Theoretical and Applied Economics
Volume XXX (2023), No. 1(634), Spring, pp. 91-114

The potential of macroeconomic forces and ICT in affecting the sectorial growth: ARDL approach in the context of East Asian countries

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Abstract. *The current study examines the potential of macroeconomic forces and information and communications technology in affecting sectorial growth. Hereby, the paper employs annual time series data varying from 2000 to 2021 with the regard to East Asia and the Pacific as a focus region. Within this framework, the study considers three different sectors namely manufacturing, services, and agriculture as proxies for sectoral growth. To proceed with the examination Autoregressive Distributed Lag (ARDL) model and Granger causality test are performed to capture the long-run and short-run dynamic relationship among the variables. As well as to determine the direction of these relationships. In accordance with the findings, the paper uncovered that both in the long and short run fixed telephone subscription, gross capital formation, government expenditure, population growth, and both importation and exportation are decreasing the growth of the manufacturing, agricultural, and service sectors. On the other hand, the general expenditure of the government and the rate of agricultural exportation raise the value produced by the agricultural sector in the long term. The recent findings can be used as evidence particularly for emerging nations and policymakers, on the necessity of utilizing certain macroeconomic elements and technology to support their nation's sectoral growth.*

Keywords: sectoral growth, ICT, macroeconomic factors, manufacturing sector, service sector, agricultural sector.

JEL Classification: F62, O11, O13, O32.

1. Introduction

The Asian powerhouse did not rise overnight. The "Asian Miracle", a phase of rapid economic growth marked by a "moving geese" form of growth, followed rapid expansion in Japan set the stage for this in the mid-1970s, and then the "Four Tigers" Hong Kong, Korea, Singapore, and Taiwan took off. Malaysia and Thailand followed these nations to take advantage of the high development route in the mid-1980s. China began to pick up pace in the late 1970s, particularly after entering the World Trade Organization at the beginning of 1990, it began to enjoy double-digit development, becoming a major economic power in Asia.

Notwithstanding the crisis's exceptional effects, the continent's economy demonstrated its ability and resiliency by quickly regaining the profitable export-led restoration path. This was especially true for several Asian economies. The Lehman Shock and the ensuing world financial crisis serve as a more contemporary example of this resiliency. The Asian economy maintained a reasonably high overall development after the recession.

Emerging Asia responded well throughout the 2008-2009 global recession. With the aid of bold and extensive financial policy and macroeconomic policy measures, it became the earliest area to recover from turbulence. Household consumption has remained strong, particularly in the bigger nations in the area, and the market trend strongly implies that economies have reached a bottom and are starting to rebuild. Within the first quarter of 2010, some Asian nations even got triple growth in their domestic product (GDP). Numerous elements contributed to this. Several scientific findings were capable of summarizing the factors behind Asia's economic development, which had been labeled a "marvel" in the nineties. They emphasize the significance of investment, intellectual resources, and demographic, structural, and political factors. (Lucas, 1993). For instance, Steven et al. (2001) conclude that East Asia's quick development was caused by its significant capacity for keeping pace, advantageous location and institutional traits, population surplus, and fiscal policies and growth-friendly tactics. The empirical research demonstrates that the continent's prolonged development was greatly influenced by economic policies, especially those that emphasized openness. (Lee and Hong, 2010, pp. 1-2).

Following the Second World War, significant Asian markets such as Japan, the Republic of Korea, and the People's Republic of China (PRC) underwent dramatic economic changes, experienced rapid capital accumulation growth, and witnessed considerable workforce shift patterns away from the farming industry and toward the manufacturing industry. Over this time, the manufacturing industry has emerged as a major driver of development. Substantial accumulation and expenditure levels, as well as export-focused regulations, have aided in this fast industrialization. Nevertheless, in recent years, the rapidly industrializing East Asian nations' rate of productivity growth has dropped dramatically. As the difference between their respective capita incomes and those of the US closed throughout the period, Japan's and other Asian economies formerly experienced high growth and started to slow down. The main drivers of the development slowdown have been identified as a variety of variables, notably reduced employment growth, lower capital rates, diminishing prices of return on capital, and slow technological innovation (Lee and McKibbin, 2018, p. 247).

The economic frameworks of different nations are incredibly varied. Regardless of whether the formation is driven by the exploitation of mineral materials, exports, farming practices that are targeted toward rural areas, commercial mass manufacturing, particularly in Asian nations, or the rise of services like communications and entertainment, etc. (Pham and Riedel, 2019, pp. 214-216).

By using ICT and beneficial market mechanisms, many nations maintain their sectorial growth. In order to visualize the cause and effect from the implied framework of development standpoint, the neoclassical theory of economic expansion and its amplified edition, the intrinsic component new tech transformation model, and the constructivist viewpoint to economic growth, the significance of innovation as a device of economic development has sparked numerous crucial and sensitive studies. Contrary to other sorts of technology, ICYT's ability to contribute to growth and progress in nations, particularly in poor nations is reliant on a number of variables, including externalities and spillover, institutionalized regulations that favor discoveries, and social resources. ICT may therefore be considered an overall technology that has an impact on several economic sectors and progressively alters how technology approaches development from a variety of angles. Firstly, ICT is a tool for integrating technology to different economic sectors, which has externalities or spillover effects on performance levels or GDP contributions. Second, ICT has aided in the remodeling of industrial operations, the development of systems, and the enhancement of information interchange both nationally and internationally. Thirdly, ICT has made it easier for those who are less fortunate to sustain their way of life. Fourthly, the development of e-government, e-finance, and e-commerce have contributed to the transformation of the way services are provided (Oyebanji et al., 2022, pp. 237-238).

The examination concerning economic forces, ICT influence, and economic growth have not existed without disparities. For instance, authors mainly focus on a limited sector or specific country. Notably, Asongu and Nwachukwu (2019) concentrated only on the impact of ICT, on the financial sector development. Garcia et al. (2016) examined only the link between ICT and the service sector without considering the influence of external factors. And Su et al. (2019) only attributed an exclusive focus on the influence of economic forces on labor participation. What is more, previous studies never investigated various sectors in the same paper. Authors have the tendency to separate sectorial analysis, for example, there is a scarcity of research comparing the service with the manufacturing sector or agriculture with the service sector, and so on. Accordingly, this paper examines the potential of economic forces and information and communications technology in affecting the sectorial growth of the East Asia region. Consequently, in order to investigate this case, the paper selected three different sectors namely, manufacturing, service, and agricultural sectors as proxies for sectorial growth. What is more, the ARDL approach and Granger causality test are used to observe the long-run and short-run estimates as well the direction of the relationships.

The format of this article is described in the following. The available literature is reviewed in the second part. The third section provides information on the sources and usage of the data as well as the econometric model. The fourth section interprets the empirical findings. The paper is concluded in the fifth section.

2. Literature review

The academic has accorded the factors that influence economic expansion a lot of emphasis. Within the last several years, development and research (R&D) and technology-based information and communication (ICT) have become more significant engines of economic development, according to a variety of conceptual and empirical frameworks. ICT's significant contribution to increased economic output, corporate profit growth, and the creation of high-value employment has led certain nations to step up their R&D spending and introduce new ICT systems. These expenditures have given rise to innovative ICT advancements that have accelerated economic expansion globally (Nair et al., 2020, pp. 1-2)

Since ICT and R&D have a favorable multiplier effect on economic growth, nations and business sectors all over the world have increased their R&D expenditures in the globalized era (Freire-Seren, 2001, pp. 20-21). According to current data by the European Commission and Organization for Economics and Development (OECD), the largest 2000 Technology transfer investors are driving advancements in the ICT sector, where over 75% of them have ICT copyrights and some other 60% have ICT concepts (Daiko et al., 2017). These expenditures and inventions have helped countries all around the world's economies flourish.

