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Research article

Innovation and economic performance: The role of financial development

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Abstract: This study empirically explores the influence of financial development (FD) in an innovation-growth nexus. Specifically, the study considers how, through FD, innovation impacts countries' export products, export values and national incomes. The system Generalized Method of Moments technique and the dynamic common correlated effect estimator are used on data of 57 economies covering the period 2000 to 2019. First, the findings reveal that, on the full sample, FD and its interaction with R&D expenditure have both short- and long-run effects on economic performance, as they both cause increases in export product, export value and national income. However, within the full sample study, the direct impact of FD is more favorable than the indirect effect. Second, within the developed and the developing economies, the study reveals that FD indirectly influences economic performance by improving the relationship between R&D expenditures and export products, export values and the national incomes of these groups of economies, both in the short- and the long-run. However, considering the developing economies, the findings show that the indirect influence of FD is more favorable than the direct effect. As a result, this study argues that FD is relevant for improving the relationship between innovation and economic performance, for both developed and developing economies. Policymakers should, therefore, ensure efficiency and stability in their financial sector as they engage in R&D activities in order to be able to harness the export-growth benefits of innovation fully. Moreover, policies that ensure sustainable money supply should be encouraged, especially within the developing economies.

Keywords: innovation; economic performance; export; national income; financial development

JEL Codes: E51, F14, O11, O32, O47, O50

1. Introduction

Innovation's influence on economic performance has been assessed from different perspectives, including economic growth (Bilbao-Osorio & Rodríguez-Pose, 2004; Cameron, 1996; Georgeta et al., 2016; Huňady & Orviská, 2014; Law et al., 2020; Lebel, 2008; Silve & Plekhanov, 2015; Verspagen, 2005) and exports (DiPietro & Anoruo, 2006; Klinger & Lederman, 2006). According to these studies, innovation does have favorable and significant influences on countries' growths and export expansions. While innovation is essential to the economic performance of countries, engaging in innovation activities is very costly, that is, it involves huge investment of capital. According to Holmstrom (1989), the process involved in innovation is not only overlong, quirky and capricious but also implicates a very high likelihood of failure.

However, based on the research on the usefulness of innovation to economic performance, several studies have also been conducted by researchers to examine the national determinants of innovation. These studies have found that the financial development (FD) of an economy is essential for determining the innovation activities of an economy (Aghion et al., 2018; Comin & Nanda, 2019; Hsu et al., 2014; ILYINA & SAMANIEGO, 2011; Meierrieks, 2014; Pradhan et al., 2018; Tadesse, 2005). According to Brown et al. (2009), FD through the equity market is an essential key for financing innovation. A country's financial depth affects how widely distributed its capital-intensive technologies are. The experimenting phase that is necessary for the adoption and diffusion of first-hand technology is greatly facilitated by deeper financial markets (Lerner and Kortum, 2000; Samila & Sorenson, 2011). Further improvement in the level of FD of countries, especially the developing economies, boosts the growth of their economies (Zhao et al., 2017) from the indirect effect of rising innovative activities. Local financial institutions are critical to ensuring the process of experimentation needed for the initial commercialization and the diffusion of technology (Comin & Nanda, 2019).

Despite the theories (Schumpeter, 1934) that the expansion of an economy's financial market is necessary for its innovation, comprehensive research that concentrates on the importance of FD in innovation and economic performance is rare in export-led growth. Though several studies have gone into financial development and economic growth (Albert Henry et al., 2019; Matei, 2020; Naliniprava, 2019), empirical studies on the role of FD in the innovation-economic performance nexus have mostly focused on growth with respect to per Capita GDP and total factor productivity (Zhang, 2019). The few studies on export trade have also focused on the direct influence of FD (Qiu, 2022; Zhao et al., 2017). As a result, the aim of this paper is to demonstrate the cross-country evidence of the influence of FD on innovation-growth performance from an export-led perspective. Specifically, this study examines whether FD impedes or improves effect of innovation activities of countries on product exports, export value and their national income. This study is of the view that as countries encourage their industries to become innovative through the massive investment in R&D, the impact should reflect in the number and value of product, thereby expanding their export product, making them gain competitive advantage and consequently increasing profitability. As firms' exports increase, the total country's exports also increase, thereby reducing the current account deficit of the country. As such,

for examining the economic performance of a country, this study focused on export growth and income growth. Two economic indicators (country export product to the world and export value) are examined in relation to export growth while income growth is examined based on gross national income (GNI). Domestic credit provided to private sectors (DCPS) is used a proxy for FD. Innovation is proxied with R&D expenditure.

This study offers new insights into the country-level influence of innovation on export-led growth by focusing on the countries' export products to the world and the value of their exports. First, this study is unique from other studies with respect to the measurement of the economic performance. Limiting it to export performance, the study focuses on how innovation is able to influence the dimension of trade performance of countries by way of its impact on the export diversification across products. Hence, there is use of a "country growth by country products to the world" indicator. Moreover, there is use of export value aiding in assessing the total value of foreign countries' spending on the diverse goods and services of the home country. To the best knowledge of the author, this is the first time these indicators are being used to assess countries' economic performance on innovation-growth empirical studies. Second, most studies on innovation and economic growth address innovation as a direct cause of increase in economic performance. This current study, with the use of three economic performance indicators, addresses this issue. This study shows that innovation first enables countries to increase diversified products for export. As more diversified products are produced to meet the needs of the international market, they increase their total value of foreigners consuming these diversified products. Increase in total value of foreigners consequently leads to improvement in economic performance through increase in the national income. It, therefore, adds up to existing studies on innovation and countries' trade. Last, the study sheds light on the development of the financial sector of countries in innovation and export-led growth which is scarce in the literature. It, therefore, highlights the relevance of FD to the innovation-export-led growth relationship by revealing that FD potentially moderates the relationship between innovation and economic performance. The study provides vital information on the significance of FD in ensuring efficient and effective innovation activities that improve economic performance.

The remaining parts of the research are ordered as follows. Section 2 deals with the literature review concerning previous studies which are related to innovation and economic performance. Section 3 deals with the data and the variables used for the study and the method employed in the data analysis. Section 4 contains the findings of the data analysis, gives the empirical results and discusses the results. Section 5 provides conclusions to the study.

2. Literature review

For this current study, the empirical review on the innovation-economic performance nexus is limited to export-led growth and productivity growth. Considering the innovation-export performance nexus, three different models are discussed. The first model has to do with the notion that promoting export by countries is a strategic policy for ensuring economic progress and improvement of the economy involved. Export is identified as a relevant factor to the promotion of economic progress and improvement (Nanid & Biswas, 1991; Nguyen, 2016; Ugochukwu & Chinyere, 2013). Promoting export has been a key element to economic performance for most countries. Looking at it from the

viewpoint of Keynesian theory, promotion of export creates an avenue for additional sources of demand. However, looking at it from the supply-side perspective, the pressure that comes with international competition creates powerful stimulus for domestic industries to become and remain competitive internationally.

The second model has to do with the idea of creative destruction (Schumpeter & Capitalism, 1950). This concept postulates that as new innovations substitute timeworn products and techniques, countries begin to enjoy monopolistic power which provides them a competitive advantage. The notion is that the greater the level of creative destruction is, the greater the economy's growth momentum (DiPietro & Anoruo, 2006). That is to say that the more innovative a country is, the greater the amount of economic growth and development.

The third notion is related with the form of trade among developed and developing economies. This model basically sets trade among countries into two parts. The first part has to do with the notion that terms of trade tend to favor the manufacturing sector over the agricultural sector. The second is that under-developed economies tend to trade agricultural products for manufacturing products mostly produced from developed economies. Based on this, developed economies are always favored in terms of trade as compared to under-developed economies. In order for this condition to change, the model could be altered such that terms of trade would favor economies that produce innovative products as compared to other products. In this case, economies that produce and export more innovative products gain more competitive advantage over economies that do not produce innovative products.

In all, innovation does not only directly foster economic growth and development but indirectly fosters it in addition, via its progressive impact on international trade. Innovation, therefore, increases a country's export level both by introducing new products that enjoy monopolistic power based on being early entrants to an enterprise and by decreasing costs on prevailing products.

