Madelen Holtedahl, Jenny Leire og Tale Snartland

Economic Growth in Thailand

Bacheloroppgave i Samfunnsøkonomi
Veileder: Irmelin Slettemoen Helgesen
Mai 2022

Bacheloroppgave

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Abstract

This study investigates the relationship between factors driving economic growth in Thailand from 1972-2021. We have used time series data collected from The World Bank and Our World in data, to estimate three different econometric models. The models used are Multiple Linear Regression, Auto-Regression and Vector Auto-Regression. The theoretical framework has been the Romer model and the Solow growth model, used to illustrate the differences between exogenous and endogenous growth theories. The results emphasized the importance of considering time. Surprising results include the negative effect of total factor productivity (TFP). Expected results are the ambiguous relationship between population growth and economic growth, in accordance with previous research. Furthermore, the study identifies a two-way relationship between foreign direct investment (FDI) and school enrollment, supporting endogenous growth theories. All variables collectively influence FDI and school enrollment, supporting the evidence from endogenous growth theories that the variables jointly affect each other. Variance decomposition analysis reveals the interdependence of GDP per capita values, while the impulse function demonstrates the significant impact of GDP per capita shocks on FDI. The study highlights the complexity of factors influencing economic growth in Thailand and suggests further research on culture and political stability.

1. Introduction

Thailand, a country located in South-east Asia, has been named one of the miracles in the region. Since the 1960's Thailand has been one of the fastest growing economies in the world, not experiencing a single year of negative growth and averaging 7,5% annual growth until the Asian financial crisis in 1997. After the Asian financial crisis, their average growth was estimated at 5 % (The World Bank, 2023), while the world averaged between 2 and 3 % yearly growth (The World Bank, 2021c). For a while they were assumed to join "Tiger" status along with its neighbors Taiwan, South Korea, Singapore, and Hong Kong. The Four Asian Tigers refers to Asian countries that experienced rapid growth and industrialisation after the 1960's (Bloomenthal, 2021).

Economic development theory continues to be relevant as it provides a framework for understanding and addressing the complex challenges and opportunities in achieving economic growth. It also provides valuable insight in understanding the fundamental factors that have shaped historical patterns of economic development. The broad discussion of what drives economic growth is the motivation behind this study. In order to discuss this, we will base our analysis on Thailand's economic development over the past 50 years. Our research question is *"Is the relationship between the prominent factors that are said to secure economic growth a one-way relationship, or do the variables jointly affect each other?"*. We will mainly focus on the relationship between foreign direct investments (FDI), total factor productivity (TFP), and GDP per capita in Thailand.

The measurement of economic growth has been up for discussion. The most used measurement historically has been gross domestic product per capita (GDP per capita). GDP only accounts for total production within the territory of the country (OECD, 2016). GDP per capita has been used rapidly among researchers, in addition to neoclassical growth theories treating economic growth and economic development as synonyms. In addition, it is also the prime measurement used by the World Bank and the United Nations when discussing growth (Brinkman & Brinkman, 2011). Generally the level of GDP is viewed as an indication for how well the domestic market is doing, implying that an increase in GDP indicates that the economy is doing well.

This study is divided into 9 sections. To begin with, we will discuss theoretical framework and literature, where we will derive one exogenous and one endogenous growth model, the Solow model and the Romer model respectively, as well as present empirical studies on economic growth. Next follows a section on Thailand's historical development. Following this, we will present descriptive statistics associated with each of the variables. Thereafter, a presentation of the method of three econometric models to analyze the relationship between economic growth and the selected variables. Section 6 will present the results from our analysis, followed by a discussion in light of our theoretical and empirical framework in section 7. Lastly, we will discuss weaknesses and limitations of this study, before the final section concludes.

2. Theoretical framework and literature

Economic growth is a complex field of research, and new theories and methods in the field have emerged in the last fifty years. There are multiple different theories arguing what the different factors leading to economic growth are. Naturally, there will be many suggestions since the developing world is severely diverse. They differ, among other things, in historical background, culture, geography and access to resources. Two central approaches are exogenous and endogenous growth models. The purpose of this section is to create the theoretical framework for our analysis, which will explain our choice of variables and econometric models. First, we will present two different growth models: one exogenous, the Solow model, and one endogenous, the Romer model. Next, we will present some empirical studies about economic growth.

The main differences between exogenous and endogenous growth theories are the assumptions they make about the sources of economic growth. The exogenous growth models assume that the rate of technological progress is determined exogenously, meaning determined by factors outside of the model. These models typically emphasize the importance of investment in physical capital and human capital as drivers of economic growth. On the other hand, endogenous growth models assume that technological progress and innovation are endogenously generated by agents in the economy (Todaro & Smith, p. 161). These models typically emphasize the importance of research and development, human capital accumulation, as well as knowledge spillovers as drivers of economic growth. An example of an endogenous growth model is the Romer model. This model, similarly to other endogenous growth models, assumes that there are increasing returns to scale (Todaro & Smith, p. 160). Increasing returns to scale refers to a situation in which an increase in the quantity inputs used in a production process results in a higher increase in the output produced. Another important difference between the two theories is that exogenous models predict that the economy will eventually converge to a steady state where the rate of economic growth is solely determined by exogenous factors. Endogenous growth models, however, suggest that there is no necessary limit to economic growth, as long as knowledge and technology continue to advance.

2.1 The Solow model

The Solow model is one of the best-known economic growth models. Whether it can describe the economic growth patterns of developing countries correctly is controversial. The Solow model predicts that if countries have the same saving rate, depreciation rate (on capital), labor force growth, and productivity growth, they will reach the same steady state/same level of income. This theory is called conditional convergence across countries. The model assumes two types of input in the production function, labor and capital. The general production function can be described as:

$$Y = F(K, L)$$

Where:

Y = Output/Gross domestic product

K = capital stock (which can also include human capital)

L = labor force

The production function has constant returns to scale, meaning that for example a 5% increase in both capital and labor will lead to a proportionate increase in output (Y).

Generally it can be written as:

$\gamma Y = F(\gamma K, \gamma L)$

Where γ is a positive constant.

A widely used production function is the Cobb-Douglas function. This function can be written as:

$$Y(t) = A(t)K(t)^{\propto}L(t)^{1-\propto}$$

Here, we can see that gross domestic product (GDP) over a given time period is a function of the Capital stock (K(t)), productivity of the labor force (A(t)), and the labor force (L(t)). α is a positive fraction given the value between zero and one. It indicates the combination of capital and labor in the production. If it is close to 1, then it is a capital intensive production, if it is closer to zero, more labor is used, and less capital. The Solow-model assumes there are substitution possibilities between labor and capital.

To view the effectiveness of the production it is useful to look at output per worker, this implies $\gamma = \frac{1}{L}$

$$\frac{Y}{L} = F\left(\frac{K}{L}, \frac{L}{L}\right) = F\left(\frac{K}{L}, 1\right) \rightarrow y = f(k)$$

For the Cobb-Douglas function:

$$y(t) = A(t)k(t)^{\propto}$$

We assume five characteristics of capital. Capital is productive, meaning that an increase in the capital stock, will lead to an increase in the productivity of the worker. The worker can now produce more efficiently than before. The second assumption is that capital can be accumulated. This is done by investment. To be able to invest, there needs to be a certain amount of GDP that is saved, meaning that there needs to be some consumption that is forgone now, in order to consume more in the future. The third assumption is that capital is rival in its use, meaning that a limited amount of people can use it at the same time. The fourth assumption is that capital gives rise to profits, where capital owners earn rents. The fifth assumption is that capital depreciates, and needs to be replaced (Todaro & Smith, 2020, p.)