ICT is a term used to describe the convergence and interaction of operating systems, telecommunications, technology, networks, and information providers that have an impact on people, businesses, and the market in general. The increased use of ICT has resulted in lower communication prices, which has eventually aided in the dissemination of information and data. ICT is a crucial driver of economic progress, particularly in modern nations, and the present embodiment of the technology transformation (Farhadi et al., 2012, pp. 1-2). The use of the web and mobile devices over the past couple of decades has sped up the spread of ICT technologies. ICT development has connected economies throughout the world. Via international supply chains and metropolitan areas, it is gradually integrating its systemic framework and technical infrastructure into complex, bidirectional interconnections that span from the individual's micro-level establishment to the worldwide platform. As a result of the success and emergence of ICT-enabled connectivity groups in these countries, markets in the twenty-first century have become interlinked with urban centers (Majeed and Ayub, 2018, p. 444).

The majority of authors believe that ICT advancement is crucial for bettering living circumstances, fostering innovation, and fostering entrepreneurship and economic progress. ICT can contribute to local inclusion and trade efficiency. Additionally, it makes knowledge and data exchange, global awareness, and financial activity easier. ICT also improves worker productivity and competencies, which have a positive indirect impact on economic development, as well as commerce and banking improvement. ICT also has an impact on other significant economic sectors, like e-business, e-trading, and e-banking. By optimizing information availability, minimizing possible business segregation, and lowering high admission prices, e-commerce is cutting travel management, market discovery, and communication expenses as well as addressing many exporters' and manufacturers' limits (Xing, 2018, pp. 566-567).

2.1. An overview of the sectoral growth

The manufacturing sector has several positive effects that are essential for economic change and perform a pivotal function in the contemporary economy. In terms of growth in proportion to GDP intake, the manufacturing industry is notably significant in the urbanization process. Because of the sector's potential role as a driver of development, urbanization, industrialization, and technological changes, as well as a provider of skilled employment and a source of beneficial spillover and positive externalities, the manufacturing sector is of particular relevance in this research.

The manufacturing industry in East Asia has developed over the period and now encompasses a broad variety of economic operations, including the refining of petroleum, the production of cement, fresh vegetables, beverages, and nicotine, the manufacture of textiles, clothing, and shoes, the manufacture of papermaking products, the production of chemicals and pharmaceuticals, the production of non-metallic goods, the production of polycarbonate and plastic products, the production of electric power and internet-based products, the production of basic metals like iron and steel (Kehinde et al., 2019, pp. 53-54).

Small and medium-sized businesses (SMEs), specifically, are serving a significant role in boosting the economic growth of Asian nations as they have become more prominent in the international economy Dey et al. (2022, pp. 2-3). According to Penélope and Thirlwall (2013), manufacturing possesses the traits that enable growth for two principal reasons. First, overall constant and dynamic returns are increasing for manufacturing, but returns for land-based industries and small services are dropping. Second, when the manufacturing industry expands job opportunities increase in comparison to other industries.

Okon and Osesie (2017, pp. 11-13), examined the impact of the manufacturing sector on Nigeria's economic development during 1981 to 2015 using the ordinary least square (OLS) approach. The paper employed the preceding factors as the dependent and independent variables in its analysis of manufacturing output, government spending, investment rate, and money supply: gross domestic product, manufacturing output, government expenditure, investment rate, and money supply. According to the report, the main factors influencing economic development in Nigeria are an investment, technology, and the industrial sector's production. The findings also indicated that neither the workforce nor the caliber of organizations had any bearing on economic growth.

Rioba (2014, pp. 34-35) looked at how crucial the manufacturing sector is to Kenya's economic development. Time-series data from 1971 to 2013 were used in the study. The analyses' dependent variables were the growth rates of manufacturing employment, non-manufacturing output, and manufacturing output. Using the standard least squares approach, the data were examined. The study found a correlation between manufacturing output and economic development in Kenya, but it was not strong enough to support further expansion.

Another research emphasizes the position and significance of the Romanian industry, particularly the manufacturing sector, as well as its effects on labor and long-term growth. The study's findings indicate that Romania has been in a loss of manufacturing jobs process for more than 20 years. Manufacturing was able to continue to be the foundation of the Romanian sector and the overall economy after 2000 as the severity of the loss of manufacturing jobs diminished. Romanian manufacturing has significant challenges due to its poor worker efficiency and low level of high- and medium-tech industrial operations (Herman, 2016, p. 982).

The expansion of service sectors and the significant shift in employment from manufacturing to the service sector are two additional significant aspects of East Asia's prosperity. The well-known empirical observation that has been modeled demonstrates that there is a favorable correlation between the percentage of services in GDP (Eichengreen and Gupta, 2013).

Another empirical investigation with a concentration on the Indian service industry shows that the sector accounts for more than 55 percent of India's Gross domestic product. In many respects, the growth of services as the most vibrant sector of the Indian economy exceedingly even the conventional sectors have been referred to as a revolution. The Indian service sector serves a growing number of overseas (outsourcing) customers in addition to serving the sizable Indian market. This has accelerated even further as a result of rising globalization and improved technology-enabled enhanced communication. Along with serving a significant local market, Indian service companies also deliver a variety of services to numerous overseas companies at lower prices (Idris and Naqshbandi, 2018, p. 169).

Numerous research has objectively looked at how FDI affects the growth of the service sector, and their findings have also varied. Agya and Wunuji (2014, p. 59) discovered a two-way causal relationship between the expansion of the service sector and FDI influx. They discovered that FDI supports the growth of the services sector by giving both monetary and technical aid, but as this sector expands, it also increases the influx of FDI from overseas. They contend that FDI investment into the service sector will raise service performance. Parallel to how it will be able to draw more FDI from overseas as it grows more profitable.

Additionally, a number of studies have shown the beneficial impact of trade openness on the expansion of the service sector. Singh and Kaur (2014, pp. 401-405) contend that trade openness has a particularly good impact on the expansion of the service sector. They claim that as trade becomes more open, the proportion of services in global commerce will rise. El Khoury and Savvides (2006, pp. 5-7) discovered that when trade is more open and the trading nation has a greater rate of per capita earnings, the percentage of services in trade volume will raise. However, when the trading nation has a lower rate of per capita income, the proportion of commodities in trade volume will significantly raise at the expense of the share of services in total trade.

Hamidov et al. (2016) examined the effects of agricultural land usage in five Central Asian nations between 2008 and 2013 by analyzing 362 papers. Owing to its position, Central Asia is crucial both geopolitically and strategically. China, the Middle East, and Europe are connected commercially via the nations of Central Asia. Because it contributes between 20 and 50% of the working force and accounts for 10 to 45% of the national GDP, agriculture is one of the key economic sectors in Central Asian nations.

The agriculture industry is another crucial one for any country. For instance, this sector is crucial to the expansion of the economies of most MENA nations, yet these nations are located in the driest and most water-scarce region of the globe, and many of them, particularly those in the Mediterranean region, are heavily reliant on agriculture. As a result, the influence of the least developed industry on the region's economies varies greatly, for instance, from roughly 3.2 percent in Saudi Arabia to 13.4 percent in Egypt. Increased automation and substantial irrigation have allowed for the vast cultivation of high-value cash commodities, such as fruits, vegetables, grains, and glucose (Abdelmadjid, 2019, p. 3).

