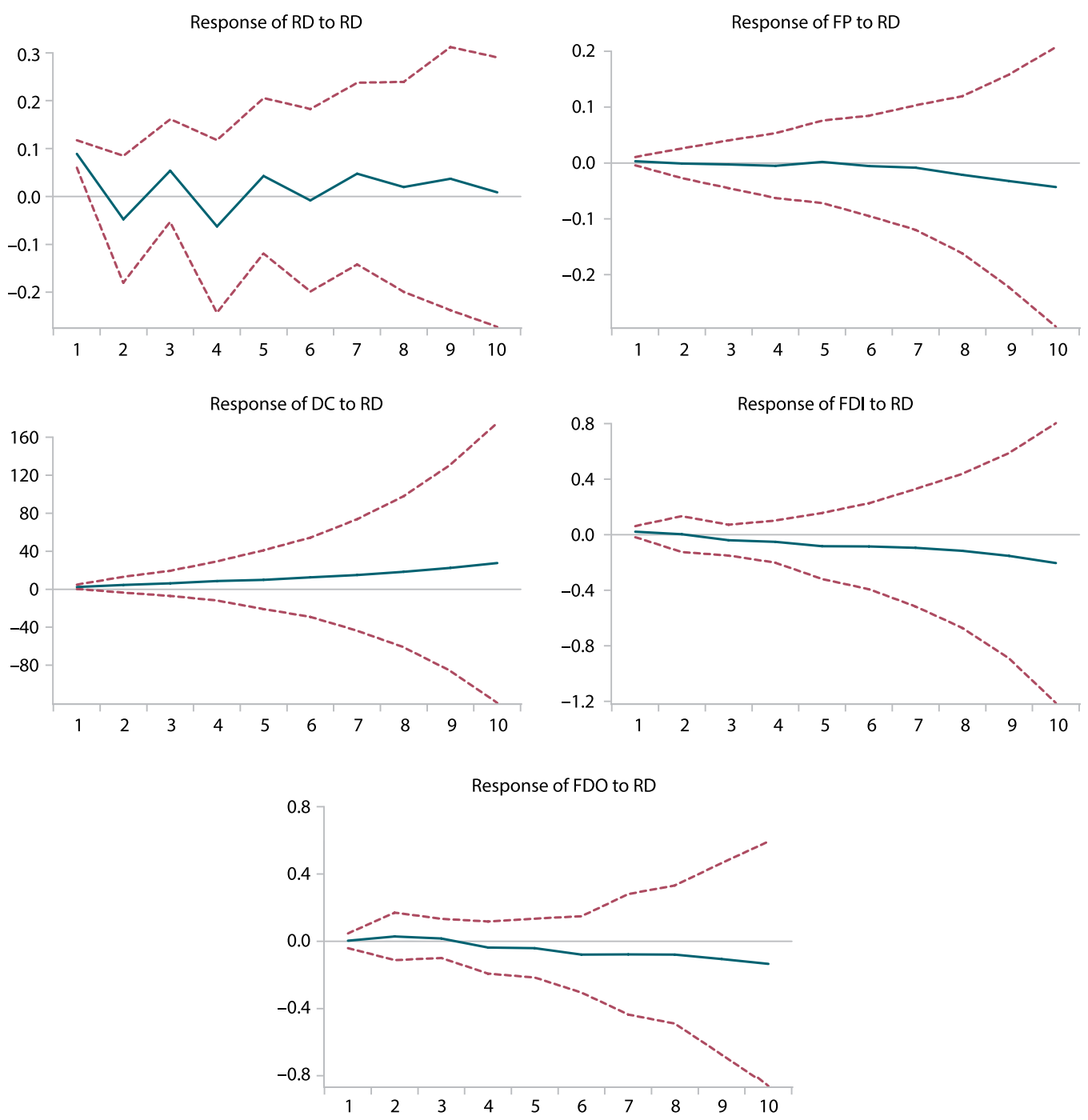

Fig. 1. Impulse response function

Рис. 1. Результаты построения функции импульсного отклика

Table 10 – Diagnostic statistics tests

Таблица 10 – Результаты аналитических статистических тестов

Test	F. stat/Prob	Remark
Heteroskedasticity Test: Breusch–Godfrey	0.6162/0.7764	No problem of heteroscedasticity
Heteroskedasticity Test: Harvey	1.3465/0.4214	No problem of heteroscedasticity
Heteroskedasticity Test: ARCH	0.0001/0.9897	No problem of heteroscedasticity
Ramsey RESET Test	0.8124/0.4338	Model is specified correctly
Breusch-Godfrey Serial Correlation LM	5.7082/0.1491	No evidence of autocorrelation
Durbin–Watson (autocorrelation)	2.9106	No evidence of autocorrelation
Jarque–Bera (normality)	0.700/0.704	Model is normally distributed

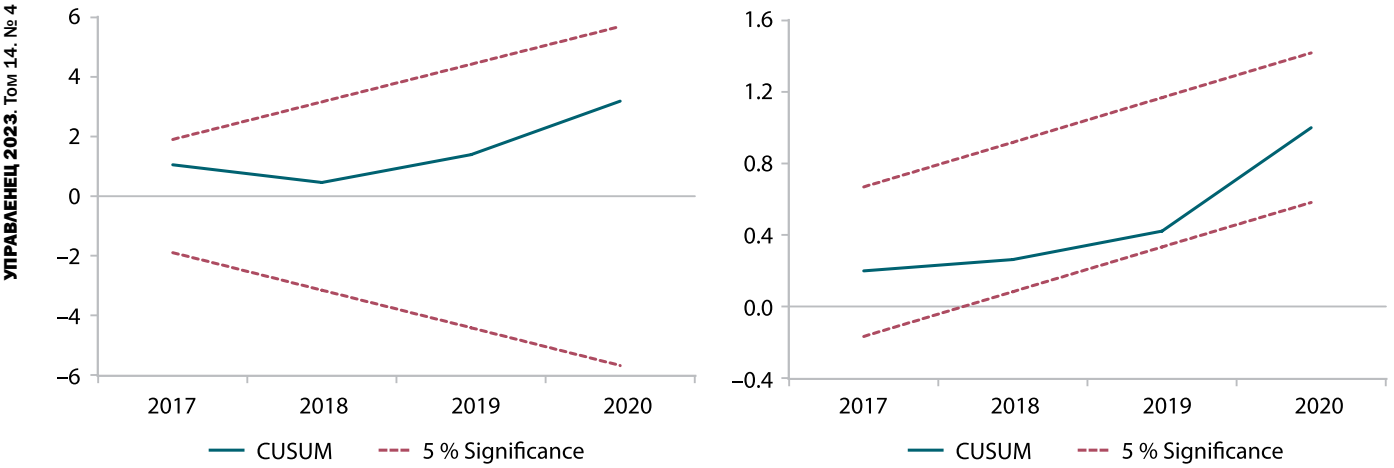

Fig. 2. CUSUM and CUSUMQ test results

Рис. 2. Результаты тестов CUSUM и CUSUMQ

DISCUSSION

Considering R&D is what fuels innovation, the majority of East Asian nations have systems in place to promote it through direct or indirect financing. The techniques they employ are aimed at providing businesses and SMEs with a range of benefits to help them fund R&D. Nevertheless, authorities are obliged to revaluate state expenditure, which results in decreased R&D financing, as a result of numerous economic and social factors, including the global recession and pandemics. By attempting to prevent businesses from cutting back on their R&D expenditures, several governments in East Asia were able to raise public funding for this industry. Despite their best efforts, nations must come up with innovative ways to encourage and fund R&D.