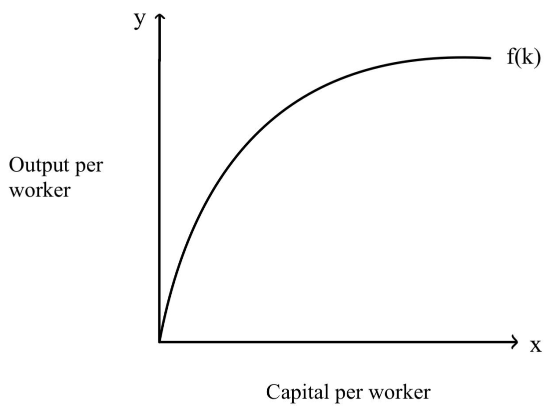
The shape of the production function can be found by differentiating output (Y) on capital (K), to find the marginal productivity of capital:

$$\frac{\partial f(k)}{\partial k} = A * \alpha * k^{\alpha-1} > 0$$

The production function is increasing with a higher amount of capital. This is because each worker has more capital to work with. When holding the amount of workers fixed, their productivity will increase.

$$\frac{\partial^2 f(k)}{\partial k} = A * \alpha * (\propto -1) * k^{\alpha-2} = (A * \propto^2) - (A * \propto) * k^{\propto-2} < 0$$

The double differentiation with respect to capital is negative, implying diminishing marginal return to capital. The intuition is that if the number of workers is fixed (L), increasing the number of machines will increase the productivity at first, however, this only applies until a certain point as the workers can't operate more machines at a time. The production function is therefore concave. The graph below illustrates this.



Further, we assume that the labor force grows at a rate n, and that capital depreciates at a rate δ. The capital stock, as mentioned in the assumptions, increases with the saving rate. This is based on the assumption that the saving rate equals the investment rate. When A is assumed constant, the change in the capital stock can be described as:

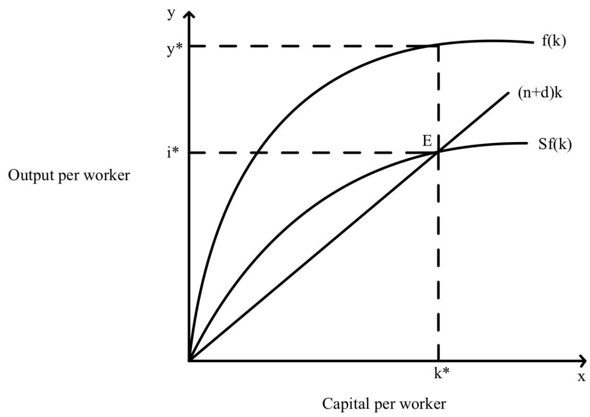
$$\Delta k = sf(k) - (\delta + n)k$$

$$\Delta k = 0$$

$$sf(k^*) = (\delta + n)k^*$$

The k^* refers to the level of capital per worker when the economy is in steady state. The reason why this is the steady state of k^*, is because if $k > k^*$, then the capital stock will decrease because depreciation and/or population growth is larger than the savings, $\Delta k < 0$. The opposite will occur if $k < k^*$. In this case the savings will be larger than the depreciation and/or population growth of capital, leading to an increase in the capital stock, $\Delta k > 0$.

If $k < k^*$, a lower level of k will result in a higher economic growth as the level of k increases. The closer k is to k^*, the economic growth will diminish. This is due to the assumption of diminishing return to capital.



If the saving rate increases, then the country will reach a higher steady state, meaning a higher level of income. This will imply a higher economic growth for a period, before the country reaches the new steady state, at a higher income per capita level.

A common subject among economists is that saving rate and income per capita does not have a one-way relationship. The discussion emphasizes that the relationship could be the other way around, that higher income per capita leads to higher saving and that the saving rate will vary with income. If this is the case, then the Solow model is problematic when trying to give a complete explanation of the relationship between saving and growth.

2.2 The Romer model

The Romer model is an endogenous growth model that shows how investment in research and development (R&D) can lead to sustained economic growth by generating technological progress. The model was developed by economist Paul Romer who argued that the Solow prediction didn't match what empirical evidence displayed; poor countries were not growing any faster than rich countries (Easterly, 2001, p. 59). The model addresses technological spillovers, which is when one firm or industry's productivity gains lead to productivity gains in other firms or industries (Todaro & Smith, 2020, p. 161). This kind of spillover is not limited to one economy, but can occur across borders as well.

The model assumes that growth processes start at firm or industry level (Todaro & Smith, 2020, p. 161). Each agent produces with constant returns to scale, which implies that the model is consistent with perfect competition. Up to this point, the assumptions match the ones of the Solow model. However, unlike the Solow model, Romer assumes that there may be increasing returns to scale at the economy-wide level. This is because Romer assumes that the economy-wide capital stock positively affects output at the industry level. This is related to the fact that endogenous economic growth theories address the importance of spillovers. The model assumes a production function that exhibits non-rivalrous knowledge spillovers. In other words, knowledge generated by one firm can be used by other firms in the economy. Romer argued that knowledge grows through investment in knowledge (Easterly, 2001, p. 148). If we recognize knowledge as a part of each firm's capital stock and assume knowledge spillovers, the Romer model captures the reason why economic growth might depend on the rate of investment (Todaro & Smith, 2020, p. 161).

We assume a Cobb-Douglas production function which can be written as follows:

$$Y_i = AK_i^{\alpha}L_i^{1-\alpha}K'^{\beta}$$

Where Y denotes total output, A represents technological progress, K denotes each industry's capital stock, L denotes industry's labor, and K´ denotes the whole economy's capital stock. To simplify, we assume that each industry will use the same level of capital and labor, so we can write the aggregate production function like this:

$$Y = AK^{\alpha+\beta}L^{1-\alpha}$$

If we assume no technological progress, A is constant, we can show that the growth rate per capita income in the economy would be:

$$g - n = \frac{\beta n}{1 - \alpha - \beta}$$

Where g is the output growth rate and n is the population growth rate. Without spillovers and with constant returns to scale, $\beta = 0$, per capita growth would be zero, given no technological progress. If we have spillovers and increasing returns to scale with $\beta > 0$, we have that $g - n > 0$ and Y/L, output per worker, is growing. This shows that the Romer model has endogenous growth because it is determined inside the model. If we also had technological progress, $A > 0$, growth would increase proportionally.

The Romer model, as well as other endogenous growth models, suggest that the variables that determine economic growth are interdependent and jointly affect each other. The two main components in the Romer model are the investment decision by firms in R&D and the accumulation of knowledge. The accumulation of physical capital and labor may increase incentives for innovation and the accumulation of knowledge, because firms choose to invest in R&D to develop new ideas that can increase their productivity and competitiveness. As a result of the investment, the level of knowledge in the economy increases. This leads to an increase in the rate of technological progress and therefore sustained long-run economic growth. On the other hand, the accumulation of knowledge and rate of technological progress may affect the productivity of physical capital and labor, leading to a more efficient use of these factors and an increase in their accumulation. This pattern is often referred to as the "virtuous circle of growth" (Easterly, 2001, p. 153). However, some countries might experience a vicious circle rather than a virtuous one.

2.3 Empirical studies

To start off, when explaining Thailand's economic growth, many empirical studies highlight the importance of FDI. Chowdhury and Mavrotas (2006) emphasize the importance of openness in the economy, and that FDI has a positive effect on economic growth. The purpose of their study was to observe the causal relationship between FDI and economic growth, suggesting they may be affecting each other. Their results suggest a bi-directional causal relationship between GDP and FDI in Thailand. Meaning that the level of FDI affects economic growth, but also that the level of FDI is dependent on economic growth. The results are important for further policy decisions, but also because it partially contradicts the conventional view that FDI affects economic growth. Along with Chowdhury and Mavrotas, Thangavelu, Yong and Chongvilaivan (2009) also found a positive relationship between FDI and GDP per capita. They present that FDI works as an injection in new capital, new technologies and marketing techniques, as well as management skills. All of which are helpful to raise competitiveness and future growth of the economy. They argue that FDI "creates positive externalities by raising productivity levels of domestic firms" (Thangavelu, 2009), which may have been established through the presence of multinational enterprises. However, multiple studies suggests that technology transfers from FDI have been limited in Thailand (OECD, 1999, p.39) One of the reasons for poorer adaptation of technology has been the capacity of locals to absorb foreign technologies, which is linked to human capital represented with level of education (OECD, 1999, p.40).