Bakari and Mabrouki (2018, p.10), looked into the connection between agricultural commerce and economic development in four North African nations between 1982 and 2016. Frameworks with fixed and random effects were employed. The research showed that Economic output, capital accumulation, and agricultural exports all positively affect economic growth, with the exception of agricultural imports, which had an insignificant sign. They claimed that in order to offset the number of imports, the agricultural sector needs to be developed and expenditures committed.

Using the ARDL model Fayçal and Ali (2016, p. 112) looked at the link between economic development in Algeria between 1970 and 2014 and government assistance for the agriculture sector. Additionally, they came to the conclusion that overall agricultural assistance, irrespective of how it relates to output and suppliers, has a beneficial long-term impact on agricultural efficiency development and economic growth.

In a study conducted by Dirir (2022, p. 23), he performed panel data from 2002 to 2022 on eight nations to estimate the number of agricultural exports. The research found that all other factors had a notable and substantial impact on agricultural exports throughout the models, with the exception of agricultural irrigated land and yearly freshwater withdrawals in agriculture.

Faridi (2012, p. 143) used a VECM model and evaluated the long-term relationship between Pakistan's GDP, agricultural exports, and non-agricultural exports from 1972 to 2008. He discovered that the capital value, employment levels, and non-agricultural exports all significantly and positively impact economic growth, suggesting that an increase of only one unit in any of these factors might increase GDP's velocity.

3. Data, model, and methodology

3.1. Data source and description

The current study examines the potential of macroeconomic forces and information and communications technology in affecting sectorial growth. Hereby, the paper employs annual time series data varying from 2000 to 2021 with the regard to East Asia and the Pacific as a focus region. The selection of this region is because of the dramatic evolution after the Second World War and the 1997 crisis. This evolution is called the East Asian economic miracle, which was achieved due to low levels of government spending and taxes, exceptionally high asset accumulation by Keynesian criteria, consistent overabundance in government revenues, and a minimal welfare state. More importantly, the prominent technological development of the region contributed to sustaining economic growth.

Based on this fact, the study considered three different sectors namely manufacturing, services, and agriculture to assess sectoral growth. As a result, we consider indicators such as Manufacturing value-added, Services value-added, and Agriculture value-added as proxies for the three sectors. What is more, the study is considering factors such as fixed telephone subscriptions, and Mobile cellular subscriptions as proxies for ICT measurement. Further, various macroeconomic forces notably, Gross fixed capital formation, General government final consumption expenditure, Population growth, and the trade of each sector are selected. Within this scope, to carry on with the examination Autoregressive Distributed Lag (ARDL) model and Granger causality test are performed to capture the long-run and short-run dynamic relationship among the variables. As well as to determine the direction of these relationships.

All the information was extracted from the World Bank Indicators.

Table 1. *Description of variables*

Variable	Abbreviation	Description	Measurement	Proxy
Dependent	MA	Manufacturing growth	Manufacturing, value added (% of GDP)	Sectorial growth
	VA	Service growth	Services, value added (% of GDP)	
	AV	Agricultural growth	Agriculture, value added (% of GDP)	
Independent	FT	Fixed telephone subscriptions	Fixed telephone subscriptions per 100 people	Information and communications technology
	MC	Mobile cellular subscriptions	Mobile cellular subscriptions per 100 people	
	MI	Manufacturing import	Manufactures imports (% of merchandise imports)	Macroeconomic Forces
	MX	Manufacturing export	Manufactures exports (% of merchandise exports)	
	SI	Service import	Service import in us$	
	SE	Service export	Service export in us$	
	AE	Agricultural export	Agricultural (% of merchandise exports)	
	AI	Agricultural import	Agricultural (% of merchandise imports)	
	GF	Capital formation	Gross fixed capital formation (% of GDP)	
	GV	Total Expenditure	General government expenditure (% of GDP)	
	PG	Population growth	Population growth (annual %)	

3.2. Econometric model

The study applies the ARDL method for an empirical investigation of cointegration developed by (Pesaran and Shin, 1999). The ARDL approach has the benefit of not requiring the same degree of integration for each variable, which is a benefit. It is not particularly important if a factor has order zero, order one, or a variable order of integration. ARDL is preferable to traditional cointegration methods because of this property. Since the traditional cointegration techniques become unstable because the test's ability to detect cointegration is reduced when there is a mixed order of integration (Laurenceson and Chai, 2003). Accordingly, the empirical models for this study are divided into three categories: the manufacturing sector model, the service sector model, and the agricultural sector model.

$$MA = \int (FT, GF, GV, PG, MI, MX, MC) \quad (1)$$

$$VA = \int (FT, GF, GV, PG, SI, SE, MC) \quad (2)$$

$$AV = \int (FT, GF, GV, PG, AE, AI, MC) \quad (3)$$

We observe MA, VA, and AV which expresses the three different sectorial models employed in the study and FT, GF, GV, PG, MI, MX, SI, SE, AE, AI, and MC which denote the regressors. Once the above equations are log-linearized, the below equation is generated:

$$MA_t = \beta_0 + \beta_1 FT_t + \beta_2 GF_t + \beta_3 GV_t + \beta_4 PG_t + \beta_5 MI_t + \beta_6 AMX_t + \beta_7 MC_t + \varepsilon_t \quad (4)$$

$$VA_t = \beta_0 + \beta_1 FT_t + \beta_2 GF_t + \beta_3 GV_t + \beta_4 PG_t + \beta_5 SI_t + \beta_6 SE_t + \beta_7 MC_t + \varepsilon_t \quad (5)$$

$$AV_t = \beta_0 + \beta_1 FT_t + \beta_2 GF_t + \beta_3 GV_t + \beta_4 PG_t + \beta_5 AE_t + \beta_6 AI_t + \beta_7 MC_t + \varepsilon_t \quad (6)$$

In these equations, β_0 is the constant, and ε_t is regarded as the equation's error term. The parameters of β_1 through β_7 are the coefficients that are utilized to calculate the different sectorial growth. Additionally, it is possible to compute both the short-run and long-run coefficients simultaneously. The preceding models were developed in order to establish ARDL bounds:

$$\begin{aligned}\Delta MA_t = {} & \propto_0 + \sum_{i=t}^{p} \propto_1 \Delta MA_{t-} + \sum_{i=t}^{p} \propto_2 \Delta FT_{t-1} + \sum_{i=t}^{p} \propto_3 \Delta GF_{t-1} + \sum_{i=t}^{p} \propto_4 \Delta GV_{t-1} \\ & + \sum_{i=t}^{p} \propto_5 \Delta PG_{t-1} + \sum_{i=t}^{p} \propto_6 \Delta MI_{t-1} + \sum_{i=t}^{p} \propto_7 \Delta MX_{t-1} \\ & + \sum_{i=t}^{p} \propto_8 \Delta MC_{t-1} + \lambda_1 MA_{t-1} + \lambda_2 FT_{t-1} + \lambda_3 GF_{t-1} + \lambda_4 GV_{t-1} \\ & + \lambda_5 PG_{t-1} + \lambda_6 MI_{t-1} + \lambda_7 MX_{t-1} + \lambda_8 MC_{t-1}\varepsilon\end{aligned} \quad (7)$$