From the productivity growth perspective, innovation has been identified to be an essential and influential factor which has the power of lifting the success of a country and its growth since it is a strong influencing factor in competitiveness and productivity (López-Cabarcos et al., 2021). The advantages of innovation in a country come in two main forms. First, as firms in countries become more innovative, they are able to increase their level of efficiency and improve the number and value of products produced, leading to a rise in demand along with the reduction of production costs (Hall, 2011). Second, as firms in countries become more innovative, they end up being able to produce better goods and services, which make them likely to grow more than other prevailing firms and fresh entrants. Several firm-level studies have confirmed the relevance of innovation to economic growth (Crespi & Zuniga, 2012; Díaz-Chao et al., 2015; Griffith et al., 2006; Martin & Nguyen-Thi, 2015; Pianta & Vaona, 2007).

Despite the plentiful evidence of innovation and productivity on the firm level, there have been also considerable empirical studies on a cross-country level. For instance, in Maradana et al. (2017), by using the cointegration method, the research asserted that innovation has a long-term relationship with growth. However, upon using the Granger causality test, the study found the existence of unidirectional and bidirectional causality for innovation and economic improvement. These relationships differed among the various countries of study. Similarly, (Bayarçelik & Taşel, 2012; Huňady & Orviská, 2014; Law et al., 2020) have asserted that innovation is a critical growth driver. Bayarçelik and Taşel (2012) used the two-stage least square method of estimation and found that R&D

expenditure and number of researchers in R&D, as innovation indicators, stimulated growth in Turkey. Huňady and Orviská (2014) used the panel fixed effect technique and showed that countries that increase their level of innovative activities usually experience increases in economic performance. In Law et al. (2020), the study compared magnitude and quality of innovation and their impact on economic growth. The findings revealed that quality of innovation, using total patent grants, yields increases in economic growth. This means that patenting, either from the domestic or foreign, is an important determining factor to economic growth (Yang, 2006). Though Lee and Kim (2009) found innovation to improve nations' progress in the long-term, they affirmed that this effect is only experienced by upper-middle and high-income countries.

On the contrary, studies in (Pala, 2019; Vuckovic, 2016) have argued against the notion that innovation promotes higher productivity, leading to increases in economic growth. In Pala (2019), the study used Swamy's random coefficient model and found that innovation indicators like R&D expenditure and researchers in R&D have negative relationships with economic growth of a majority of the countries of study. A similar result was found in Law et al. (2020) using quantity of patents as a representation for innovation. Vuckovic (2016) using a multiple regression analysis on emerging economies found no substantial link concerning innovation and economic growth.

3. Data and methodology

3.1. Method and empirical model

3.1.1. Method

The dynamic panel regression analysis was carried out using the system-GMM estimator (both the one-step and the two-step). This method of estimation is best for situations where N > T (Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998). The GMM estimator resolves the endogeneity problems in Fixed Effect or Random Effect and any other model, and hence it reduces any biases or provides a more specific parameter estimation. The system GMM also comes with more robust advantages than the difference GMM. The only disadvantage that comes with the use of GMM is that it is difficult and possible to generate invalid estimates (Roodman, 2009). Though the estimators for both the one step System-GMM and two step System-GMM are asymptotically normal, the two-step estimation provides a more powerful asymptotic normal estimator. Hence, the study uses both estimators, where the two step System-GMM is used as a robust estimation. For more robustness, the study conducted a separate dynamic panel regression analysis on the developed and developing economies.

3.1.2. Empirical model

The empirical model for this study is based on the Schumpeterian growth model (Schumpeter, 1934) where development is a function of innovation and entrepreneurs. However, following DiPietro and Anoruo (2006), this study perceives development to be a function of R&D expenditure, education,

labor force participation rate and foreign direct investment inflows. Hence, in order to assess how innovation affects economic performance, the following linear function was formulated.

$$EP = f(RDE, EDU, LFPR, LNFDI) \tag{1}$$

where "*EP*" represents economic performance, "*RDE"* represents R&D expenditure, *"EDU"* is level of education, *"LFPR"* is labor force participation rate, and *"LNFDI"* is natural logarithm of foreign direct investment inflows.

Following the system GMM estimation technique, the equation is stated as follows.

$$\Delta EP_{i,t} = \beta_0 \Delta EP_{i,t-1} + \beta_1 \Delta RDE_{i,t} + \beta_2 \Delta EDU_{i,t} + \beta_3 \Delta LFPR_{i,t} + \beta_4 \Delta LNFDI_{i,t} + \Delta\eta_{i,t} \tag{2}$$

To investigate the role FD plays in the link between innovation and EP, domestic credit provided to the private sector (DCPS) is used as a proxy and is interacted with R&D expenditure. The model is stated as

$$\begin{aligned} \Delta EP_{i,t} = \beta_0 \Delta EP_{i,t-1} + \beta_1 \Delta RDE_{i,t} + \beta_2 \Delta DCPS_{i,t} + \beta_3 \Delta [RDE \times DCPS]_{i,t} \\ + \beta_4 \Delta EDU_{i,t} + \beta_5 \Delta LFPR_{i,t} + \beta_6 \Delta LDFDI_{i,t} + \Delta\eta_{i,t} \end{aligned} \tag{3}$$

where RDE*DCPS is the interaction of R&D expenditure and FD proxy.

For estimating the long-run relationship, the variables that show significant coefficients are used. The coefficients are generated by dividing the coefficient of the significant independent variables by the lagged value of the dependent variable. Based on this, the equation is formulated as

$$L_X = (\_b[X]) \,/\, E(1 - \_b[L1.Y]) \tag{4}$$

where L_x represents the long-run output, _b is the coefficient value, X is the significant independent variable, and L1.Y represents the coefficient of the lagged dependent variable.

3.2. Data

In order to assess the innovation-economic performance relationship and the role of FD, this study uses panel data for 57 countries consisting of 35 developed economies and 22 developing countries, covering a period of 20 years from 2000 to 2019. The division of countries into developed and developing is based on the IMF classification of countries based on the income level. However, middle and lower income countries are grouped as developing economies. Developed countries are high income economies with gross national income of $13,205 or more, whereas developing countries include low income economies with gross national income of $1,085 or less, lower middle-income economies with gross national income between $1,086 and $4,255, upper middle-income economies with gross national income between $4,256 and $13,205. Countries are selected depending on the data that is available within the specific years of study. Most of the data are sourced from World Bank Development Indicators (WDI-2021 update) and United Nations Development Program (UNDP). The variables for the study consist of export product (EXPP), export value (EXPV), gross national income (GNI), R&D expenditure, Education, Labor force participation rate, FDI and domestic credit provided to private sectors.

3.2.1. Response variables

In this study, the dependent variable is economic performance. In measuring economic performance, several researchers have used GDP or per Capita GDP (Blanco et al., 2016; Bozkurt, 2015; Das, 2020; Pala, 2019; Zhang, 2019), export share (TEKİN & HANCIOĞLU, 2017), real export or export share (Hur et al., 2006; Zhao et al., 2017). This study introduces two measures (country export products and export value) that are new in the literature. In order to be able to compare the empirical results of this study to the prevailing literature, the study uses GNI as an additional response variable. Three economic indicators are used as proxy for the response variable. The study measured economic performance by using export product, export value, and national income data. Export product (EXPP) is a proxy representing all the country's export products to the world within a particular year. As countries invest more in R&D, they are expected to be more innovative and competitive in their products (Neves et al., 2016). Hence, R&D should be able to increase the quantity of a country's export products, making them innovative and competitive in terms of the supply of products to the world, thereby making these countries more diversified in their products to the world. An additional response variable, export value (EXPV), is introduced to assess the value added to the countries' exports as a result of their innovative activities. Export value is thus a proxy for the most recent exported value converted to US dollars and represented as a percentage of the source time frame average (2000). Data for export product and export value are both sourced from the database of World Integrated Trade Solution (WITS). Gross national income is a country's total income from its citizens and firms irrespective of where they exist. As firms become innovative and become competitive by producing increased diversified product for export, and adding value to their export, these firms are expected to benefit in the form of increased profitability. As the national income of every economy is tied to the profitability of its industries, as firms increase in profit, the national income is expected to have an associated improvement. Hence, the use of the three indicators for economic development would enable the reliability of the results and help to compare which aspect benefits most form the direct and indirect effect of innovation. Data for gross national income is sourced from WDI.