Even though the Thai government spends approximately 5.5 percent of GDP annually on education, the overall low level of human capital in the population has remained a problem. Making it difficult to attract FDI in industries that require high - skilled workers, as well as creating original Thai brands. In the 1980s Thailand had a rise in the textile and garment industry, which was mainly caused by FDI (Nidhiprabha, 2017). Industries such as textile and electronics are known to be labor intensive, and that it does not require a high educational level. This emphasizes the fact that Thailand struggles to attract FDI in jobs that require high human capital.

There is broad consensus among economists that human capital plays a key role in sustainable economic growth. Education has become a measurement of this, as higher education makes one function more efficiently. Behind is the theory that education follows the ability to receive, decode and understand information necessary to enhance learning and work performance (Nelson & Phelps, 1966). However, empirically the relationship has been harder to determine. Research finds the results inconclusive, which is argued to be caused by estimation difficulties. That is because much macroeconomic data deal with non-stationary time series analysis, as well as some research operating with stationary time series data. Kraipornsak (2009) uses stationary data in his study, where he finds a positive result of human capital in agriculture, but insignificant effects of human capital on growth in industry and services. Moreover, Diao, Rattsø and Stokke present that Thailand has experienced increased levels of education and skills. However, they consist mainly of labor intensive industries, and the effect of education has not been as important for growth compared to other developing countries (Diao et al., 2005). Lastly, research has also stressed that larger investment in education leads to higher education levels within the population (Douangngeune et al., 2005).

One of the most prominent factors explaining income differences between developing and developed countries is their different productivity levels. Empirical evidence suggests that large disparity in output per worker also explains different income levels. Further contributing to why countries have different growth rates (Todaro & Smith, 2020, p.54). One measure of productivity is TFP. In their study, Diao, Rattsø and Stokke (2005) present the importance of TFP growth for Thailand's economic growth. They find that learning by doing, along with technology adaptation and foreign technology spillovers are important factors. Continuing, Kraipornsak (2009) found differences in total factor productivity growth between sectors. He finds a positive long run effect of TFP in agriculture, but a insignificant contribution in services. As well as a positive contribution of human capital in agriculture and insignificant contribution in industries and services. Most importantly he found that TFP had a positive contribution to the general growth of the total economy.

Both Mason (1988) and Furuoka (2009) illustrate that there is no consensus about the relationship between population growth and economic growth. Population growth may have positive effects on economic growth as it can advance living standards. This happens because a large population creates higher domestic competition and an increased market size, thus attracting new business. On the contrary, the negative relationship between population growth and economic development is related to the increased dependency burden. Referring to the share of the population seen as economically unproductive, such as children and elders. This pessimistic view on population growth has been significant ever since Thomas Malthus' publications and warnings about "over-population" (Furuoka, 2009). Furuoka studied Thailand specifically, and found that the increased population in Thailand Granger-caused the economic development the country experienced.

3. Historical development

This section will present the different development strategies used, and the historical development of Thailand, captured by changes over the 50 year time period.

Since the 1960's, Thailand has had several different development strategies with different policies. They started as an economy focusing on growth through agriculture, where the majority of their exports were rice, teak, tin and rubber. In the early 1960's the Thai government focused on developing economic infrastructure such as roads, dams and water reservoirs to enhance agricultural production. In this period international trade was controlled by the government, where among other things you had to pay an export tax. Moreover, in 1966 the government established the Board of Investment as a measure towards the industrialization process (OECD, 2021).

Their road to industrialization was further strengthened with the import-substitution strategy in the early 1970's. The goal was to "limit dependence on imported goods, save foreign exchange rate, increase domestic value added and diversify away from agriculture" (OECD, 2021). It started on consumer goods but later also included capital and intermediate goods. The ministry of Finance, the military and protected firms build a strong lobby against a strategy shift from import substitution to export promotion. However, during the early 1980's this became problematic as the struggle to trade agricultural products harmed further growth in the sector and pressured the balance of payments. The former protection "was reduced by lowering tariffs, relaxing price controls and eliminating export taxes" (OECD, 2021). The move from mild protectionism towards exports, attracted FDI and paved the way towards industrialization.

GDP per capita

The graph below shows the evolution of GDP per capita from 1972 - 2021. GDP per capita increased from about US $1007 in 1972, to US $6123 in 2021, peaking at US $6456 in 2019. The graph also illustrates the rapid annual growth of 7,5% until 1996, and a slower growth after the turn of the millennium (The World Bank, 2023).

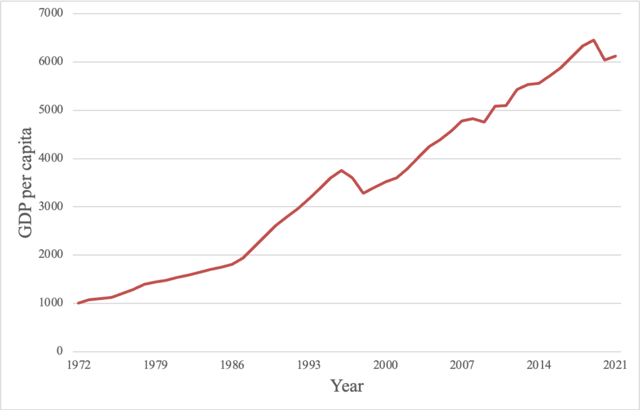


Figure 1: GDP per capita development in Thailand, 1972-2021

Calculation based on "GDP per capita" data from the World Bank

Until now the Thai economy had been on a continuous economic boom, however, they experienced a drop during the 1997 Asian financial crisis. The Thai baht collapsed and the authorities tried defending it through high interest rates. Regardless, it led to large capital flight and further deep recession. However, they were able to recover quickly in the early 2000's by structural reforms and growth in the global economy. This included two main approaches: attracting FDI and comparative advantages. FDI was attracted by tax breaks for foreign investors, eliminating local content requirements so that foreign investors could fully contribute to the manufacturing sectors, in addition to funding infrastructure projects such as the new Bangkok airport. The comparative advantages included goods such as trade, food and tourism. The tourism sector has been a significant contributor to the Thai economy. This sector accounted for 23% of total employment in Thailand in 1991, and has since then increased to 46% (The World Bank, 2021a).

Throughout the 21st century they were able to recover from the larger dips such as the Asian financial crisis, the 2008-09 financial crisis, as well as the major flood in 2011. However, the following effects from the COVID-19 pandemic are expected to reduce the tremendous growth, as a result of less FDI and lower exports. The partial halt is also caused by increased public debt because of large infrastructure projects. They also have issues regarding education and other skills, all of which needs to be resolved in order to escape the "middle-income trap" (OECD, 2021).

Foreign direct investment

In South-East Asia, FDI has proven to be a stable source to secure development, compared to other international capital inflow resources. Much so because it is used with long term considerations in mind. This includes strategic economic interests such as access to markets and resources. In addition to financial capital, FDI also includes technological, organizational and intellectual capital (Thangavelu et al., 2009). Both the Asian financial crisis in 1997 and foreign direct the Mexican peso crisis in 1994, suggest that FDI holds better than other forms of assets/inflows (OECD, 1999, p34). Which is also due to the long term considerations argued by Thangavelu and co.