$$\Delta \mathrm{VA_t} = \propto_0 + \sum_{i=t}^{p} \propto_1 \Delta VA_{t-} + \sum_{i=t}^{p} \propto_2 \Delta FT_{t-1} + \sum_{i=t}^{p} \propto_3 \Delta GF_{t-1} + \sum_{i=t}^{p} \propto_4 \Delta GV_{t-1} + \sum_{i=t}^{p} \propto_5 \Delta PG_{t-1} + \sum_{i=t}^{p} \propto_6 \Delta SI_{t-1} + \sum_{i=t}^{p} \propto_7 \Delta SE_{t-1} + \sum_{i=t}^{p} \propto_8 \Delta MC_{t-1} + \lambda_1 MA_{t-1} + \lambda_2 FT_{t-1} + \lambda_3 GF_{t-1} + \lambda_4 GV_{t-1} + \lambda_5 PG_{t-1} + \lambda_6 SI_{t-1} + \lambda_7 SE_{t-1} + \lambda_8 MC_{t-1} \varepsilon \quad (8)$$

$$\Delta \mathrm{AV_t} = \propto_0 + \sum_{i=t}^{p} \propto_1 \Delta AV_{t-} + \sum_{i=t}^{p} \propto_2 \Delta FT_{t-1} + \sum_{i=t}^{p} \propto_3 \Delta GF_{t-1} + \sum_{i=t}^{p} \propto_4 \Delta GV_{t-1} + \sum_{i=t}^{p} \propto_5 \Delta PG_{t-1} + \sum_{i=t}^{p} \propto_6 \Delta AE_{t-1} + \sum_{i=t}^{p} \propto_7 \Delta AI_{t-1} + \sum_{i=t}^{p} \propto_8 \Delta MC_{t-1} + \lambda_1 MA_{t-1} + \lambda_2 FT_{t-1} + \lambda_3 GF_{t-1} + \lambda_4 GV_{t-1} + \lambda_5 PG_{t-1} + \lambda_6 AE_{t-1} + \lambda_7 AI_{t-1} + \lambda_8 MC_{t-1} \varepsilon \quad (9)$$

The $\propto$ 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 ($\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = \lambda_8 = 0$) or the alternative hypothesis of cointegration ($\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq \lambda_7 \neq \lambda_8 \neq 0$) based on the F-test. Additionally, this F-test was developed based on the relevance of the lower and upper bound values, which were primarily expressed by (Pesaran et al., 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 formulas are shown below.

$$\Delta \mathrm{MA_t} = \gamma_0 + \sum_{i=t}^{p} \delta_i \Delta MA_{t-1} + \sum_{i=t}^{p} \phi_i \Delta FT_{t-1} + \sum_{i=t}^{p} \phi_i \Delta GF_{t-1} + \sum_{i=t}^{p} \phi_i \Delta GV_{t-1} + \sum_{i=t}^{p} \phi_i \Delta PG_{t-1} + \sum_{i=t}^{p} \phi_i \Delta MI_{t-1} + \sum_{i=t}^{p} \phi_i \Delta \mathrm{MX}_{t-1} + \sum_{i=t}^{p} \phi_i \Delta MC_{t-1} + \mu ECT_{t-1} + \upsilon_t \quad (10)$$

$$\Delta VA_t = \gamma_0 + \sum_{i=t}^{p} \delta_i \Delta VA_{-1} + \sum_{i=t}^{p} \phi_i \Delta FT_{t-1} + \sum_{i=t}^{p} \phi_i \Delta GF_{t-1} + \sum_{i=t}^{p} \phi_i \Delta GV_{t-1} + \sum_{i=t}^{p} \phi_i \Delta PG_{t-1} + \sum_{i=t}^{p} \phi_i \Delta SI_{t-1} + \sum_{i=t}^{p} \phi_i \Delta SE_{t-1} + \sum_{i=t}^{p} \phi_i \Delta MC_{t-1} + \mu ECT_{t-1} + \upsilon_t \quad (11)$$

$$\Delta AG_t = \gamma_0 + \sum_{i=t}^{p} \delta_i \Delta AG_{-1} + \sum_{i=t}^{p} \phi_i \Delta FT_{t-1} + \sum_{i=t}^{p} \phi_i \Delta GF_{t-1} + \sum_{i=t}^{p} \phi_i \Delta GV_{t-1} + \sum_{i=t}^{p} \phi_i \Delta PG_{t-1} + \sum_{i=t}^{p} \phi_i \Delta AE_{t-1} + \sum_{i=t}^{p} \phi_i \Delta AI_{t-1} + \sum_{i=t}^{p} \phi_i \Delta MC_{t-1} + \mu ECT_{t-1} + \upsilon_t \quad (12)$$

According to the overall models above, the parameters μ, reflect the speed of adjustment, and ECT stands for the error correction term.

3.3. Granger causality test

Additionally, it was intended to record how the different variables related to one another causally. The Granger causality test, recommended by (Granger, 1969), was performed to ascertain whether there is a causal link between the variables. Below a more comprehensive explanation of the model is provided:

$$X_t = \sum_{l=1}^{p} \left(a_{11,1} X_{t-1} + a_{12,1} Y_{t-1}\right) + \mu_t \quad (13)$$

$$Y_t = \sum_{l=1}^{p} \left(a_{21,1} X_{t-1} + a_{22,1} Y_{t-1}\right) + \epsilon_t \quad (14)$$

As presented in equation (13) and (14) is the model order, $a_{ij,1}(i,j = 1,2)$ are the coefficients of the model, and μ_t and ϵ_t denotes the residuals. Ordinary least squares can be used to estimate the coefficients, and F tests can identify the Causality relationship between X and Y.

3.4. Unit root test

To ensure the stability and reliability of the data the study performed stationarity tests that consist of the Augmented Dickey-Fuller test (ADF) and the Phillips-Perron test (PP). Starting with the augmented Dickey-Fuller test, it assumes that u is a white noise error term. However, if u is autocorrelated we would need a drift version of the test which allows for higher-order lags. Accordingly, the test is augmented using p lags of the original series (Dickey and Fuller, 1979). Furthermore, the Phillips-Perron test corrects for any serial correlation and heteroskedasticity in the errors by some direct modification to the test statistics (Phillips and Perron, 1988). Below the equations for both tests are presented.

$$\Delta y_t = \psi y_{t-1} + \mu + \alpha t + \sum_{i=1}^{p} \beta \Delta y_{t-1} + u_t \quad (15)$$

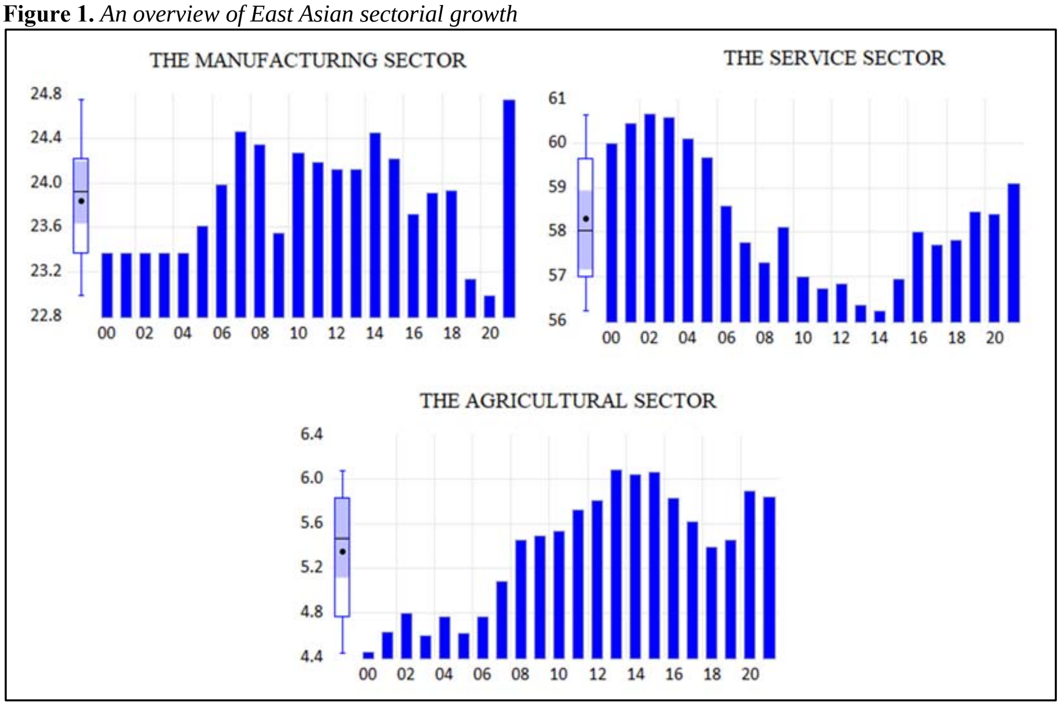
$$\Delta y_t = \psi y_{t-1} + \mu^* + \delta t + u_t, \qquad u_t \backsim I(0), ARMA(p,q) \quad (16)$$