3.2.2. Explanatory variables

Based on this study, two explanatory variables are used, R&D expenditure (RDE) and Domestic credit provided to private sectors (DCPS). RDE represents the gross domestic expenditure of a country on R&D, represented as a percentage of GDP. It includes basic research, applied research, and experimental development of an economy. R&D expenditure has been widely used by most empirical studies on the innovation-growth nexus (Ballot et al., 2006; Blanco et al., 2016; Bozkurt, 2015; Das, 2020; Pala, 2019; Yüksel, 2017). Though patents have been used in most of the literature to measure innovation (Das, 2020), this study excluded patents because in most cases not all inventions are protected by patents and even valuable. However, whether innovation is patented or not, R&D expenditure of the innovative firms are always accounted for. Domestic credit provided to the private sector is a proxy for FD of an economy, and it is used as an interaction variable. Since innovation activities are costly, finance, therefore, becomes an important factor in the link between innovation and exports. Economies with greater financial development are expected to have

increases in their exports (Beck, 2002; Hur et al., 2006; Shahbaz & Rahman, 2014). Data for R&D expenditure and domestic credit provided to private sector are obtained from World Bank Development Indicators (WDI).

3.2.3. Control variables

In order to ensure reliability and validity of the empirical results, reducing biases, the study is controlled using variables like EDU, LFPR and FDI. These control variables were selected based on existing literature on innovation and economic development (Klinger & Lederman, 2006; Zhang, 2019).

4. Results and discussion

4.1. Data analysis

4.1.1. Descriptive statistics

The descriptive statistics as shown in Table 1 present the summary of the data used for the analysis, with the focus on the mean, standard deviation, minimum and maximum values for all the variables and the coefficients of variation. Considering the mean values, the positive values for all the series imply that the variables have an increasing trend. Education has the highest mean, of 106.5338, while RDE has the lowest mean value, of 1.3085. Since LFPR has the lowest CV, of 0.0536, it indicates that the series has the lowest standard deviation, implying that there is less variation in LFPR with respect to the mean compared with other variables. Moreover, it is observed that EXPP has the highest CV, which explains a higher standard deviation, indicating that the variable is more volatile. Hence, it can be seen that LFPR, LNGNI and LNFDI are less volatile as compared to LNEXPV, DCPS and RDE. It is observed that EXPP, LNEXPV, LNGDP, RDE, LFPR, LNFDI and DCPS have minimum values of −22.3602, 1.7707, 9.0557, 0.0147, 66.5897, 51.8617, 6.3013, 1.2258 and maximum values of 44.8987, 3.2960, 13.3311, 4.9528, 278.23, 78.746, 11.8656, 304.575, respectively.

Table 1. Summary statistics.

Parameter	Obs.	Mean	Std. Dev.	Min.	Max.	CV
EXPP	1140	3.8575	8.0704	−22.3602	44.8987	2.0921
LNEXPV	1140	2.3778	0.2705	1.7707	3.2960	0.1138
LNGNI	1140	11.3112	0.8216	9.0557	13.3311	0.0726
RDE	1140	1.3085	1.0202	0.0147	4.9528	0.7797
EDU	1140	106.5338	21.5422	66.5897	278.23	0.2022
LFPR	1140	66.8123	3.5796	51.8617	78.746	0.0536
LNFDI	1140	9.8145	0.8435	6.3013	11.8656	0.0859
DCPS	1140	72.3973	56.2687	1.2258	304.575	0.7772

Note: compiled by the author. All values are in 4 decimal places.

4.1.2. Cross-Section dependence test

Due to possible presence of unobserved factors or similar economic network factors that may dwell among the various countries of study, there could be the possibility of cross-section dependence (Chudik & Pesaran, 2013). Similarly, due to the inter-dependence of nations across the globe, there is the possibility of cross-sectional dependence among the series. When this happens, all units in the cross-sectional data may be correlated and generate invalid statistics in the results (Dong et al., 2018). Table 2 displays the outcomes of the cross-section dependence test. The null hypothesis for the cross-section dependence states that there is cross-section independence. The rule of thumb is that in the case the p-value is close zero, it indicates that the series are correlated across the panel groups. The result indicates a significant presence of cross-section dependence in the series, which means that all the series are highly correlated. However, in order to deal with the problem of cross-sectional dependence, the second autoregressive test, AR (2), and the Hansen test from the System GMM were used for assessing serial correlation and the validity of the estimator's instruments. Moreover, time dummies are included in the system GMM in order to ensure that the assumption of no correlation across the individuals in the idiosyncratic disturbances hold. For the developed and developing economies, since the number of groups is relatively small with respect to the time period, the study employs the dynamic common correlated effects (DCCE), which aid in resolving cross-sectional dependence issues.

Table 2. Cross-section dependence test.

Parameter	CD-test	P-value
EXPP	131.685	0.000
LNEXPV	165.416	0.000
LNGNI	157.668	0.000
RDE	22.4	0.000
EDU	1.941	0.052
LFPR	50.767	0.000
LNFDI	50.373	0.000
DCPS	28.719	0.000

Note: compiled by the author.

4.1.3. Panel Unit Root Tests

Table 3 presents the results for the panel units root tests. EXPP and LNFDI are stationary at level for all the four tests. LNEXPV is stationary at level for IPS, ADF and CADF tests but significant at first order difference for the CIPS test. LNGNI is stationary at levels of IPS, CIPS and CADF tests but stationary at first order difference when tested with ADF. RDE is seen to be stationary at first order difference for all the four tests. EDU is stationary at level for ADF and CADF but stationary at first order difference for IPS and CIPS. LFPR and DCPS are stationary at first order difference for all tests except ADF which show the series to be stationary at level. Since some of the variables are stationary at first difference, time specific effects were controlled for in the system GMM estimation where the

period of years were included in the model. However, for the DCCE estimation, non-stationary variables were differenced at first order.

Table 3. Panel Unit Root Tests.

Parameters	IPS		ADF		CIPS		CADF	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
EXPP	−15.12***		−28.59**		−4.39***		−19.65***	
LNEXPV	−3.28***		−2.88***		−2.02	−3.63***	−2.131**	
LNGNI	−3.53***		1.3	−17.83***	−2.19**		−6.30***	
RDE	6.5	−12.57***	0.07	−7.10***	−1.63	3.18**	−0.58	−3.86**
EDU	1.35	−9.71***	4.95***		−1.51	2.70**	−3.82***	
LFPR	7.06	−10.26***	−8.94***		−1.205	−2.024*	−0.48	−3.67***
LNFDI	−9.13***		3.37***		−3.52**		−6.72***	
DCPS	1.55	−10.56***	−2.19**		−1.87	−3.54***	−1.868	−3.54***

Note: *, ** and *** indicate 10%, 5% and 1% significance levels, respectively. All values are approximated to 2 decimal places.

4.2. Empirical results

4.2.1. Innovation, FD and export products

Table 4 illustrates the relationship between innovation, FD and the country's export products. For both estimators, model 1 deals with the consequences of innovation on countries' export products to the world, while model 2 addresses the moderating role of FD to innovation-country export products nexus. Considering the model, under both one-step and two-step System-GMM estimation, it is revealed that EXPP (1) is positive and significant at 1% significance level, implying that the previous year's export product influences the current year's country growth. RDE is seen to have a favorable impact on export products. The implication is that a unit increase in R&D expenditure propels 0.7221 unit (one-step System-GMM) and 0.6873 unit (two step System-GMM) improvements in the country's export products to the world. This result provides evidence that more investment into R&D by countries is sufficient to increase their level of export products. A further investigation into the essence of FD shows, under model 2, that improvement in FD of the countries, via increase in DCPS enhances countries' export products. Specifically, increases in DCPS improve export products by 0.1920 and 0.1865 under one step System-GMM and two step System-GMM, respectively. Though RDE exhibits a negative and significant relationship, the interaction term (RDE * DCPS), which is the most interested, is seen to exhibit a positive and substantial influence on export product. The result reveals that capability of R&D to promote countries' export products largely depends on their level of FD. FD, therefore, plays a vital role in the innovation-export products nexus, as it is evidenced that an increase in DCPS associated with increase in R&D expenditure improves 0.1461 (one step System-GMM) or 0.1569 (two step System-GMM) in countries' product export to the world. These findings are in conformity with (Lewandowska et al., 2016; TEKİN & HANCIOĞLU, 2017) but in contrast with Zhao et al. (2017) as they found an N-shaped relationship between FD and exports.