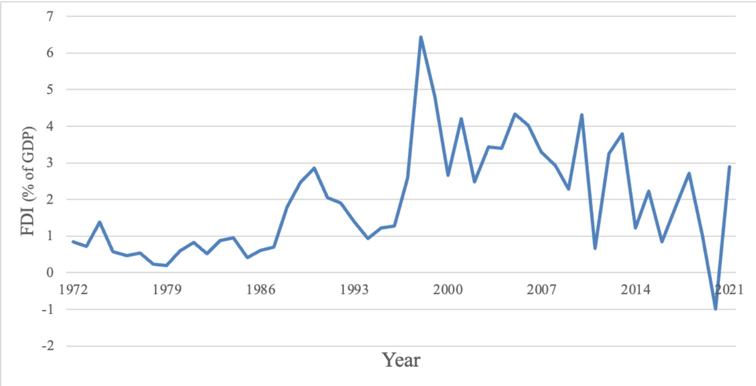


Figure 5: Foreign direct investment development in Thailand, 1972-2021

Calculation based on "Foreign direct investment, net inflows (% of GDP)" data from the World Bank

The graph shows the evolution of FDI in Thailand over the past 50 years. The data indicate that there hasn't been a clear time trend, illustrated by the large variations in the observations. At the start of this period, FDI was at about 0.8%, and in 2021 it was at about 2.9%. The large increase in the late 1980's was a result of the general rapid growth at the time, while the decline in the early 1990's was due to a military coup following political unrest, overloaded transport networks and a shortage of skilled workers, among other factors. In addition, Japan was experiencing economic difficulties at home, therefore reducing their investments abroad, leading to less FDI in Thailand (OECD, 1999, p211). Following the Asian financial crisis, the graph indicates a positive trend and impressive growth rates. The only exceptions are the drops in 2011 and 2020, which can be explained by large costly floods and the COVID-19 pandemic.

Secondary school enrollment

The graph below shows the development in the ratio of people who are enrolled in secondary education from 1972 till 2021. Secondary school enrollment works as a proxy for education. Note that there are some missing values in the data. In 1972, the school enrollment was at the minimum, with 19% of the total population in the secondary education level. Since then, the share has increased, peaking in 2015 with 120%. Numbers above 100% indicate that people are continuing education. We observe a large increase in 2013, which can be explained by increased investments and policy reforms (Michel, 2015).

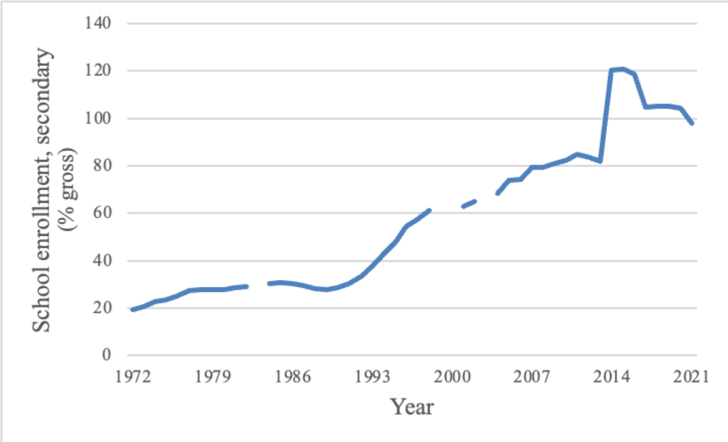


Figure 3: Secondary school enrollment development in Thailand, 1972-2021

Calculation based on "School enrollment, secondary (% gross)" data from the World bank

Gross capital formation

The graph below shows the development of the gross capital formation, which is used as a proxy for investment rate. There has not been a clear time trend on the money spent on investments. The rate was 22% of GDP in 1972 and 29% in 2021. Following the rapid growth period from 1987-1992, the Thai economy experienced a structural change.The change includes more industrial structure and larger technological sophistication, followed by larger investments in infrastructure, all contributing to future economic growth, as we can see by the peak of 43% in 1995. At this time they were investing in seaborn development, new highways, mass transit systems in Bangkok, new dams, industrial estates, hotels and resort complexes etc. (Falkus, 1995). The large drop to 20% of GDP in 1998 and 2008 is explained by the Asian financial crisis and the 2008 financial crisis.

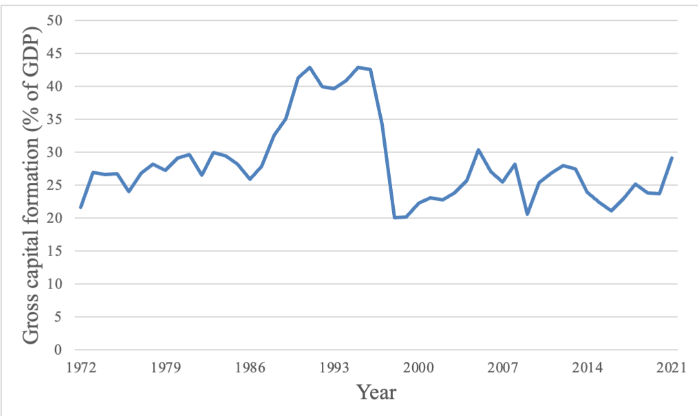


Figure 2: Gross capital formation development in Thailand, 1972-2021

Calculation based on "Gross capital formation (% of GDP)" data from the World Bank

Total factor productivity

The graph below shows the evolution of TFP in Thailand from 1972 to 2019. It shows a clear positive time trend. The TFP was 0.54 in 1971, meaning that TFP was 54% lower in 1972 than it was in 2017. At the end of this period, in 2019, TFP was 3% higher than it was in 2017. The absolute change from 1972 to 2019 was a 0.49 increase and the relative change was at a 90% increase. As mentioned, the growth in TFP is among effects caused by increased exports and trade liberalization, and FDI and their spillover effects.

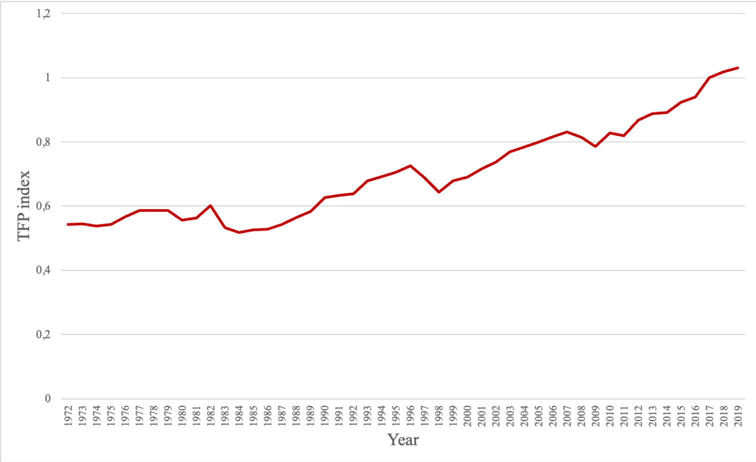


Figure 6: Total factor productivity development in Thailand, 1972-2019

Calculation based on "Total factor productivity" data from Our World in Data

Population growth

A common characteristic of the developing world is a rapid growing population. The population growth is calculated from the difference between birth rates and death rates. In total, the world has experienced a dramatic fall in birth rates per woman, almost halved in the past fifty years (Todaro & Smith, 2020, p.59). The graph below shows the population growth evolution measured as annual percentage growth. The population growth rate has had a decreasing trend since 1972 where it was at its highest at about 2.8%. The lowest value of growth rate was in 2021 where it was about 0.2%. Robey, Rutstein and Morris (1993) argue that reduced fertility rates are partially explained by increased use of contraceptives and education levels.

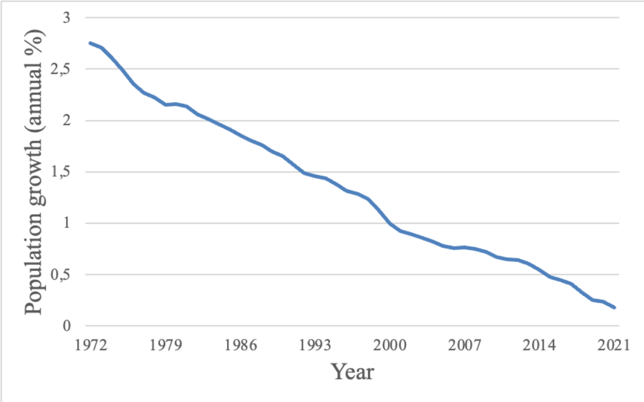


Figure 4: Population growth development in Thailand, 1972-2021

Calculation based on "Population growth (annual %)"data from the World bank

4. Data

In this section we are going to present the descriptive statistics associated with each variable, and explain how they are measured. We have gathered the variables that are usually included in the Solow model and the Romer model, as well as a few other variables that we believe to be relevant based on previous research done on economic growth. All variable data is obtained from the World bank except TFP, which is from Our World in Data. The main factors we will be looking at when trying to explain the economic growth in Thailand is TFP and FDI, but we will also include, investment rate, population growth, and secondary school enrollment in our analysis.