As per equation (15) p is used to augment the past autoregressive lags of the difference term. While μ and αt denotes the time trend parameter and also the intercept. In equation (16) ψy consist of the initial term of the data while the term u_t implies the stationarity at level I(0). Additionally, μ^* expresses the intercept while δt denotes the time trend.

4. Findings analysis

The figure below provides an overview of the different sectoral growth in East Asian countries. Based on Figure 1, the manufacturing sector has continued to grow over the years reaching a peak of 24.8% in 2021 in comparison to other sectors. Next, the service sector appears to be decreased over the years from 60% to 55%. Interestingly, even with the rise of technological development and the prominent industrialization of East Asia, the agriculture sector has never stopped expanding during the last 21 years which illustrates the efforts of East Asian countries of promoting the agricultural sector.

Figure 1. *An overview of East Asian sectorial growth*



Source: Author's analysis.

The descriptive statistics enabled researchers 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. Starting with the manufacturing sector the percentage of growth in that sector ranges from 22.99 to 24.75, with an average of 23.92. Next, the service sector reveals a minimum of 56.23% to a maximum of 60.66% and an average of 58.05%. Further, the agricultural sector exhibits a minimum growth of 4.44% and reaches a maximum growth of 6.08% over the years. All the variables have a positive kurtosis and low level of standard deviation which implies the absence of volatility among the variables. More importantly, all the variables are negatively skewed except VA, GV, MI, AE, and AI.

Table 2. *Descriptive statistics*

	MA	VA	AV	FT	GF	GV	PG
Median	23.92	58.05	5.47	8.61	31.90	16.2	0.73
Maximum	24.75	60.66	6.08	8.71	35.12	17.5	0.94
Minimum	22.99	56.23	4.44	8.45	27.47	15.3	0.26
Std. Dev.	0.48	1.42	0.54	0.08	2.77	0.50	0.14
Skewness	-0.01	0.31	-0.31	-0.2	-0.17	0.39	-1.40
Kurtosis	1.91	1.87	1.65	1.61	1.41	3.50	5.40
Jarque-Bera	1.07	1.52	2.03	1.91	2.41	0.79	12.49
	MI	MX	SI	SE	AE	AI	MC
Median	66.5	81.5	11.96	11.93	1.20	2.26	9.24
Maximum	75.5	84.1	12.17	12.11	1.61	3.24	9.48
Minimum	59.1	75.4	11.5	11.51	0.88	1.71	8.37
Std. Dev.	4.97	3.16	0.21	0.20	0.167	0.39	0.34
Skewness	0.20	-0.3	-0.47	-0.54	0.22	0.66	-0.75
Kurtosis	2.15	1.51	1.80	1.80	3.26	3.08	2.33
Jarque-Bera	0.81	2.46	2.126	2.38	0.25	1.61	2.47
Observation	22	22	22	22	22	22	22

Source: Author's analysis.

Another crucial method for getting assumptions between variables before they are approached is the correlation matrix.

In Table 3 the results for the manufacturing sector demonstrates a moderate positive correlation between FT, GF, SI, SE, AE, and MC with the manufacturing sector. Whereas, we observe a negative correlation between GV, PG, MI, and AI with the manufacturing sector. Similarly, we perceive a positive relationship between FT, GF, GV, SI, SE, and MC with the agricultural sector. This suggests, both the manufacturing and agricultural sector are correlated with the same ICT indicators and macroeconomic forces. However, the service sector display unidentical outcome. For instance, we detect a negative correlation between FT, GF, GV, SI, SE, AE, and MC with the service sector. Based on this result we comprehend that the service sector is negatively correlated with the factors that have a positive relationship with the manufacturing and agricultural sectors.

Table 3. *Matrix of correlation*

Variables	MA	VA	AV	FT	GF	GV	PG
MA	1	-0.63	0.48	0.38	0.31	-0.22	-0.19
VA	-0.63	1	-0.82	-0.38	-0.68	-0.15	0.17
AV	0.48	-0.82	1	0.02	0.88	0.59	-0.50
FT	0.38	-0.38	0.02	1	-0.24	-0.52	0.21
GF	0.31	-0.68	0.88	-0.24	1	0.72	-0.65
GV	-0.22	-0.15	0.59	-0.52	0.72	1	-0.62

Variables	MA	VA	AV	FT	GF	GV	PG
PG	-0.19	0.17	-0.50	0.21	-0.65	-0.62	1
MI	-0.64	0.91	-0.79	-0.37	-0.70	-0.23	0.32
MX	-0.51	0.79	-0.61	-0.58	-0.33	0.01	-0.14
SI	0.42	-0.75	0.88	-0.06	0.96	0.58	-0.64
SE	0.45	-0.78	0.89	-0.04	0.95	0.57	-0.64
AE	0.13	-0.04	-0.29	0.34	-0.50	-0.51	0.72
AI	-0.33	0.56	-0.75	-0.09	-0.80	-0.54	0.83
MC	0.40	-0.74	0.89	0.02	0.93	0.62	-0.69
Variables	MI	MX	SI	SE	AE	AI	MC
MA	-0.64	-0.51	0.42	0.45	0.13	-0.33	0.40
VA	0.91	0.79	-0.75	-0.78	-0.04	0.56	-0.74
AV	-0.79	-0.61	0.88	0.89	-0.29	-0.75	0.89
FT	-0.37	-0.58	-0.06	-0.04	0.34	-0.09	0.02
GF	-0.70	-0.33	0.96	0.95	-0.50	-0.80	0.93
GV	-0.23	0.01	0.58	0.57	-0.51	-0.54	0.62
PG	0.32	-0.14	-0.64	-0.64	0.72	0.83	-0.69
MI	1	0.74	-0.76	-0.79	-0.01	0.63	-0.75
MX	0.74	1	-0.39	-0.42	-0.34	0.24	-0.42
SI	-0.76	-0.39	1	0.99	-0.47	-0.85	0.98
SE	-0.79	-0.42	0.99	1	-0.44	-0.85	0.97
AE	-0.01	-0.34	-0.47	-0.44	1	0.71	-0.50
AI	0.63	0.24	-0.85	-0.85	0.71	1	-0.90
MC	-0.75	-0.42	0.98	0.97	-0.50	-0.90	1

Source: Author's analysis.

In order to ascertain whether the random walk assumption is present in the long-term fluctuated period information, the ADF and Phillip Perron test unit root tests are used.