Additionally, the effects of other variables show that EDU and LFPR have no significant influence on countries' product exports. However, LNFDI is seen to, unexpectedly, exhibit an adverse impact on country growth.

Table 4. Regression for innovation, FD and export product.

Parameter	One-step System-GMM		Two-step System-GMM	
	Model 1	Model 2	Model 1	Model 2
EXPP (1)	0.7423***	0.8542***	0.8544***	0.8923***
	(3.15)	(3.48)	(4.41)	(4.18)
RDE	0.7221***	−13.9703***	0.6873***	−12.6528***
	(5.05)	(2.74)	(4.19)	(2.74)
DCPS		0.1920**		0.1865**
		(2.59)		(2.59)
RDE * DCPS		0.1461**		0.1569**
		(2.56)		(2.56)
EDU	−0.0302	−0.1045	−0.3240	−0.4651
	(−0.68)	(−1.33)	(−0.83)	(−1.23)
LFPR	0.0641	0.2994	0.0389	0.1084
	(1.37)	(1.39)	(0.54)	(1.12)
LNFDI	−0.5171**	1.3086	−0.5726**	1.3121
	(−2.35)	(1.06)	(−2.34)	(1.01)
AR1	0.000	0.000	0.006	0.000
AR2	0.225	0.240	0.482	0.497
Sargan	0.000	0.000	0.000	0.000
Hansen	0.139	0.154	0.169	0.163
Observ.	1083	1083	1083	1083
Instruments	43	44	43	44
No. of groups	57	57	57	57
Year dummies	YES	YES	YES	YES

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. The t-statistics are in parentheses.

4.2.2. Innovation, FD and export value

Table 5 illustrates the results on innovation, FD and export value. Throughout the models under both one step and two step System-GMM, it is evidenced that the lag of export value is positive and significant, which implies that the previous year's is important for the current year's impact. Similarly, RDE under all models show favorable and significant relationship with LNEXPV, implying that R&D expenditure is important for improving countries' export values. This finding is in conformity with DiPietro and Anoruo (2006), as they found that a country's increase in creativity is associated with enhancement in the value of its exports. In model 2, RDE and DCPS are seen to exhibit positive and significant impacts on export value, under both one step and two step System-GMM. The interaction term (RDE * DCPS) is seen to be positive and, moreover, significant. An increase in DCPS

accompanied with an increase in R&D expenditure improves countries' export values. Innovation is, hereby, declared to be a key factor to improving countries' export values.

Additionally, the results for the control variables reveal that EDU, LFPR and LNFDI have no significant impact on the export values of the countries of study. The AR (2) and the Hansen tests reveal that there is no existence of serial correlation within the model and that the instruments for the model are valid.

Table 5. Regression for innovation, FD and export value.

Parameter	one step System-GMM		two step System-GMM	
	Model 1	Model 2	Model 1	Model 2
LNEXPV (1)	0.9815***	0.9226***	0.9666***	0.9459***
	(50.60)	(18.16)	(21.53)	(16.25)
RDE	0.0428**	0.5017**	0.0180**	0.2962*
	(2.16)	(2.60)	(2.23)	(1.73)
DCPS		0.0069**		0.0056**
		(2.53)		(2.01)
RDE * DCPS		0.0052**		0.0326**
		(2.45)		(2.51)
EDU	−0.0072	−0.0037	−0.0025	−0.0027
	(−0.43)	(−1.36)	(−1.61)	(−0.92)
LFPR	0.2295***	0.0122	0.0082	0.0128
	(3.47)	(1.36)	(1.16)	(1.28)
LNFDI	0.0564	0.0720	−0.1030	0.0479
	(1.23)	(0.80)	(−1.54)	(0.70)
AR1	0.022	0.010	0.001	0.005
AR2	0.117	0.111	0.117	0.111
Sargan	0.001	0.000	0.000	0.000
Hansen	0.192	0.160	0.224	0.160
Observ.	1083	1083	1083	1083
Instruments	41	42	41	42
No. of groups	57	57	57	57
Year dummies	YES	YES	YES	YES

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. The t-statistics are in parentheses.

4.2.3. Innovation, FD and national income

Table 6 demonstrates the outcome of the relationship between innovation, FD and national income for the full sample. The results show an inconsistency in the effect of RDE on national income, thereby indicating a weak relationship between R&D expenditure and national income. The result of the short-run direct effect of R&D expenditure on national income is in line with Bozkurt (2015). However, factoring in FD, the outcomes show that DCPS and RDE*DCPS have substantial and positive effects on national income. Moreover, the result discloses that the direct influence of FD through DCPS on national income is greater than the indirect effect.

Table 6. Regression for innovation, FD and national income.

Parameter	One-step		Two-step	
	Model 1	Model 2	Model 1	Model 2
LNGNI (1)	0.8507***	1.1224***	0.8720***	1.1555***
	(19.69)	(12.22)	(18.87)	(11.55)
RDE	0.0215*	−0.1360	0.0125*	−0.1446
	(1.88)	(−1.15)	(2.31)	(−0.78)
DCPS		0.0047**		0.0037**
		(2.54)		(2.28)
RDE * DCPS		0.0024**		0.0021*
		(2.25)		(1.89)
EDU	0.0000	−0.0009	0.0002	−0.0020
	(−0.10)	(−0.08)	(0.18)	(−0.20)
LFPR	−0.0020	0.0288*	−0.0008	0.0209
	(−0.81)	(1.68)	(−0.26)	(1.19)
LNFDI	0.1054***	−0.0271	0.0797**	−0.0143
	(3.37)	(−0.63)	−2.26	(−0.37)
AR1	0.000	0.049	0.001	0.050
AR2	0.230	0.757	0.107	0.446
Sargan	0.000	0.057	0.000	0.057
Hansen	0.103	0.177	0.103	0.177
Observ.	1083	1083	1083	1083
Instruments	42	42	42	42
No. of groups	57	57	57	57
Year dummies	YES	YES	YES	YES

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. The t-statistics are in parentheses.

4.3. Further analysis

The study conducted an additional test to check the long-term relations among the variables of study. The outcomes of the long-run relationships are presented in Tables 7–9. In generating the long-run relationship, the study used the variables that have only significant impacts on the dependent variables in the short-run. A separate estimation was done to evaluate their effects. The long-run relationship is generated by dividing the coefficient of the significant variable by one minus the coefficient of the lagged response variable.

4.3.1. Long-run relationship for innovation, FD and export product

Table 7 presents the long-run relationship for the innovation-country export product nexus. The results reveal that, in model 1, R&D expenditure has a long-run relationship with country export product, with a unit increase leading to 0.7642 unit (one step System-GMM) or 0.7269 unit (two step System-GMM) increase in country product export. These findings are similar to the outcomes in model 2, both in the presence and without the presence of DCPS. Furthermore, the interaction of R&D

expenditure and FD reveal a long-run relationship with country growth both in the one step System-GMM and two step System-GMM.

Table 7. Long-run regression of innovation, FD and country export product.

Parameter	One step		Two step	
	Model 1	Model 2	Model 1	Model 2
RDE	0.7642***	−14.4202***	0.7269***	0.6231***
	(5.49)		(4.37)	(3.78)
LFPR				
DCPS		0.1982**		0.1654**
		(2.48)		(2.39)
RDE * DCPS		0.1508**		0.2010**
		(2.42)		(2.77)
LNFDI	−0.5472**		−0.6056**	
	(−2.51)		(−2.42)	

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses.