4.1 Descriptive statistics

Descriptive Statistics

Variables	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
GDP per capita	50	3439.259	1726.837	1007.79	6456.242
Gross capital formation (% of GDP)	50	28.332	6.284	20.071	42.863
Secondary school enrollment (%)	46	57.439	32.061	19.292	120.651
Population growth (annual %)	50	1.331	0.738	0.175	2.75
FDI (% of GDP)	50	1.94	1.489	-0.99	6.435
TFP (index)	48	0.701	0.147	0.519	1.031

GDP per capita

GDP per capita is gross domestic product divided by population. The data is measured in constant

2015 US dollars (The World Bank, 2021d). GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Including GDP per capita, as opposed to total GDP in a country, gives us information not only about economic growth, but provides knowledge on the living standard in Thailand as well. This is because if the population grows rapidly at the same time as GDP, then GDP per capita will not increase as much compared to a lower population growth.

Gross capital formation

Gross capital formation is the total amount of money spent on investing in buildings, roads, and equipment to a country's economy (The World Bank, 2021e). It also includes the value of changes in inventories held by companies. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales. Net acquisitions of valuable items are also considered capital formation. The values are measured as a percentage of total GDP in the economy.

Secondary school enrollment

Secondary school enrollment refers to the education received after the basic education at primary level. This variable is measured in gross terms, meaning the enrollment ratio refers to the proportion of total enrollment, irrespective of age, in this level of education (The World Bank, 2021g). The variable is calculated by dividing the number of students enrolled in secondary education, regardless of age, by the population of the age group which officially corresponds to secondary education. The values are then multiplied by 100, meaning they are given as a percentage.

Population growth

Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage (The World Bank, 2021f). Population counts all residents regardless of legal status or citizenship. Total population growth rates are calculated on the assumption that rate of growth is constant between two points in time.

Foreign direct investment, net inflows

One of our independent variables is foreign direct investment (FDI), net inflows. This variable refers to direct investment equity flows in the reporting economy (The World Bank, 2021b). It is a form of international investment in which a company or individual in one country invests in and manages operations in another country. Net inflows refer to the total amount of money that flows into a particular financial market, asset, or investment during a given period. The values associated with this variable are given as a percentage of GDP.

Total Factor Productivity

Total factor productivity (TFP) can be explained as the "portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely the inputs are utilized in production" (Comin, 2010, p. 260). TFP is complex and contains many aspects. Total factor productivity is not only a measure of technical progress. It also captures the effects of government policy, political unrest, and even weather shocks (Bosworth and M. Collins, 2008, p.48). The total factor productivity is denoted as the A in both the Solow growth model and the Romer model. This variable is measured as an index, and in order to interpret the magnitude of an index, you have to know the base period and the base value (Woolridge, 2012, p. 359). This TFP index uses 2017 as the base period, where the base value is 1. This means that when interpreting the coefficients associated with TFP, we have to do so relative to what the TFP was in 2017. The data is not measured for cross-country differences in cost of living, but is adjusted for inflation (Our World in Data, 2019).

5. Method

Based on the Solow model, the Romer model, and existing literature on the aspects of the economic growth in Thailand, this study will examine if the relationship between factors that are said to secure economic growth is a one-way relationship, or if the relationship is more complex than that. To test this hypothesis we have chosen to estimate three different regression models. First, we estimated two Multiple Linear Regression models (MLR), one with a time trend variable and one without, with the help of the "Ordinary Least Squares" (OLS) method. Secondly, we estimated an Auto-Regressive model (AR) to capture the time aspect of our research hypothesis in a more in debt way. Finally, we estimated a Vector Auto-Regressive model (VAR) to examine whether the variables jointly affect one another. In this section, we explain our method and the estimation of our models, including its components, mechanisms and assumptions. To carry out this analysis, we have chosen to use the data processing program STATA. We have used this program to analyze the relationship between the dependent variable GDP per capita, and the independent variables foreign direct investments, saving rate, school enrollment, population growth, and total factor productivity.

Since we are using models with the Cobb-Douglas production function as the framework for this analysis, we use the natural logarithm of GDP per capita, investment rate, school enrollment, population growth and TFP. This is partially to fulfill the assumption of linearity in the parameter of the explanatory variables (Woolridge, 2012, p. 349). The other assumptions will be explained further down. Another advantage of taking the logarithmic value of the variables is that it makes it possible to interpret the estimated effects of the explanatory variables on the independent variable in percentage. This is also the reason why we use the logarithm of the explained variable. FDI is a factor important to include, but it is not in the production function, therefore it does not have to be logarithmic. Also, it has a few years with negative values. Logarithms of negative numbers would be undefined.

5.1 Multiple Linear Regression model with OLS

First, we estimated a Multiple Linear Regression using the Ordinary Least Squares method. MLR is a statistical method used to model the relationship between a dependent variable and multiple independent variables, assuming a linear relationship between them (Woolridge, 2012, p. 68). An MLR model extends the concept of simple linear regression, where there is only one independent variable. The general model looks like this:

$$Y = B_0 + B_1 x_1 + B_2 x_2 + B_3 x_3 + \dots + B_n x_n + u$$

In multiple linear regressions with the OLS method, the goal is to estimate the parameters of the linear equation that best predicts the value of the explained variable based on the values of the independent variables. The OLS estimator refers to the procedure through which you obtain the estimates for the parameters (B_0, B_1, B_2, B_3, B_4, B_5), by minimizing the sum of squared residuals. In other words, the method helps you estimate the linear curve that minimizes the distance between the predicted and actual values. By minimizing the errors, we can find the most accurate estimates.

The OLS method is generally used to analyze cross-sectional data, meaning data collected on different variables obtained at a particle point in time. Running a regression with the OLS method could be useful to say something about the general relationships between our variables, and to capture the causal effect between them.

For the regression results to be reliable and valid, the following assumptions must hold (Woolridge, 2012, p. 45-48). The first assumption, MLR 1, states that the parameters, (B_0, B_1, B_2, B_3, B_4, B_5), need to be linear. MLR 2 is the assumption that we must have a random sample to be able to say anything about the population. If it is not a random sample, the results you find in your estimation are most likely not representative for the rest of the population. MLR 3 is the assumption that there needs to be variation in the explanatory variables, as well as no perfect collinearity. This means that we cannot only assume enough variation in the variables, but also that they are not a linear combination of each other. Then it is not possible to separately estimate the impact of the different x-variables on the y-variable. If the standard deviation of x is 0, MLR 3 does not hold. MLR 4 is the zero conditional mean, and is expressed with this equation:

$$E(u_i|x_i) = 0$$

This means that the average value of X does not change across different "slices" of the population. In other words, the different explanatory variables cannot be correlated with the error term. When this assumption holds, we say that the variables are exogenous. Otherwise, they are endogenous. This is the hardest assumption to hold, because it is hard to include all variables in the model that can be correlated with the other explanatory variables. When assumption 1-4 holds, we say that our OLS estimates are unbiased. MLR 5 is the assumption about homoskedasticity (Woolridge, 2012, p. 51). This assumption states that the variables should have the same variability. MLR 1-5 are also referred to as the Gauss-Markov assumptions. MLR 6 assumes that the error term, u, is normally distributed and independent of the explanatory variables (Woolridge, 2012, p. 168).