Consequently, in accordance with Table 4, the outcome for both tests reveals that all the variables are stationary at first difference except for MA, and MC which displayed stationarity both at the level and first difference. Hence, we can proceed with the cointegration approach since the panel unit root test results indicate that certain variables are stationary at a level while others are stationary after the first difference and the variables did not reach the second difference.

Table 4. *Unit root test*

Variables	Panel A: Augmented Dickey-Fuller test (ADF) test				
	At level	Note	At first difference	Note	Decision
MA	-2.781*	Stationary	-4.748***	Stationary	I (0) I (1)
VA	-1.693	Not stationary	-2.772*	Stationary	I (1)
AV	-1.378	Not stationary	-3.632**	Stationary	I (1)
FT	-2.006	Not stationary	-3.217**	Stationary	I (1)
GF	-1.004	Not stationary	-4.350***	Stationary	I (1)
GV	-0.983	Not stationary	-3.527**	Stationary	I (1)
PG	1.234	Not stationary	-2.843*	Stationary	I (1)
SI	-2.020	Not stationary	-3.236**	Stationary	I (1)
SE	-1.846	Not stationary	-3.247**	Stationary	I (1)
MI	-1.803	Not stationary	-3.086**	Stationary	I (1)
MX	-1.201	Not stationary	-2.728*	Stationary	I (1)
AI	-1.880	Not stationary	-3.358**	Stationary	I (1)
AE	-1.501	Not stationary	-4.050***	Stationary	I (1)
MC	-2.547	Not stationary	-4.223***	Stationary	I (1)

Variables	Panel B: Phillips-Perron test (ADF) test				
	At level	Note	At first difference	Note	Decision
MA	-2.524	Not stationary	-3.367**	Stationary	I (1)
VA	-1.318	Not stationary	-3.417**	Stationary	I (1)
AV	-1.516	Not stationary	-3.625**	Stationary	I (1)
FT	-1.779	Not stationary	-4.032***	Stationary	I (1)
GF	-0.394	Not stationary	-3.381**	Stationary	I (1)
GV	-1.604	Not stationary	-4.763***	Stationary	I (1)
PG	-1.036	Not stationary	-3.181**	Stationary	I (1)
SI	-1.767	Not stationary	-4.367***	Stationary	I (1)
SE	-1.658	Not stationary	-5.133***	Stationary	I (1)
MI	-1.600	Not stationary	-3.863***	Stationary	I (1)
MX	-1.428	Not stationary	-5.008***	Stationary	I (1)
AI	-1.879	Not stationary	-3.134**	Stationary	I (1)
AE	-1.455	Not stationary	-4.742***	Stationary	I (1)
MC	-10.621***	Stationary	-2.576	Not stationary	I (0) I (1)

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively

Source: Author's analysis.

In order to create an effective analysis, the Autoregressive distributed lag test method will assist us to assesse the short- and long-run elasticities between variables. With that in mind, the ARDL bounds prediction of Table 5 demonstrates that all the models contain factors that are serially correlated and exhibit long-run relationships. Accounting for causality and partial equilibrium correlations seen between variables, the F-statistics are noteworthy for all the models at the 1% level with 9.42, 4.61, and 4.22 values that are underneath the I (1) upper limit. As a result, we will proceed with the error correction and long-run estimation.

Table 5. *ARDL bounds testing estimates*

Significance	I (0) Bound	I (1) Bound
10%	1.92	2.89
5%	2.17	3.21
2.5%	2.43	3.51
1%	2.73	3.9
Model 1. Manufacturing sector		
Test Statistic	Value	K
F-Statistic	9.4245	7
Model 2. Service sector		
Test Statistic	Value	K
F-Statistic	4.6109	7
Model 3. Agricultural sector		
Test Statistic	Value	K
F-Statistic	4.2216	7

Source: Author's analysis.

Table 6 expresses both the long-run and short-run cointegration for the manufacturing sector. Additionally, the model shows that the error correction term (called Adjustment) is statistically significant and negative (-1.41). This statement demonstrates the rate at which equilibrium is restored following a shock to the long-run causal relation. Based on the short-run results, we observe that FT, GF, GV, PG, MI, and MX are negatively affecting the growth of the manufacturing sector. This implies that fixed telephone subscription, gross capital formation, government expenditure, population growth, and both importation and exportation are decreasing the growth of the manufacturing sector. Simultaneously, the long-run result displays an identical outcome to the short-run estimation. For instance, we perceive the level of fixed telephone subscription, gross capital formation, government expenditure and the percentage of trade are reducing the manufacturing sector by 9.6%, 0.3%, 1.1%, -0.12%, and -0.13% respectively.

Table 6. *Model 1 manufacturing sector*

Sector: Manufacturing value added				
Selected Model: ARDL (1, 0, 1, 0, 0, 1, 1, 1)				
Short-run cointegrating Form				
Variables	Coefficients	St. Error	t-Statistics	Prob.
∆MA(-1)	-1.418180***	0.380420	-3.727930	0.0058
∆FT	-13.74944**	4.098137	-3.355047	0.0100
∆GF	-0.233315	0.199166	-1.171459	0.2751
∆GF(-1)	-0.548084*	0.256178	-2.139463	0.0648
∆GV	-1.581604***	0.351740	-4.496519	0.0020
∆PG	-3.080948**	1.166113	-2.642066	0.0296
∆MI	-0.077112	0.042415	-1.818041	0.1066
∆MI(-1)	-0.175074**	0.056355	-3.106625	0.0145
∆MX	-0.097163	0.056570	-1.717567	0.1242
∆MX(-1)	-0.191729***	0.050965	-3.761929	0.0055
∆MC	-9.950752	5.961275	-1.669232	0.1336
∆MC(-1)	0.994432	1.852337	0.536853	0.6060
ECT(-1)	-1.418180***	0.108884	-13.02466	0.0000
Long-run coefficients				
Variables	Coefficients	St. Error	t-Statistics	Prob.
FT	-9.695132***	2.515552	-3.854077	0.0048
GF	-0.386470**	0.150610	-2.566037	0.0333
GV	-1.115235***	0.206040	-5.412719	0.0006
PG	-2.172466	1.267692	-1.713718	0.1249
MI	-0.123450**	0.039900	-3.093946	0.0148
MX	-0.135193**	0.048121	-2.809443	0.0229
MC	0.701203	1.158882	0.605068	0.5619
Constant	152.4187***	34.47137	4.421603	0.0022

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's analysis.

The outcome of the service sector growth is illustrated in Table 7. In correspondence with the results, we detect that both in the long run and short run factors such as population growth and service importation have an influence on the service sector. This suggests the level of East Asia population growth decreases the service growth by 3.45%, whereas the importation rate of service increases the service sector by 13%. The rest of the variables exhibit no evidence of cointegration.