4.3.2. Long-run relationship for innovation, FD and export value

The study assessed the long-run relationship for the innovation-export value nexus and the role that FD plays in this relationship. From the results presented in Table 8, it is obvious that innovation, through R&D has a long-run impact on export value. For all the models under both one step and two step System-GMM, it is seen that increasing R&D expenditure by economies is associated with a rise in the countries' export values. FD being present, a unit increase in R&D expenditure will enhance 64986.35% (one step System-GMM) or 23769.82% (two step System-GMM) improvement in countries' values of exports, in the long-run. Similarly, the interaction term (RDE * DCPS) reveals a positive and significant long-run relationship with export value. More specifically, increase in domestic credit provided to private sectors along with more R&D expenditure will promote 6.96% (one step System-GMM) or 6.23% (two step System-GMM) value added to countries' exports. However, it is evidenced in the long-run that the direct effect (0.0895 for one-step and 0.1051 for two-step) of FD on export value is more than the indirect effect (0.0673 for one-step and 0.0604).

Table 8. Long-run regression of innovation, FD and export value

Parameter	One step		Two step	
	Model 1	Model 2	Model 1	Model 2
RDE	2.3114** (2.07)	6.4783* (1.65)	0.2384** (2.65)	5.4752** (2.48)
LFPR	−5.5895 (1.55)			
DCPS		0.0895*		0.1051**
		(1.67)		(2.07)
RDE * DCPS		0.0673*		0.0604*
		(1.72)		(1.87)

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses.

4.3.3. Long-run relationship for innovation, FD and national income

Table 9 depicts the long-run relation between the variables under consideration. The results reveal that, in model 1, RDE has a long-run influence on national income (Bozkurt, 2015). DCPS and RDE*DCPS have positive and substantial long-run effects on national income, as shown in model 2 in both one-step and two-step approaches. Moreover, the results show that, in the long-run, the direct effect of FD is more favorable than the indirect effect.

Table 9. Long-run regression for innovation, FD and national income.

Parameter	One step		Two step	
	Model 1	Model 2	Model 1	Model 2
RDE	0.1441**		0.0977**	
	(2.34)		(2.30)	
LFPR		−0.2352 (−1.28)		
DCPS		0.0390**		0.0240*
		(2.03)		(1.80)
RDE * DCPS		0.0193*		0.0137**
		(1.82)		(2.38)
LNFDI	0.7059***		0.6231***	
	(9.67)		(5.39)	

Note: *, ** and *** indicate 10%, 5% and 1% significance levels, respectively. The z-statistics are in parentheses.

4.4. Robustness

A further analysis is conducted to check the robustness of the results. In this analysis, the countries are divided into developed and developing economies, and a dynamic panel regression analysis is conducted on each group. Since the number of countries for developed and developing economies is 35 and 22, respectively, estimating these groups using system GMM is unreliable as Hansen and AR(2) test values fall out of the acceptable range, as well as the number of instruments exceeding number of groups. As such, the study uses the dynamic common correlated effects estimator (DCCE). DCCE allows for heterogeneity within the slopes, and the country specific estimates are averaged across all the groups. Moreover, using this estimator aids in solving the problem of cross-sectional dependence, as it allows instrumental-variable estimation and tests for weak cross-sectional dependence. Using the Autoregressive Distributed Lag (ARDL) option, both the short- and the long-run relationships are assessed. The results are presented in Tables 10–12 for developed economies and Tables 13–15 for developing economies.

4.4.1. Regression on developed economies

Table 10 demonstrates the robustness results on how FD affects innovation and country export product relation, for only the developed economies. The results show that RDE influences countries' export products in model 1. The result is similar to the long-run estimation. This implies that R&D

expenditure has both short-run (0.1247) and long-run (0.1247) impacts on the export products of developed economies. Moreover, with the existence of DCPS, it is observed in model 2 that RDE and DCPS have positive and significant relationships, both in the short-run and long-run, with export product. Nonetheless, the interaction term, RDE*DCPS has positive and insignificant relationship in the short-run, but it shows positive and significant impact in the long-run. These results imply that R&D expenditure has both direct and indirect impacts on export product for developed economies. However, the indirect impact through financial development is exhibited only in the long-run. Moreover, the direct impact exhibits a more favorable relationship than the indirect impact in the long-run.

Considering the controls, it is observed that labor force participation rate has both short-run and long-run significant impacts on export products. Moreover, the lagged dependent variable is positive and significant, indicating that the previous year's export product has an impact on the current level of export products. While the error term suggests previous disequilibrium is corrected at 110% (based on model 2), the p-value for the cross-sectional dependence statistics reveal that there is weak cross-sectional dependence.

Table 10. Regression for innovation, FD and country export product.

Parameter	Model 1	Model 2
DEPV.	EXPP	
SR		
L.EXPP	0.0601** (2.91)	0.0120*** (9.29)
RDE	0.1247** (2.28)	0.3991* (1.83)
DCPS		0.0128* (1.79)
RDE*DCPS		0.0097 (1.09)
EDU	−0.2571 (−0.90)	−0.0138 (−1.20)
LFPR	1.1351* (1.73)	0.3681** (2.26)
LNFDI	0.9702 (1.43)	−0.0449 (−0.95)
ECT (−1)	−1.0602*** (−33.64)	−1.1020*** (27.63)
LR		
DCPS		0.0028 (0.80)
EDU	−0.2428 (−0.87)	0.0139* (1.81)
RDE*DCPS		0.0098 (1.09)
LFPR	1.0327 (1.62)	0.3713** (2.26)
LNFDI	0.8563 (1.33)	−0.0453 (−0.95)
RDE	0.1247** (2.29)	0.4017* (1.83)
OBSERV.	663	663
GROUPS	35	35
F-statistics	3.47	1.93
Prob. > F	0.00	0.00
R-squared (MG)	0.80	0.81
CD. Statistics	1.26	1.13
p-value of CD	0.2087	0.2604

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses. DEPV., SR and LR indicate dependent variable, short-run and long-run.

In Table 11, the results reveal positive coefficients for RDE in model 1 for innovation and export value relation. Similarly, in the long-run, RDE is seen to favorably influence export value. However, in model 2, with the existence of DCPS, the outcomes show that RDE is positive but insignificant both in the short-run and the long-run. This implies that, with the existence of DCPS, R&D expenditure exhibits a weak relationship with export value. Nonetheless, DCPS is seen to have positive and substantial influence on export value only in the short-run (0.0167). Moreover, the interaction term, RDE*DCPS, shows favorable and substantial influence on export value both in the short-run (0.007) and in the long-run (0.0053). The implication is that FD has both short and long-run influences on the relation between innovation and export value. Furthermore, the direct influence of DCPS on export value (0.0167) is more favorable than the indirect effect on export value (0.0047). Still, the direct effect of innovation through R&D expenditure is more favorable without the presence of FD than with the presence of FD.

Additionally, the lag of LNEXPV is positive and significant within both models, implying that the past export values of the countries play major roles in the current year's export values. The p-values of the F-statistics as well as the CD-statistics imply that the model is fit and that there is no cross-sectional dependence across the panels.

Table 11. Regression for innovation, FD and export value.

Parameter	Model 1	Model 2
DEPV.	LNEXPV	
SR		
L.LNEXPV	0.0557* (1.82)	0.0720* (1.86)
RDE	0.2980* (1.92)	0.2210 (1.13)
DCPS		0.0167* (1.82)
RDE*DCPS		0.0047* (1.85)
EDU	−0.0015 (−0.36)	0.0077** (2.09)
LFPR	−0.0042 (−0.09)	−0.0400 (0.50)
LNFDI	−0.0057 (−0.60)	−0.0082 (−0.80)
ECT (−1)	−0.9443*** (−30.82)	−0.9280*** (−24.02)
LR		
DCPS		0.0297 (1.55)
EDU	−0.0019 (−0.45)	0.0095** (2.52)
RDE*DCPS		0.0053** (2.08)
LFPR	−0.0183 (−0.45)	−0.0985 (−1.02)
LNFDI	−0.0050 (−0.53)	−0.0028 (−0.23)
RDE	0.2602** (2.11)	0.2399 (1.28)
OBSERV.	663	663
GROUPS	35	35
F-statistics	1.49	1.76
Prob. > F	0.00	0.00
R-squared (MG)	0.99	0.99
CD. Statistics	0.17	0.29
p-value of CD	0.8656	0.7736

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses. DEPV., SR and LR indicate dependent variable, short-run and long-run.