The OLS regression model that will be used in this analysis can be expressed like this:

$$log(GDPpercapita) = B_0 + B_1 log(invrate) + B_2 log(popgrowth) + B_3 log(schenrollsec)$$

$$B_4 FDI + B_5 log(TFP) + u_t$$

The equation shows how the independent variables are expected to influence GDP per capita. GDP per capita is our explained variable, while the explanatory variables are investment rate, population growth, school enrollment, FDI and TFP. B_0 is the intercept with the y-axis when all independent variables are equal to 0. B_1 is the parameter associated with investment rate and tells us the slope of the curve, all else equal. Similarly, B_2 is associated with population growth and so on, all else equal. u_t is the error term and is unknown. This term contains other variables that affect GDP per capita that are not already included in the model (Woolridge, 2012, p. 71). No matter how many explanatory variables we include in the model, there will always be factors not included, meaning we will always have an error term.

Once we have estimated the parameters you can write the OLS regression line as a function of the explanatory variables. The estimates you find for the parameters are denoted as $(\hat{\beta}_0, \hat{\beta}_1, \ldots, \hat{\beta}_k)$ and we refer to these as the partial effects, or the ceteris paribus effects. These are estimated coefficients because we can't actually observe the values of the true coefficients. These are, however, the empirical best guesses of the true coefficients and are obtained from data from a sample of the Ys and Xs. They are called partial effects because with multiple regressions you are able to partial out the other variables when you are looking at the effect of one variable. This is done by taking the partial derivative with respect to the different independent variables. By doing this, we estimate the expected change in GDP per capita given a one unit change in one of the independent variables, all else equal.

Since we are interested in looking at the factors that affect GDP per capita in Thailand from 1972 to 2021, it is important to take into account the aspect of time. Using STATA, we have computed graphs that show the relationships between the variables and the time variable *t*, in the descriptive statistics section. As mentioned, we can see that school enrollment and TFP follow a similar time trend as GDP per capita. It is therefore interesting to include a time trend variable in the model to see how this will affect our results. The model will then look like this:

$$log(GDPpercapita) = B_0 + B_1 log(invrate) + B_2 log(popgrowth) + B_3 log(schenrollsec)$$

$$B_4 FDI + B_5 log(TFP) + B_6 t + u_t$$

5.2 Auto-Regressive model

We are interested in looking at the factors affecting economic growth over time. As shown in the section with historical development, several of the variables we include in this model show a clear time trend. A standard multiple linear regression does not take this into account.

An Autoregressive model can reduce some of the challenges facing time series data. This is a dynamic model, "which the current value of the dependent variable Y is a function of the current value of X and a lagged value of Y itself" (Studenmund, 2014, p. 392). Including the lagged dependent variable as an independent variable will reduce the effect of a time trend, because the past value is included in explaining the present value.

A general example of an autoregressive model is:

$$Y_t = \alpha_0 + \beta_0 X_t + \lambda Y_{t-1} + u_t$$

With the variables we use, we can estimate the model:

$$log(GDPpercapita) = B_0 + B_1 log(invrate) + B_2 log(popgrowth) + B_3 log(schenrollsec)$$

$$B_4(FDI) + B_5 logTFP + B_6 \, log(GDP\ per\ capita)_{t-1} + u_t$$

Another thing one should be aware of, especially in time series regression is serial correlation. Serial correlation violates MLR. 4, which is the assumption of zero conditional mean. If this assumption is violated, the error term from one period is not independent of the error term in other time periods (Studenmund, 2014, p.322). This often occurs in time series, because the order of the observations plays a central role. We can distinguish between different kinds of serial correlation, however the kind that is most commonly used is the *First-order serial correlation,* and occurs when the value of the error term in one period is influenced by the value of the error term in the previous period (Studenmund, 2014, p.323).

$\epsilon_t = \rho \epsilon_{t-1} + u_t$

$\epsilon_t = the\ error\ term\ of\ the\ equation\ in\ question$

$\rho = the\ first - order\ autocorrelation\ coefficient$

$u = a\ classical(not\ serial\ correlated)\ error\ term$

ρ measures to which extent the serial correlation occurs, and also in which direction. The assumption is that the autocorrelation coefficient lies between $-1<\rho<1$. If $\rho=0$, then there is no serial correlation. The value of ρ indicates if there is a positive or negative serial correlation. A positive correlation implies that the current error term will tend to have the same sign as the error term in the previous period. The opposite goes for negative serial correlation, then the current error term will tend to have the opposite sign as the previous period(s) error term (Studenmund, 2014, p.323-324).

In the autoregressive model, Y_{t-1} is included as an explanatory variable. The previous periods dependent variable:

$$Y_{t-1} = B_0 + B_1 X_{t-1} + B_2 Y_{t-2} + \epsilon_{t-1}$$

So if ϵ_{t-1} is larger because of serial correlation in the error term, then Y_{t-1} will be larger than it would have been with no serial correlation in the error term, meaning that it is overestimated. This again results in a higher current dependent variable and a higher current error term. This violates MLR.3, which states that the error term is independent of the explanatory variables. In addition, "serial correlation in a dynamic model also causes estimates of the standard errors of the estimated coefficients and the residuals to be biased." (Studenmund, 2014, p.397).

Serial correlation also occurs because of lagged effects from previous events. For example, higher school enrollment is likely to not have an immediate effect on GDP per capita, but an effect after some time. If this is the case there is a time lag, meaning that the cause of the change will not have an effect until later. Another kind of serial correlation is impure serial correlation. Impure correlation can be corrected and can be caused by for example omitting a relevant variable. The result is that the effect that cannot be explained by the independent variables, are included in the error term. Impure serial correlation can also occur because the researcher chooses the wrong function form (Studenmund, 2014, p.325-326).

Another important aspect of time series is that variables are often observed to be cointegrated. Cointegration occurs as a result of a long-term relationship between non-stationary variables, and it is important to be aware of this to avoid spurious regression results. If there are spurious regression results, the estimated independent variable(s) can appear to have a higher significant effect on the dependent variable, than they actually have.

This happens because the independent variables have the same time trend as the dependent variable (D'Amico, 2021).

By looking at the graphs above, GDP per capita has a clear positive time trend, indicating that the present value of GDP per capita (time t), cannot be viewed independently of the GDP per capita in the previous period(t-1). The independent variables TFP and school enrollment also seem to have a clear positive trend.

If a variable is stationary, they have the properties that:

1. The mean of X_t is constant over time,
2. The variance of X_t is constant over time, and
3. The simple correlation coefficient between X_t and X_{t-k} depends on the length of the lag (k) but on no other variable (for all k).

If one or more of these assumptions are violated, then the variable is non-stationary. Notice that the error term can also be non-stationar*y.* If point two in the properties of stationarity is not fulfilled, then the assumption of homoscedasticity (MLR. 5), stating that there will be the same variability, is violated. (Studenmund, 2014, p.402)

To test if the variables are stationary or non-stationary we use the Dickey-Fuller test. If the Dickey-Fuller test shows that the variables are non-stationary, we take the first difference of the variables, and check again. The variables should now be stationary. There are different forms of the dickey-Fuller test, but based on the graphs indicating a time trend, we include this time trend in the test.

Assuming Y is a variable, $\Delta Y_t = B_1 Y_{t-1} + B_2 t + v_t$, where $B_1 = \gamma - 1$

$H_0: B_1 = 0$

$H_1: B_1 < 0$

The null hypothesis states that the variable is non-stationary, while the alternative hypothesis states that the variable is stationary.

Dickey-Fuller test for unit root

Variables	DF Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	P-value
GDP per capita (log)	-0.295	-4.159	-3.504	-3.182	0.9896
FDI	-4.076	-4.159	-3.504	-3.182	0.0068
TFP (log)	-2.081	-4.178	-3.512	-3.187	0.5570
Investment rate (log)	-2.695	-4.159	-3.504	-3.182	0.2383
School enrollment (log)	-1.222	-4.224	-3.532	-3.199	0.9058
Population growth (log)	4.072	-4.159	-3.504	-3.182	1.0000

From the test, we cannot reject the null hypothesis, and conclude with a 5% significance level that all the variables except FDI, are non-stationary.

Before testing for cointegration it is important to know that the variables are of the same integration order (J.D Economics, 2021). To do this we perform the Dickey-fuller test with first difference.