Even while governmental institutions engage in research and development, it appears that private corporations have a greater influence on technological advancement. Implementing R&D in higher education also sparks innovation, which supports development. Thus, it is crucial to consider the domestic credit offered to the private sector as an important measurement of research and development. The industrialized nations or those with sizable populations are capable of funding such spending when it involves R&D funding at the national level. That is the reason East Asian countries are considered the hub of technological advancement due to their large population. The promotion of research and development is generated through academic engagement and allocation of funds, industry-level cooperation, greater investments in human capital, and financial incentives for businesses and organizations.

Within this context, the study explored the interlinkage that exists between fiscal policy and foreign direct investment with research and development. East Asian countries were considered the focus region due to their prominent technological advancement. What is more, we performed an autoregressive distributed lag, cointegration models, and pairwise Granger causality test on a time frame of 20 years.

The findings presented that both short-run and long-run factors exhibited a significant impact on R&D. For instance, an increase in fiscal policy and FDI outflows demonstrated a fall in technological advancement. This suggests that the total expenditure of East Asian countries does not seem to be allocated to research and development. While the latter implies the total value of the outward direct investment is not generally used in domestic activities, thus it cannot support research and development. In terms of fiscal policy outcomes, the results contradict the findings of Li and Qi [2023]. In contrast to our findings, both authors discovered that the intensity of fiscal R&D funding in science and technology has a significant positive effect on overall innovation efficiency and phased innovation efficiency. Another study uncovered by Shakhmuradyan [2022] also presented no prominent link between fiscal policy and research and development.

Accordingly, it is rare to observe expenditure and FDI outflows causing a negative influence on R&D. However, it is possible that specific types of fiscal policies or FDI outflows could have a negative impact on technological advancement under certain conditions. For example, if fiscal policies are not targeted effectively towards R&D or if FDI outflows are dominated by low-tech industries, it could limit the potential for technological advancement. Additionally, if FDI outflows result in a 'brain drain' of skilled workers and researchers from domestic firms, this could also have a negative impact on technological advancement. Fiscal policy also often faces competing demands for limited public resources, such as healthcare, education, infrastructure, and social welfare. As a result, R&D may not receive the level of funding it needs to drive innovation and growth. Therefore, it is important for policymakers to carefully design and implement fiscal policies and manage FDI outflows in a way that maximizes their potential for promoting technological advancement. This may involve targeting fiscal policies specifically towards R&D and promoting high-tech FDI inflows, as well as im-

plementing measures to ensure that FDI outflows do not result in a 'brain drain' or other negative impacts on domestic firms.

On the other hand, domestic credit provided to the private sector and FDI inflows demonstrated an increase in the research and development. Apparently, East Asian countries provide a significant amount to the private sector because they are conscious that technological advancement can not only be ensured through the public sector. These findings are in agreement with Qi, Peng and Xiong [2022] who analysed the effects of fiscal and tax incentives on regional innovation capability. The authors exposed that the fiscal expenditure for science and technology, fiscal and tax policy, macro tax burden, business tax (BT), and value-added tax (VAT) have a significant boosting effect on the regional innovation capability. What is more, the outcome in terms of FDI outflows is in conformity with Li, Chang and Zheng [2021] who used a panel dynamic OLS model with breaks to reveal that FDI is positively associated with innovation performance and vice versa in OECD countries.

This positive outcome implies that domestic credit granted to the private sector can provide firms with the necessary funding to invest in R&D activities. This can include financing for the acquisition of equipment and technologies, as well as funding for the hiring of skilled researchers and scientists. This can help firms to overcome financial constraints that might otherwise limit their ability to invest in R&D activities. Secondly, FDI inflows can bring new technologies, knowledge, and skills into a country, which can stimulate innovation and technological progress. Multinational corporations (MNCs) that invest in R&D activities in a host country may also transfer some of their knowledge and expertise to local firms through spillover effects. This can contribute to the development of local R&D capabilities and help to promote technological advancement in the host country. Moreover, FDI inflows can create new opportunities for collaboration between local firms and foreign partners, which can further promote R&D activities. For example, local firms may partner with MNCs to develop new products or technologies, or to participate in joint R&D projects.