In Table 12, it is observed that RDE has neither short-run nor long-run significant effects on national income in both models. This implies that, with or without DCPS, R&D expenditure does not influence LNGNI of developed economies. On the other hand, DCPS and its interaction term, RDE*DCPS, exhibit positive significant impacts on income growth of developed economies. However, while DCPS exhibits significant impact only in the short-run, RDE*DCPS is significant both in the short-run and the long-run. Similarly, the findings reveal that the indirect impact of DCPS is more favorable than the direct. FD is, therefore, seen to be more relevant in the relationship between R&D expenditure and national income. LFPR and LNFDI are seen to exhibit positive significant impacts in the short-run. However, this is inconclusive, as there is inconsistency in the outcomes among the two models. Moreover, the lagged coefficient of national income is positive and significant, indicating its relevance to the current year's national income improvement.

Table 12. Regression for innovation, FD and national income.

Parameter	Model 1	Model 2
DEPV.	LNGNI	
SR		
L.LNGNI	0.7115*** (13.87)	0.5575*** (9.52)
RDE	−0.0607 (−1.54)	0.0386 (0.86)
DCPS		0.0039* (1.84)
RDE*DCPS		0.0041** (2.00)
EDU	0.0009 (0.33)	0.0008 (0.22)
LFPR	0.0259* (1.70)	0.0211 (0.97)
LNFDI	0.0330*** (3.13)	−0.0000 (0.00)
ECT (−1)	−0.2885*** (−5.62)	−0.4425*** (−7.55)
LR		
DCPS		0.0134 (1.49)
EDU	0.0385 (0.99)	0.0135 (0.60)
RDE*DCPS		0.0119* (1.72)
LFPR	0.2543* (1.66)	0.0658 (1.32)
LNFDI	0.1252 (1.23)	−0.0159 (−0.43)
RDE	−1.2641 (−1.59)	0.0179 (0.12)
OBSERV.	663	663
GROUPS	35	35
F-statistics	17.00	10.27
Prob. > F	0.00	0.00
R-squared (MG)	0.94	0.96
CD. Statistics	0.44	−0.22
p-value of CD	0.6609	0.8239

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses. DEPV., SR and LR indicate dependent variable, short-run and long-run.

4.4.2. Regression on developing economies

Table 13 demonstrates the robust analysis between innovation, FD and country export product for developing economies. RDE has positive and consistent insignificant impacts across the models both in the short-run and the long-run. However, the results disclose a consistent positive and significant effect of DCPS and the interaction term, RDE*DCPS, on country product export, both in the short-run and in the long-run. These findings are in disagreement with Paudel and Alharthi (2021), as their study revealed no long-term relation for FD and export performance. The implication is that depth of FD in developing economies plays a vital role in the innovation-product export nexus by improving the relationship. The ability of innovation to propel an increasing effect on product export in developing economies, therefore, largely depends on the depth of financial institutions in the countries. Additionally, LFPR has a short-run positive effect on product export. These findings are in conformity with Shahbaz and Rahman (2014), as their study also revealed that FD induces exports growth in Pakistan. LNFDI, contrary to Gebremariam and Ying (2022), has a consistent positive and significant effect on export products of developing economies, both in the short-run and in the long-run.

Table 13. Regression for innovation, FD and export product.

Parameter	Model 1	Model 2
DEPV.	EXPP	
SR		
L.EXPP	0.1490** (2.27)	0.3391*** (3.39)
RDE	13.8922 (1.36)	9.9273 (0.18)
DCPS		0.1630** (2.09)
RDE*DCPS		2.7910** (2.33)
EDU	0.1722 (0.62)	0.8721 (1.31)
LFPR	6.3953* (1.77)	6.7698* (1.71)
LNFDI	2.9076** (2.41)	4.2694* (1.72)
ECT (−1)	−1.1490*** (17.49)	−1.3391*** (−13.37)
LR		
DCPS		0.0182** (2.01)
EDU	0.0599 (0.32)	0.6588 (1.42)
RDE*DCPS		2.0576** (2.30)
LFPR	5.4078 (0.88)	4.8248 (0.64)
LNFDI	2.6120*** (2.58)	3.8928** (2.04)
RDE	10.9368 (1.31)	6.4860 (0.16)
OBSERV.	416	416
GROUPS	22	22
F-statistics	1.14	1.74
Prob. > F	0.00	0.00
R-squared (MG)	0.81	0.89
CD. Statistics	0.49	0.03
p-value of CD	0.6215	0.9789

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses. DEPV., SR and LR indicate dependent variable, short-run and long-run.

From Table 14, RDE has positive but inconsistent significance effects on export value in models 1 and 2, indicating a weak relationship in the short-run. In the long-run, RDE exhibits positive and significant impacts within the two models. However, when DCPS is introduced, the results disclose that both DCPS and the interaction term, RDE*DCPS, have positive and substantial effects on export value in developing economies. Moreover, a long-run relationship is found between DCPS, RDE*DCPS and export value (see model 2). The findings affirm that RDE*DCPS (0.1720 for short-run and 0.2308 for long-run) yields a greater effect on export value in developing economies than DCPS (0.0281 for short-run, and 0.0385 for long-run). The implication is that the indirect effect of DCPS on export is more favorable than the direct effect. FDI has a weak relationship with developing economies' export value, as the results are inconsistent within the two models.

Table 14. Regression for innovation, FD and export value.

Parameter	Model 1	Model 2
DEPV.	LNEXPV	
SR		
L.LNEXPV	0.1952*** (3.58)	0.1485*** (2.67)
RDE	0.3763** (2.03)	0.8201 (1.50)
DCPS		0.0281* (1.85)
RDE*DCPS		0.1720** (1.97)
EDU	0.0047 (1.52)	−0.0060 (−0.95)
LFPR	0.0534 (0.28)	−0.0112 (−0.13)
LNFDI	0.0583** (2.01)	0.0059 (0.15)
ECT (−1)	−0.8048*** (−14.77)	−0.9309*** (−16.09)
LR		
DCPS		0.0385** (1.98)
EDU	0.0090 (1.58)	−0.0081 (−1.06)
RDE*DCPS		0.2308** (2.04)
LFPR	0.2224 (0.99)	−0.0328 (−0.30)
LNFDI	0.1048** (2.10)	−0.0034 (−0.07)
RDE	0.7697** (2.09)	1.1631* (1.65)
OBSERV.	416	416
GROUPS	22	22
F-statistics	1.64	2.05
Prob. > F	0.00	0.00
R-squared (MG)	0.98	0.99
CD. Statistics	1.15	0.22
p-value of CD	0.2499	0.8223

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses. DEPV., SR and LR indicate dependent variable, short-run and long-run.

Considering the robustness for the relationship between innovation, FD and national income, the results in Table 15 show consistency, in terms of significance, in the results of RDE throughout the models, indicating a strong effect of R&D expenditure on LNGNI. Without the presence of FD, R&D

expenditure exhibits adverse effects on national income for both short-run and long-run relationships. Similarly, Pala (2019) found a negative significant relationship between R&D expenditure and GDP growth of developing economies. However, upon introducing DCPS, the results show consistency in coefficients and significance in model 2 for both short-run and long-run relationship between R&D expenditure and national income. This means that FD is essential for improving the relationship between innovation and income growth of developing economies. DCPS and RDE*DCPS have positive and significant effects on income growth both in the short-run and in the long-run. Furthermore, the results demonstrate that the indirect effect of DCPS is more than the direct effect on income growth. This is in line with Paudel (2020). This implies that the significance of FD on the innovation-export nexus is directly reflected in the improvement in the economic growth of developing economies through the increase in income. Additionally, the results demonstrate that LNFDI has significant positive effects, both in the short-run and long-run, on income growth in developing economies, which supports the studies of Sultanuzzaman, Fan, Akash, Wang, and Shakij (2018). However, this is inconsistent with the results in model 2.

Table 15. Regression for innovation, FD and national income.