Table 7. *Model 2 service sector*

Sector: Service value added				
Selected Model: ARDL (2, 1, 0, 0, 0, 1, 1, 0)				
Short-run cointegrating Form				
Variables	Coefficients	St. Error	t-Statistics	Prob.
∆VA(-1)	0.304392	0.328472	0.926690	0.3849
∆VA(-2)	-1.409062***	0.302132	-4.663735	0.0023
∆FT	30.30267	12.44349	2.435223	0.0451
∆FT(-1)	-4.974293	4.354659	-1.142292	0.2909
∆GF	-0.402639	0.234624	-1.716105	0.1299
∆GV	0.243764	0.669664	0.364009	0.7266
∆PG	-4.863056*	2.498893	-1.946084	0.0927
∆SI	7.857509	11.74006	0.669290	0.5248
∆SI(-1)	18.93500	10.83533	1.747524	0.1240

Sector: Service value added				
Selected Model: ARDL (2, 1, 0, 0, 0, 1, 1, 0)				
Short-run cointegrating Form				
Variables	Coefficients	St. Error	t-Statistics	Prob.
ΔSE	-7.052522	6.267885	-1.125184	0.2976
ΔSE(-1)	-14.36116	7.920713	-1.813114	0.1127
ΔMC	-3.927921	6.931242	-0.566698	0.5886
ECT(-1)	-1.409062***	0.149424	-9.429979	0.0000
Long-run coefficients				
Variables	Coefficients	St. Error	t-Statistics	Prob.
FT	-3.530217	3.382056	-1.043808	0.3313
GF	-0.285750	0.151112	-1.890978	0.1005
GV	0.172997	0.468396	0.369340	0.7228
PG	-3.451272**	1.371209	-2.516956	0.0400
SI	13.43802*	6.419832	2.093204	0.0746
SE	-10.19200*	5.195188	-1.961815	0.0906
MC	-2.787614	4.725039	-0.589966	0.5738
Constant	83.58436	65.61847	1.273793	0.2434

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's analysis.

Table 8 presents both the long-run and short-run estimates for the agricultural sector growth. Within this scope, the table shows that in the short-run FT, PG, AE, and AI have an impact on the growth of the agricultural sector. Nevertheless, this impact differs across factors for instance the level of fixed telephone subscription, and agricultural importation reduce the agricultural sector growth by 4.32% and 3.20%. Whilst, the population growth, and the rate of agricultural exportation in East Asian countries increase the agricultural sector growth by 2.9% and 3.3%. What is more in the long-run result we discern that government expenditure and the rate of agricultural exportation increase the value generated by the agricultural sector.

Table 8. *Model 3 Agricultural sector*

Sector: Agricultural value added				
Selected Model: ARDL (1, 1, 0, 1, 1, 1, 1, 0)				
Short-run cointegrating Form				
Variables	Coefficients	St. Error	t-Statistics	Prob.
AV(-1)	-0.898563***	0.218988	-4.103254	0.0046
ΔFT	-9.936182**	3.940336	-2.521658	0.0397
ΔFT(-1)	-4.323338*	2.163945	-1.997896	0.0859
ΔGF	-0.142361	0.105821	-1.345293	0.2205
ΔGV	0.121890	0.141464	0.861632	0.4174
ΔGV(-1)	0.343888	0.205189	1.675955	0.1377
ΔPG	0.349543	1.907456	0.183251	0.8598
ΔPG(-1)	2.940861*	1.321090	2.226088	0.0613
ΔAE	0.735459	0.855641	0.859541	0.4185
ΔAE(-1)	3.323559**	1.052920	3.156516	0.0160
ΔAI	-0.663077	0.844908	-0.784792	0.4583
ΔAI(-1)	-3.202281**	1.194758	-2.680276	0.0315
ΔMC	-0.370388	1.048810	-0.353150	0.7344
ECT(-1)	-0.898563***	0.103192	-8.70772	0.0001
Long-run coefficients				
Variables	Coefficients	St. Error	t-Statistics	Prob.
FT	-4.811390	2.583191	-1.862576	0.1048
GF	-0.158432	0.117109	-1.352858	0.2182
GV	0.382709*	0.199222	1.921021	0.0962
PG	3.272848*	1.404486	2.330282	0.0526

Sector: Agricultural value added				
Selected Model: ARDL (1, 1, 0, 1, 1, 1, 1, 0)				
AE	3.698748**	1.361880	2.715913	0.0299
AI	-3.563779	1.491127	-2.389990	0.0482
MC	-0.412200	1.194823	-0.344988	0.7402
Constant	51.05213	30.31491	1.684060	0.1360

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's analysis.

The Granger causality test uncovers a sequence of associations among factors, resulting in long-term economic remedies. The Granger causality estimates in Table 9 reveal various associations among the factors. For instance, starting with the manufacturing growth model there are unidirectional causal relationships between fixed telephone subscriptions and manufacturing sector growth. Also, between population growth and manufacturing sector growth.

Next, there is relationship between the manufacturing importation and exportation and manufacturing sector growth. This suggests that fixed telephone subscriptions, population growth, and manufacturing importation and exportation have prominent associations with the manufacturing sector growth.

Similarly, in Table 10 we perceive various unidirectional causal relationships in terms of the service sector. In particular between Fixed telephone subscriptions and service sector growth. Between population growth and service sector growth. And between service exportation and service sector growth. These outcomes imply that the service sector and manufacturing sector possess a causal relationship with the same factors.

Finally, in Table 11 which portrays the agricultural sector, the result showcases a unidirectional causal relationship with gross capital formation, agricultural importation, and Mobile cellular subscriptions. The rest of the variables demonstrated no evidence of causality with examined sectors.

Table 9. *The Granger causality estimates for the manufacturing sector*

Model 1. Manufacturing sector		
Hypothesis	Prob.	Decision
FT Granger cause MA	0.0030**	Unidirectional
MA Granger cause FT	0.8682	
GF Granger cause MA	0.4179	No causality
MA Granger cause GF	0.6053	
GV Granger cause MA	0.2795	No causality
MA Granger cause GV	0.1955	
PG Granger cause MA	0.0925*	Unidirectional
MA Granger cause PG	0.3991	
MI Granger cause MA	0.0581*	Unidirectional
MA Granger causes MI	0.5681	
MX Granger cause MA	0.0185**	Unidirectional
MA Granger cause MX	0.1728	
MC Granger cause MA	0.3311	No causality
MA Granger cause MC	0.1548	

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's analysis.

Table 10. *The Granger causality estimates for the service sector*

Model 2. Service sector		
Hypothesis	Prob.	Decision
FT Granger cause VA	0.0115**	Unidirectional
VA Granger cause FT	0.2210	
GF Granger cause VA	0.1308	No causality
VA Granger cause GF	0.3494	
GV Granger cause VA	0.5974	No causality
VA Granger cause GV	0.2417	
PG Granger cause VA	0.0528*	Unidirectional
VA Granger cause PG	0.7283	
SI Granger cause VA	0.6663	No causality
VA Granger causes SI	0.1497	
SE Granger cause VA	0.6767	Unidirectional
VA Granger cause SE	0.0567*	
MC Granger cause MA	0.8814	No causality
MA Granger cause MC	0.2884	

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's analysis.

Table 11. *The Granger causality estimates for the agricultural sector*

Model 3. Agricultural sector		
Hypothesis	Prob.	Decision
FT Granger cause AV	0.298	No causality
AV Granger cause FT	0.262	
GF Granger cause AV	0.085*	Unidirectional
AV Granger cause GF	0.413	
GV Granger cause AV	0.967	No causality
AV Granger cause GV	0.240	
PG Granger cause AV	0.208	No causality
AV Granger cause PG	0.998	
AE Granger cause AV	0.707	No causality
AV Granger causes AE	0.202	
AI Granger cause AV	0.253	Unidirectional
AV Granger cause AI	0.001**	
MC Granger cause AV	0.042**	Unidirectional
AV Granger cause MC	0.983	

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's analysis.

The final problem we discuss has to do with how well our ARDL models fit. A number of stability and diagnostic tests were run for this purpose. Heteroscedasticity, conditional heteroscedasticity, Ramsey's RESET test, and normality are all examined using diagnostic tests.