Dickey-Fuller test for unit root

Variables	DF Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	P-value
GDP per capita (log, first-difference)	-4.186	-3.594	-2.936	-2.602	0.0007
FDI (first-difference)	-9.519	-3.594	-2.936	-2.602	0.0000
TFP (log, first-difference)	-6.241	-3.607	-2.941	-2.605	0.0000
Investment rate (log, first-difference)	-6.388	-3.594	-2.936	-2.602	0.0000
School enrollment (log, first-differenc	-6.381	-3.682	-2.972	-2.618	0.0000
Population growth (log, first-differenc	-2.346	-3.594	-2.936	-2.602	0.1574

From these results, we then conclude that at a 5% significance level, we reject the null hypothesis for all variables except for population growth, implying that the variables are stationary with first-difference. That is why we use first difference variables, to avoid spurious regression results. In addition, differentiating the variables can also be a way of avoiding the problem with a time trend, because the variables only show the change from the period t-1 to period t.

The considerations one have to take into account when dealing with time series, indicates that performing a multiple linear regression based on OLS is too simple and naive. The model will not take into account the time aspect, even though adding a time trend variable in the OLS estimate can be an improvement, compared to the one without a time trend. An autoregressive model is a dynamic model, and captures the time aspect. However, both the AR and OLS regression models assume random sampling (MLR.2). This is likely to be violated, because the order of the observations matter with time series. In addition the variables were found to be non-stationary based on the Dickey-Fuller test, except FDI. Not taking this into consideration can lead to spurious results. If the results are spurious, the

B-coefficients with the same time trend are likely to have an overestimated effect on the dependent variable. In addition, serial correlation can lead to a violation of the MLR.4 assumption.

5.3 Vector Auto-Regressive model

Based on the challenges with the respective models discussed above, we have chosen to opt for a Vector Auto-Regressive model (VAR). An auto-regressive model implies that the variable is a linear function of its own past values. Vector refers to our model having multiple variables, meaning that all variables are linear functions of past values of itself and past values of other variables (Woolridge, 2012, p. 657). There are several advantages of using a VAR model when analyzing time-series data. To begin with, this type of model captures the interdependence between variables, which means it can provide a better understanding of how the variables interact and affect each other over time. Unlike traditional regression models that assume a static relationship between the variables over time, VAR models allow for dynamic forecasting by capturing changes in the relationships between variables over time (Woolridge, 2012, p. 657-658).

Before we can estimate the VAR model, we have to explain the assumptions associated with a time series analysis. TS.1 states that the time series follows a model that is linear in its parameters (Woolridge, 2012, p. 349). The second assumption states that there should be no perfect collinearity. TS. 3 is the zero conditional mean assumption, similar to MLR.4. It is important to note that this assumption comes with two implications. Firstly, z can not have a lagged effect on y. Secondly, strict exogeneity excludes the possibility that changes in the error term today can cause future changes in x. Usually, it is not a problem that the error term at time t might be correlated with past independent variables because we are controlling for those past values in the model. However, feedback from the error term to future values of the independent variables is always an issue. This means that assumption TS. 3 is generally violated. Under assumptions TS. 1-3, the OLS estimators are considered unbiased. Assumption TS. 4 considers homoskedasticity, which means that conditional on the independent variable, the variance of the error term at time t is the same for all time periods. It is important that the error term and the independent variables are independent, and that the variance of the error term must be constant over time (Woolridge, 2012, p. 353). Assumption

TS. 5 considers serial correlation, or autocorrelation. Errors are serially correlated when they are correlated across time. The assumption can be expressed mathematically like this:

$$Corr(u_t, u_s) = 0, \text{ for all } t \neq s.$$

Assumptions TS.1 through TS. 5 are referred to as the Gauss-Markov assumptions. Under these assumptions, the OLS estimators are the best linear unbiased estimators conditional on the independent variables. Finally, we have assumption TS. 6 considers normality (Woolridge, 2012, p. 355). It states that the errors of different time periods are independent of the independent variables, and are independently and identically normally distributed. Under TS. 1 through TS. 6, the OLS estimators are assumed to follow a normal distribution.

Before we can estimate the VAR model in STATA, we have to perform numerous tests to check if our data is suitable for this type of regression. These tests also have assumptions and implications that need to hold for our results to be as accurate as possible. The first assumption is that the variables should be stationary (D'Amico, 2021). We did this above with the Dickey-Fuller test, and concluded that the variables were stationary in the first difference, and can therefore exclude the possibility of spurious results.

The Engle Granger two step method is a test for cointegration among the variables. The test is based on the residuals from an OLS estimation and testing the residuals for stationarity. If the residuals are stationary, then the variables are cointegrated (D'Amico, 2021). The test statistic is smaller than the critical value in absolute measures, and we therefore conclude with a 5% significance level that the variables are not cointegrated. Because this analysis showed that the variables are not cointegrated, we therefore use a standard VAR model in its reduced form. "A reduced form VAR expresses each variable as a linear function of its own past values, the past values of all other variables being considered and a serially uncorrelated error term" (Stock and Watson, 2001, p. 102).

"If the lag-length is too large, then degrees of freedom are wasted, and if the lag-length is too small, then the model will not be well specified" (JD Economics, 2021, 12:03). Lag can be explained as the "length of the time between cause and effect"(Studenmund, 2014, p.234). Based on the following criterias: Akaike, Schwarts and Hannan-Quinn, the optimal lag-length for our model is three, because both Akaike and Hannan-Quinn- criterion are suggesting using 3 lags. We are therefore concerned that if we use more than 3 lags, useful information will not be included in the model, and that the number of variables will be too small to get a precise model, but if we use less than three lags, this can cause a more imprecise model estimation.

Thereafter, the model is controlled for autocorrelation in the residuals, by using the Lagrange-multiplier test. If there is autocorrelation in the residuals, then the assumption of homoscedasticity is violated. This test shows that with 3 lags there is no autocorrelation.

The second assumption of the VAR model is that the error terms in the estimated VAR model should be "white-noice disturbances. Commonly called innovation or shock terms" (D'Amico, 2021). The Portmanteau test for "white-noice" in STATA shows that the residuals can be considered to be "white-noice" at a 5% significance level.

Another thing to be aware of when the sample size is not that big, as in our case, is that the residuals are normally distributed. If the test shows that there is no normal distribution, then this can be an indication that shocks and extreme values in the data leads to asymmetry. This again affects the result of the regression results, and can influence the accuracy in hypothesis testing and confidence intervals, because these measures are based on the assumption of normal distribution (Studenmund, 2014, p. 104). The test showed that the residuals can be considered to be normally distributed.

Based on the tests discussed above, we have chosen to opt for three lags, and first difference on all the included variables in the model. A formal representation of the VAR model can be expressed by this equation:

$$\begin{aligned}\Delta \log(GDPpc)_t = a_0 + \phi_{11}\Delta \log(GDPpc)_{t-1} + \phi_{12}\Delta \log(Investment\ rate)_{t-1} + \phi_{13}\Delta \log(School)_{t-1} \\ + \phi_{13}\Delta \log(TFP)_{t-1} + \phi_{13}\Delta FDI_{t-1} + \phi_{13}\Delta \log(Population\ growth)_{t-1} + u_t\end{aligned}$$

Here ϕ_{11} represents the coefficient associated with how GDP per capita responds to its own value in the previous period. ϕ_{12} is the coefficient associated with the effect of the change in investment rate in the previous period on GDP per capita. The same goes for the others.