Parameter	Model 1	Model 2
DEPV.	LNGNI	
SR		
L.LNGNI	0.2838*** (5.58)	0.1330***(2.54)
RDE	−0.1550** (−1.97))	0.8264** (2.36)
DCPS		0.0269** (2.39)
RDE*DCPS		0.0773* (1.65)
EDU	−0.0027* (1.81)	−0.0033 (−1.24)
LFPR	−0.0051 (−0.18)	−0.0475 (−0.94)
LNFDI	0.0444*** (2.75)	−0.0039 (−0.14)
ECT (−1)	−0.7162*** (−14.09)	−0.8670*** (−10.04)
LR		
DCPS		0.0396*** (2.61)
EDU	−0.0042* (1.87)	−0.0033 (−1.17)
RDE*DCPS		0.1673* (1.73)
LFPR	−0.0213 (−0.50)	−0.0186 (−0.30)
LNFDI	0.0616** (2.42)	−0.0007 (−0.02)
RDE	−0.3181* (1.95)	1.5589* (1.76)
OBSERV.	416	416
GROUPS	22	22
F-statistics	1.60	1.49
Prob. > F	0.00	0.00
R-squared (MG)	0.68	0.99
CD. Statistics	0.31	0.06
p-value of CD	0.7536	0.9500

Note: *, ** and *** specify 10%, 5% and 1% significance levels, respectively. z-statistics are in parentheses. DEPV., SR and LR indicate dependent variable, short-run and long-run.

5. Conclusions

This study mainly examined the role of FD in the innovation-economic performance nexus. The study provides more evidence on how innovation, through financial development, influences economic performance in light of countries' trade and development. Specifically, economic performance was measured using three indicators: countries' export products to the world, export value and gross national income (GNI). Meanwhile, innovation was measured using R&D expenditure. Domestic credit provided to private sectors was used as a proxy for FD. The use of three indicators is to enable this study to provide a systematic approach in which innovation affects economic performance and, moreover, to provide reliable and valid empirical findings.

First, analyzing the full sample, the study reveals that FD and its interaction with R&D expenditure exert positive and significant effects on economic performance, both in the short-run and long-run, through the increase in export products, export value and the national income. Second, the findings on developed economies alone reveal that FD is pivotal in the innovation-growth nexus through the increase in export product (both short and long-run), export value (both short and long-run) and national income (both short and long-run). The findings implicate that increase in innovation activities, along with increased financial depth, within the developed economies augments economic development through improvement in export products, export value and the national income. Third, analyzing only developing economies, the study finds that FD has both short and long-run direct and indirect effects on export product, export value and national income. Moreover, the findings reveal that, in developing economies, the indirect influence of FD on economic performance through the increases in export product, export value and national income is more favorable than the direct effect. This implies that for developing economies to enjoy the full benefits of innovation on economic performance, an efficient and effective depth of the financial sector is required.

These findings come with the following policy implications for developing economics. Financial development, when accompanied with increase in R&D, is an essential driver for economic performance, as it enforces improvement in export products, export value and the national income. Moreover, the study implies that financial development has the ability to aid domestic firms in developing economies to enter into the foreign markets. As such, policy makers should ensure that efficient and effective financial reforms are carried out to ensure the easy accessibility of credit by both private and state manufacturing enterprises to enhance the expansion of the export sector. Moreover, there should be improvement in the laws and the regulations of the domestic financial market. Additionally, the study showed that FDI inflows in developing economies foster national income. As such, policymakers of developing economies should ensure favorable financial policies to attract foreign financial banks to improve the supply of money in the economy. However, this policy should be done with caution, as increases in financial banks in the economies could cause a crowding out effect.

Though this study has shown that financial development plays a vital role in the relationship between innovation and economic development, the focus is on financial institutions. Further study could be conducted focusing on the role of financial markets.

Conflict of interest

The author declares no conflicts of interest in this paper.

References

Aghion L, Howitt P, Levine R (2018) Financial development and innovation-led growth, In: Beck, T., Levine, R., *Handbook of finance and development*, Edward Elgar Publishing, 3–30. https://doi.org/10.4337/9781785360510.00007

Albert Henry N, Yusheng K, Michael Kobina G (2019) Banking system stability and economic sustainability: A panel data analysis of the effect of banking system stability on sustainability of some selected developing countries. *Quant Financ Econ* 3: 709–738. https://doi.org/10.3934/QFE.2019.4.709

Arellano M, Bond S (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Rev Econ Stud* 58: 277–297. https://doi.org/10.2307/2297968

Arellano M, Bover O (1995) Another look at the instrumental variable estimation of error-components models. *J Econom* 68: 29–51. https://doi.org/10.1016/0304-4076(94)01642-D

Ballot G, Fakhfakh F, Taymaz E (2006) Who benefits from training and R&D, the firm or the workers? *Brit J Ind Relat* 44: 473–495. https://doi.org/10.1111/j.1467-8543.2006.00509.x

Bayarçelik EB, Taşel F (2012) Research and Development: Source of Economic Growth. *Procedia Soc Behav Sci* 58: 744–753. https://doi.org/10.1016/j.sbspro.2012.09.1052

Beck T (2002) Financial development and international trade: Is there a link? *J Int Econ* 57: 107–131. https://doi.org/10.1016/S0022-1996(01)00131-3

Bilbao-Osorio B, Rodríguez-Pose A (2004) From R&D to Innovation and Economic Growth in the EU. *Growth Change* 35: 434–455. https://doi.org/10.1111/j.1468-2257.2004.00256.x

Blanco LR, Gu J, Prieger JE (2016) The impact of research and development on economic growth and productivity in the US states. *South Econ J* 82: 914–934. https://doi.org/10.1002/soej.12107

Blundell R, Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models. *J Econom* 87: 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Bozkurt C (2015) R&D expenditures and economic growth relationship in Turkey. *Int J Econ Financ Issues* 5: 188–198.

Brown JR, Fazzari SM, Petersen BC (2009) Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom. *J Finance* 64: 151–185. https://doi.org/10.1111/j.1540-6261.2008.01431.x

Cameron G (1996) Innovation and economic growth. Available from: http://eprints.lse.ac.uk/id/eprint/20685.

Chudik A, Pesaran MH (2013) Large panel data models with cross-sectional dependence: a survey. http://dx.doi.org/10.2139/ssrn.2316333

Comin D, Nanda R (2019) Financial Development and Technology Diffusion. *IMF Econ Rev* 67: 395–419. https://doi.org/10.1057/s41308-019-00078-0

Crespi G, Zuniga P (2012) Innovation and Productivity: Evidence from Six Latin American Countries. *World Dev* 40: 273–290. https://doi.org/10.1016/j.worlddev.2011.07.010

Das RC (2020) Interplays among R&D spending, patent and income growth: new empirical evidence from the panel of countries and groups. *J Innov Entrep* 9: 1–22. https://doi.org/10.1186/s13731-020-00130-8

Díaz-Chao Á, Sainz-González J, Torrent-Sellens J (2015) ICT, innovation, and firm productivity: New evidence from small local firms. *J Bus Res* 68: 1439–1444. https://doi.org/10.1016/j.jbusres.2015.01.030

DiPietro WR, Anoruo E (2006) Creativity, innovation, and export performance. *J Policy Model* 28: 133–139. https://doi.org/10.1016/j.jpolmod.2005.10.001

Dong K, Hochman G, Zhang Y, et al. (2018) CO_2 emissions, economic and population growth, and renewable energy: empirical evidence across regions. *Energy Econ* 75: 180–192. https://doi.org/10.1016/j.eneco.2018.08.017

Gebremariam TK, Ying S (2022) The foreign direct investment-Export performance nexus: An ARDL based empirical evidence from Ethiopia. *Cogent Econ Finance* 10: 2009089. https://doi.org/10.1080/23322039.2021.2009089

Georgeta BN, Eugenia ML, Florina FA (2016) Innovation And International Competitiveness Of A Country. *Ann Fac Econ* 1: 35–43.