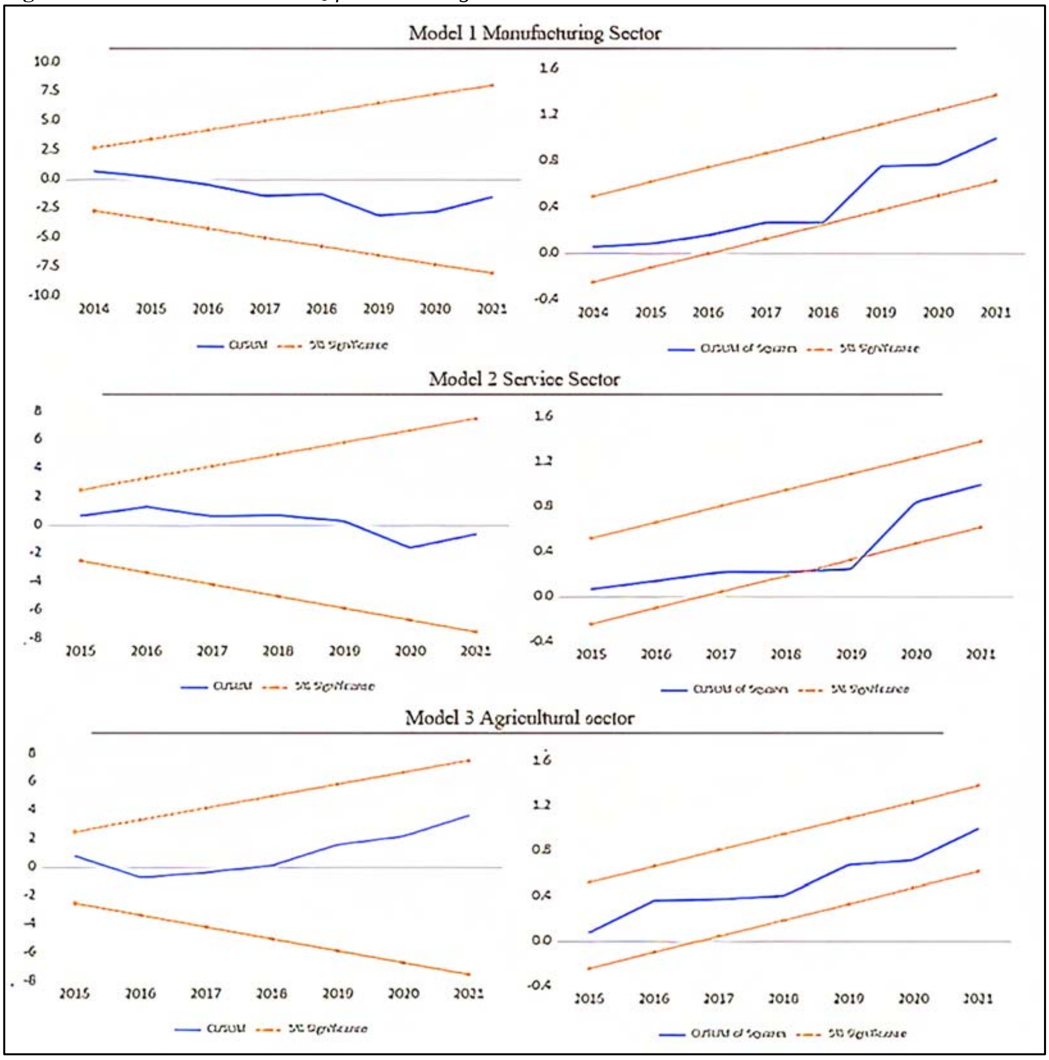
Therefore, in accordance with Table 12, the provided models have no evidence of heteroskedasticity based on the Breusch-Godfrey and Harvey tests. Also, the Ramsey RESET test's results demonstrate that the proposed model is free of misspecification errors. While the Jarque-Bera for normality confirms all the models are normally distributed. Hereby, the ARDL bounds test yield objective and reliable estimates. Additionally, the CUSUM and CUSUMSQ plot demonstrates that all the models are stable because the graph is contained inside the 5% level of significance limits. See Figure 2.

Table 12. *The diagnostic test*

Sectorial Models	Specification	Ramsey RESET Test	Heteroskedasticity Test: Breusch-Godfrey	Heteroskedasticity Test: Harvey	Jarque-Bera (normality)
Manufacturing sector	F-statistic	0.3537	0.7283	1.442	0.3638
	Prob.	0.7340	0.7007	0.3078	0.8336
Service sector	F-statistic	2.9611	0.6644	2.0660	3.2434
	Prob.	0.1418	0.7454	0.1712	0.1975
Agricultural sector	F-statistic	0.6213	2.0225	0.9683	2.0259
	Prob.	0.5572	0.1775	0.5456	0.3631
Decision		No omitted variables	No evidence of Heteroskedasticity	No evidence of Heteroskedasticity	All the models are normally distributed

Source: Author's analysis.

Figure 2. *CUSUM and CUSUMQ for sectorial growth*



Source: Author's analysis.

5. Conclusion

Asia, the biggest and most populated of the hemispheres, has had the fastest rate of global wealth growth since 1960. In reality, this increase has not happened across the region at the same rate. The eastern half of Asia, which includes China, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, China, and Thailand, outperformed the western region overall during this time period, though there were also regional differences in performance. The Philippines had the worst performance, growing at a rate of around 2 percent annually in per capita terms, almost in line with the standard of non-Asian nations. Better performance was seen in China, Indonesia, Japan, Malaysia, and Thailand, which had growth rates of 3-5 percent.

Due to advanced manufacturing output and affordable intermediate input manufacturing, East Asian expansion has been notably significant in terms of its dominance of global markets. This increase in performance has been supported by rapidly growing real salaries, significant and increasing expenditures in human resources, and a more equitable dispersion of income. Measures of healthcare, education, and other socioeconomic metrics have surged as unemployment has significantly declined in East Asian nations. In reality, per capita income in several of these nations has increased so quickly that they are no longer considered emerging.

Within this scope, the current paper examined the influence of selected macroeconomic factors and ICT on the sectorial growth of the East Asian and Pacific region from the period 2000 to 2021. To proceed with the study, we considered three different sectors namely manufacturing, services, and agriculture as proxies for sectoral growth. What is more, the paper performed the ARDL approach 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.

Based on the findings we discovered numerous outcomes across the three different sectors. Starting with the manufacturing sector, both the short-run and long-run results revealed that fixed telephone subscription, gross capital formation, government expenditure, population growth, and both importation and exportation are decreasing the growth of the manufacturing sector. Next, the service sector model displayed that the level of East Asia's population decreases the service growth, whereas the importation rate of service increases the service sector in both the short and long-run estimates. Moreover, model three, which evaluates the region's agricultural growth, showed that the extent of fixed telephone subscriptions and agricultural imports restrain the sector's expansion. On the other hand, the expansion of the East Asian population and the rate of agricultural exporting contribute to the expansion of the agricultural industry. Furthermore, we discover that government spending and the rate of agricultural exporting raise the value produced by the agricultural sector in the long term. Finally, the Granger causality test demonstrated that fixed telephone subscriptions, population growth, and manufacturing importation and exportation have prominent associations with the manufacturing sector growth. Simultaneously, the service sector and manufacturing sector possess a causal relationship with the same factors.

Finally, the agricultural sector showcased a unidirectional causal relationship with gross capital formation, agricultural importation, and Mobile cellular subscriptions. The rest of the variables demonstrated no evidence of causality with examined sectors.

The current findings can provide evidence, especially to developing countries and policymakers about the fact of capitalizing on particular macroeconomic factors and technologies to assist the sectoral growth of their country. Additionally, since Asia is a diverse and vibrant continent in terms of economy and resources, the paper offers an overview of three different sectors in East Asia.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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