Furthermore, the pairwise Granger test illustrated a one-way causal association between fiscal policy and research and development. This can be due to the fact that fiscal policy can directly influence R&D activities through funding and subsidies. Governments can allocate funding, which can stimulate private sector investment in research and development as well. Additionally, tax incentives and subsidies can be used to encourage private sector investment in R&D. Secondly, fiscal policy can indirectly influence research and development activities through its impact on the business environment. Policies such as tax reform, investment incentives, and trade agreements can create a favourable business environment, which can encourage firms to engage in R&D. Thirdly, the one-way causal association may also be due to the fact that research and development activities often require significant capital investment, and fiscal policy can play a critical role in providing the necessary financing for these activities. For example, government funding and tax incentives can help reduce the costs of R&D activities, making them more financially feasible for firms. It is important to mention that FMOLS and DOLS models exhibited similar results to the ARDL model. Hence, these models can be considered sensitivity checks to support the results obtained from the ARDL approach.

In this study, we make contributions to the existing literature and provide evidence, particularly for countries that are still behind in technological advancement, by investigating the link and interconnection between fiscal policy, foreign direct investment, the allocation of funds to the private sector, and research and development. The findings will offer insights and evidence to African countries, especially the author's country Djibouti, on identifying the factors that need to be revitalized in order to promote research and development. We mainly recommend that countries allocate more funds to education and the private sector if they desire to increase technological advancement.

CONCLUSION

The current paper was undertaken to determine how the fiscal policy, FDI, and credit provided to the private sector affect R&D in the East Asia region over the last 20 years. To proceed with the study, the paper performed Autoregressive Distributed Lag and Granger causality tests to capture the long-run and short-run dynamic relationship among the variables, as well as to determine the direction of these relationships. Next, we utilized Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) models to capture the cointegration between fiscal policy, FDI, domestic credit, and R&D. Accordingly, the findings exhibited that the fiscal policy and FDI outflows of the region have a detrimental influence on the expenditure allocated to the R&D. In contrast, the findings uncovered that FDI inflows and domestic credit provided to the private sector have a significant positive impact on research and development. It is important to highlight that both FMOLS and DOLS presented identical outcomes with the ARDL model. Lastly, the Granger causality illustrated a one-way causal association between fiscal policy and research and development. In terms of contribution, the current study will help understand the relationship between FDI and R&D and how foreign investors can influence a country's R&D activities through technology transfer, knowledge spillovers, and collaboration with local firms. This could help policymakers develop strategies to attract FDI that can benefit their R&D sector. Next, it will provide insights into how policymakers can design effective fiscal policies to promote R&D, particularly in areas that are crucial for a country's economic pro-

gress. Finally, the study evaluates the effectiveness of existing R&D policies and identifies areas for improvement. This could help government authorities assess the impact of their policies and make informed decisions about future R&D investments and policy initiatives.

Policy implication. In compliance with the study outcome, several key policy implications can be extracted. One of them is that fiscal policy can play a critical role in promoting foreign direct investment and research and development activities in East Asian countries. Specifically, the study finds that tax incentives and subsidies can be effective in attracting FDI and promoting R&D activities, while also stimulating private-sector investment in these areas.

Therefore, policymakers in East Asia should consider implementing targeted fiscal policies that incentivize FDI and R&D. This may include measures such as tax breaks for firms that engage in research and development, investment incentives for firms that invest in new technologies or innovation, and subsidies for firms that engage in collaborative research and development projects. In addition to fiscal policies, policymakers should also consider other institutional factors that can impact research and development in East Asian states. This may include measures to strengthen intellectual property protection, reduce corruption, and promote greater transparency and accountability in government decision-making processes. In conclusion, the study highlights the important role that fiscal policy and FDI can play in promoting research and development activities in East Asian countries and provides guidance for policymakers seeking to develop effective policies that promote sustainable technological advancement and development in the region. ■

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