Griffith R, Huergo E, Mairesse J, et al. (2006). Innovation and productivity across four European countries. *Oxford Rev Econ Policy* 22: 483–498. https://doi.org/10.3386/w12722

Hall BH (2011) Innovation and productivity. https://doi.org/10.3386/w17178

Holmstrom B (1989) Agency costs and innovation. *J Econ Behav Organ* 12: 305–327. https://doi.org/10.1016/0167-2681(89)90025-5

Hsu PH, Tian X, Xu Y (2014) Financial development and innovation: Cross-country evidence. *J Financ Econ 112*: 116–135. https://doi.org/10.1016/j.jfineco.2013.12.002

Huňady J, Orviská M (2014) The impact of research and development expenditures on innovation performance and economic growth of the country—the empirical evidence. *CBU International Conference Proceedings* 2: 119–125. https://doi.org/10.12955/cbup.v2.454

Hur J, Raj M, Riyanto YE (2006) Finance and trade: A cross-country empirical analysis on the impact of financial development and asset tangibility on international trade. *World Dev* 34: 1728–1741. https://doi.org/10.1016/j.worlddev.2006.02.003

ILYINA A, SAMANIEGO R (2011) Technology and Financial Development. *J Money Credit Bank* 43: 899–921. https://doi.org/10.1111/j.1538-4616.2011.00401.x

Klinger B, Lederman D (2006) Innovation and export portfolios. *World Bank Policy Research Working Paper*.

Law SH, Sarmidi T, Goh LT (2020) Impact of innovation on economic growth: Evidence from Malaysia. *Malaysian J Econ Stud* 57: 113–132. https://doi.org/10.22452/MJES.vol57no1.6

Lebel P (2008) The role of creative innovation in economic growth: Some international comparisons. *J Asian Econ* 19: 334–347. https://doi.org/10.1016/j.asieco.2008.04.005

Lee K, Kim BY (2009) Both institutions and policies matter but differently for different income groups of countries: Determinants of long-run economic growth revisited. *World Dev* 37: 533–549. https://doi.org/10.1016/j.worlddev.2008.07.004

Lerner J, Kortum S (2000) Assessing the contribution of venture capital to innovation. *Rand J Econ* 31: 674–692. https://doi.org/10.2307/2696354

Lewandowska MS, Szymura-Tyc M, Gołębiowski T (2016) Innovation complementarity, cooperation partners, and new product export: Evidence from Poland. *J Bus Res* 69: 3673–3681. https://doi.org/10.1016/j.jbusres.2016.03.028

López-Cabarcos MÁ, Piñeiro-Chousa J, Quiñoá-Piñeiro L (2021) An approach to a country's innovation considering cultural, economic, and social conditions. *ECON RES-EKON ISTRAZ* 34: 2747–2766. https://doi.org/10.1080/1331677X.2020.1838314

Maradana RP, Pradhan RP, Dash S, et al. (2017) Does innovation promote economic growth? Evidence from European countries. *J Int Entrepreneurship* 6: 1. https://doi.org/10.1186/s13731-016-0061-9

Martin L, Nguyen-Thi TU (2015) The Relationship Between Innovation and Productivity Based on R&D and ict Use. An Empirical Analysis of Firms in Luxembourg. *Rev Econ* 66: 1105–1130. https://doi.org/10.3917/reco.pr2.0048

Matei I (2020) Is financial development good for economic growth? Empirical insights from emerging European countries. *Quant Financ Econ* 4: 653–678. https://doi.org/10.3934/QFE.2020030

Meierrieks D (2014) Financial development and innovation: Is there evidence of a Schumpeterian finance-innovation nexus? *Ann Econ Financ* 15: 343–363.

Naliniprava T (2019) Does measure of financial development matter for economic growth in India? *Quant Financ Econ* 3: 508–525. https://doi.org/10.3934/QFE.2019.3.508

Nanid S, Biswas B (1991) Export and economic growth in India: Empirical evidence. *Indian Econ J* 38: 53–59. https://doi.org/10.1177/0019466219910305

Neves A, Teixeira AAC, Silva ST (2016) Exports-R&D investment complementarity and economic performance of firms located in Portugal. *Invest Econ* 75: 125–156. https://doi.org/10.1016/j.inveco.2016.03.004

Nguyen TH (2016) Impact of export on economic growth in vietnam: empirical research and recommendations. *Int Bus Manag* 13: 45–52. http://dx.doi.org/10.3968/9040

Pala A (2019) Innovation and Economic Growth in Developing Countries: Empirical Implication of Swamy's Random Coefficient Model (RCM). *Procedia Comput Sci* 158: 1122–1130. https://doi.org/10.1016/j.procs.2019.09.252

Paudel RC (2020) The role of financial development in economic growth of Nepal: ARDL approach of cointegration with structural break analysis. *J Econ Bus* 3.

Paudel RC, Alharthi M (2021) Role of financial development in the export performance of a landlocked developing country: The case of Nepal. *Cogent Econ Finance* 9: 1973653. https://doi.org/10.1080/23322039.2021.1973653

Pianta M, Vaona A (2007) Innovation and Productivity in European Industries. *Econ Innov New Technol* 16: 485–499. https://doi.org/10.1080/10438590600914569

Pradhan RP, Arvin MB, Bahmani S (2018) Are innovation and financial development causative factors in economic growth? Evidence from a panel granger causality test. *Technol Forecast Soc Change* 132: 130–142. https://doi.org/10.1016/j.techfore.2018.01.024

Roodman D (2009) How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata J* 9: 86–136. https://doi.org/10.1177/1536867X0900900106

Samila S, Sorenson O (2011) Venture capital, entrepreneurship, and economic growth. *Rev Econ Stat* 93: 338–349.

Schumpeter JA (1934) The theory of economic development, translated by Redvers Opie. *Harvard Econ Stud* 46: 0404.

Schumpeter JA, Capitalism S (1950) *Capitalism, Socialism, and Democracy*, 3rd Edition, Harper and Row, New York.

Shahbaz M, Rahman MM (2014) Exports, financial development and economic growth in Pakistan. *Int J Dev Issues* 13: 155–170. https://doi.org/10.1108/IJDI-09-2013-0065

Silve F, Plekhanov A (2015) Institutions, innovation and growth: cross-country evidence. http://dx.doi.org/10.2139/ssrn.3119688

Sultanuzzaman MR, Fan H, Akash M, et al. (2018) The role of FDI inflows and export on economic growth in Sri Lanka: An ARDL approach. *Cogent Econ Finance* 6: 1518116. https://doi.org/10.1080/23322039.2018.1518116

Tadesse SA (2005) Financial development and technology. http://dx.doi.org/10.2139/ssrn.681562

TEKİN E, HANCIOĞLU Y (2017) The Effects of Innovation on Export Performance in Developing Countries1, *Innovation and Global Issues 1: Extended Abstracts Book*, 416–418.

Ugochukwu US, Chinyere UP (2013) The impact of export trading on economic growth in Nigeria. *Int J Econ Bus Financ* 1: 327–341.

Verspagen B (2005) Innovation and economic growth, In: Fagerberg, J., Mowery, D.C., *The Oxford handbook of innovation*, Oxford Academic, 487–513. https://doi.org/10.1093/oxfordhb/9780199286805.003.0018

Vuckovic M (2016) The relationship between innovation and economic growth in emerging economies. *Organ Response Glob Driven Inst Changes* 130: 1–7.

Qiu XZ (2022) An empirical analysis of the influence of financial development on export trade: evidence from Jiangsu province, China. *ECON RES-EKON ISTRAZ* 35: 1526–1541. https://doi.org/10.1080/1331677X.2021.1975554

Yang CH (2006) Is innovation the story of Taiwan's economic growth? *J Asian Econ* 17: 867–878. https://doi.org/10.1016/j.asieco.2006.08.007

Yüksel S (2017) The impacts of research and development expenses on export and economic growth. *Int Bus Account Res J* 1: 1–8. http://dx.doi.org/10.15294/ibarj.v1i1.1

Zhang S (2019) *Essays on financial development, innovation and Chinese economy*, The University of Manchester (United Kingdom).

Zhao L, Liu Z, Wei W, et al. (2017) FDI outflows, exports and financial development. *J Econ Stud* 44: 987–1002. https://doi.org/10.1108/JES-01-2017-0020

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