It is also possible to represent the model as a matrix, to simplify the notation:

$$\begin{bmatrix}\Delta\log\,(GDPpc)_t \\ \Delta FDI_t \\ \Delta \log(TFP)_t\end{bmatrix} = \beta_0 + \phi \begin{bmatrix}\Delta \log(\,GDPpc)_{t-1} \\ \Delta FDI_{t-1} \\ \Delta \log(TFP)_{t-1}\end{bmatrix} + \begin{bmatrix}u_{1,t} \\ u_{2,t} \\ u_{3,t}\end{bmatrix}$$

Where β_0 is the vector of intercept coefficients, u_t is the error term for each variable, and ϕ is the vector of the effects of the lagged values of the variables: $\begin{bmatrix} \phi_{11} & \phi_{12} & \phi_{13} \\ \phi_{21} & \phi_{22} & \phi_{23} \\ \phi_{31} & \phi_{32} & \phi_{33} \end{bmatrix}$

A matrix including all variables would be presented as a 6x6 matrix if we had just included 1 lag. However, we have included 3 lags, and as a result of this, the matrix would have been very large. For simplicity, we have only presented a matrix including GDP per capita, FDI and TFP, with one lag each.

6. Results

In this section we are going to present the results of our three regressions.

The variables are all measured in logarithmic terms, except for FDI. This allows us to interpret them in percentage terms. However, it is important to note that several of the variables are already in percentage, such as investment rate, school enrollment and population growth, while TFP is measured as an index. Because the variables in the VAR model are in first-difference terms, they have to be interpreted as the change in the variable from one year to another. This is the case, also when not explicitly stated.

6.1 MLR model results

Results of MLR with and without time trend		
Dependent variable: GDP per capita (logarithm)		
Variables	Without time trend (1)	With time trend (2)
Investment rate (log)	0.79***	0.403***
	(0.07)	(0.053)
School enrollment, secondary (log)	0.683***	0.126*
	(0.092)	(0.073)
Population growth (log)	-0.467***	0.247***
	(0.278)	(0.087)
TFP (log)	-0.454	0.224
	(0.278)	(0.16)
FDI	0.046***	0.018***
	(0.01)	(0.006)
t		0.043***
		(0.004)
Constant	2.507***	5.083***
	(0.52)	(0.372)
N	44	44
R^2	0.982	0.995
*** p < 0.01, ** p < 0.05, * p < 0.1		

Table 1: Results of OLS regression with and without time trend.

OLS without a time trend

An OLS of the multiple linear regression model without time trend gives significant estimated results for all variables except for TFP. All interpretations are under the assumption of all else equal.

A 1% increase in TFP is expected to reduce GDP per capita by 0,45%. An increase of 1% in investment rate, measured as a share of GDP, leads to an increase of approximately 0,79% in GDP per capita. The estimated effect of a 1% increase in educational level is that it increases GDP per capita by 0,68%. This implies that increasing the human capital will lead to a higher economic growth. A 1% increase in the population growth, leads to a decrease in GDP per capita by -0,47%. This is indicating that increased population leads to lower GDP per capita. An increase in FDI by 1%, leads to a 4,6% expected increase in GDP per capita (100*0,046 =4,6).

OLS regression with time trend

All the results are statistically significant on all levels, except for school enrollment only being significant at 10 per cent level and TFP not being significant. Including a time trend variable, changes the effects of population growth and TFP on GDP per capita, from negative to positive. For the other variables, including the time trend, reduces the estimated effect of each of the variables, by lowering the values of the beta-coefficients. This indicates that the beta-coefficients were overestimated in the previous OLS regression model. One explanation for this, can be that the beta-coefficients of the explanatory variables have the same time trend as GDP per capita. Which can be seen in education, where the expected effect is reduced from 0.68 to 0.13. In addition, the significance level of education is reduced to 10% with a time trend, indicating that the long term relationship between GDP per capita and education is not as clear as first presumed.

The beta coefficient for the time trend, all else equal, explains 4% of the change in GDP per capita. This indicates that there is a time trend, and that it is likely that not including this can lead to spurious results.

The coefficient R-squared is a common measure of goodness of fit that indicates the proportion of variance in the dependent variable that can be explained by the independent variables in the model (Woolridge, 2012, p. 38). It ranges from 0 to 1, with higher values indicating a better fit. Goodness of fit is a measure of how well a MLR model fits the observed data. It assesses whether the model adequately captures the patterns and relationships in the data. However, it can be misleading if used the R-squared in isolation, as it does not necessarily indicate the quality of the predictions. By including more variables, the R-squared usually increases, as in our case where our R-squared is 0.982 without time trend, and 0.995 with time trend. In addition, generally when analyzing time-series data, the R-squared can be artificially high when the dependent variable is trending. (Woolridge, 2012, p. 370). This can lead to overestimation of the R-squared value, making the model appear to fit the data better than it actually does.

6.2 AR model results

Results of Auto Regression	
Dependent variable: GDP per capita (logarithm)	
Variables	
Investment rate (log)	0.079
	(0.052)
School enrollment, secondary (log)	-0.076
	(0.058)
Population growth (log)	-0.058
	(0.042)
TFP (log)	-0.127
	(0.108)
FDI	0.00
	(0.004)
GDP per capita (log)	
L1.	0.956***
	(0.058)
Constant	0.475**
	(0.218)
N	43
R^2	0.998
*** p < 0.01, ** p < 0.05, * p < 0.1	

Table 2: Results of Auto-Regressive model.

None of the variables in the autoregressive model are statistically significant, except for the first difference of GDP per capita, which is significant on all levels. The following interpretations are based on the assumption of all else equal.

The autoregressive model estimated a 1% increase in the investment rate, leading to a 0,079% increase in GDP per capita. The autoregressive model estimates that investment rate plays a less significant role in explaining GDP per capita than the previous MLR model with and without time trend did. This suggests that how the regression model is estimated, will influence the estimated effect of the independent variables.

A 1% increase in TFP is expected to decrease GDP per capita by 0,127%. Even though OLS with a time trend and the AR-model tries to include the time aspect, the results from the respective estimated models, predicts two opposite effects of TFP on GDP per capita.

A 1% increase in the population growth is expected to decrease GDP per capita by 0,058%. The effect of population growth is considerably lower than OLS estimates without a time trend. The estimated negative effect of population growth, is in contrast to the estimated effect in the OLS model with a time trend. Both the results for population growth and TFP indicate that how the aspect of time is considered in the model, has a significant impact on the estimated effect.

An increase in the education variable of 1%, is estimated to decrease GDP per capita by 0,076%. Compared to the OLS with and without a time trend, the estimated effect of education has opposite effects on GDP per capita. This implies that an increased level of education in the population has negative effects on GDP per capita.

The lagged variable of GDP per capita has a beta coefficient of 0,956, which is higher than the beta coefficient for the time trend. This indicates that the most prominent factor in explaining GDP per capita, is the lagged value of GDP per capita.

6.3 VAR model results

The results of the regression models estimated above, shows that the effect of the different explanatory variables depend on the estimated regression model and the regression method. Therefore we estimated a VAR model, however to interpret the VAR model results does not necessarily give much insight in the relationship between the variables. Therefore, we use the Granger-Causality test, Impulse-response functions and variance decomposition

Granger-Causality test

The Granger-causality tests are statistical tests for “causality” in the sense of whether lagged observations of a variable helps to predict future values of another variable (D’Amico, 2021). In other words, the test checks if one variable Granger-causes the other one. It is important to differentiate Granger-causality from causality in a theoretical sense. This test does not provide evidence for a causal relationship in the sense of one variable being the true cause of the other (Studenmund, 2014, p. 400). The test only assesses whether there is a statistical relationship between the two variables, based on their past values. Therefore, a statistically significant Granger-causality test does not necessarily mean that one variable is the true cause of the other. However, this test is useful because it allows us to analyze which variable "leads" the other, and the leading variables can be useful for forecasting purposes.

We have the following hypotheses:

$$H_0:\ X\ does\ not\ Granger\ cause\ Y$$

$$H_1:\ X\ Granger\ causes\ Y$$

This implies that if p < 0,05, we conclude at a 5% significance level, that the null hypothesis should be rejected, meaning that X Granger causes Y (J.D Economics, 2021, 17:51). The test is a chi-squared test of the joint significance of the other variables in the regression, including lags of the independent variable. All variables are in first-difference and log-versions of the variables, except FDI which is only in first-difference.

The following table illustrates the results associated with investment rates (IR), FDI and TFP, as well as other significant results from the Granger-causality test.

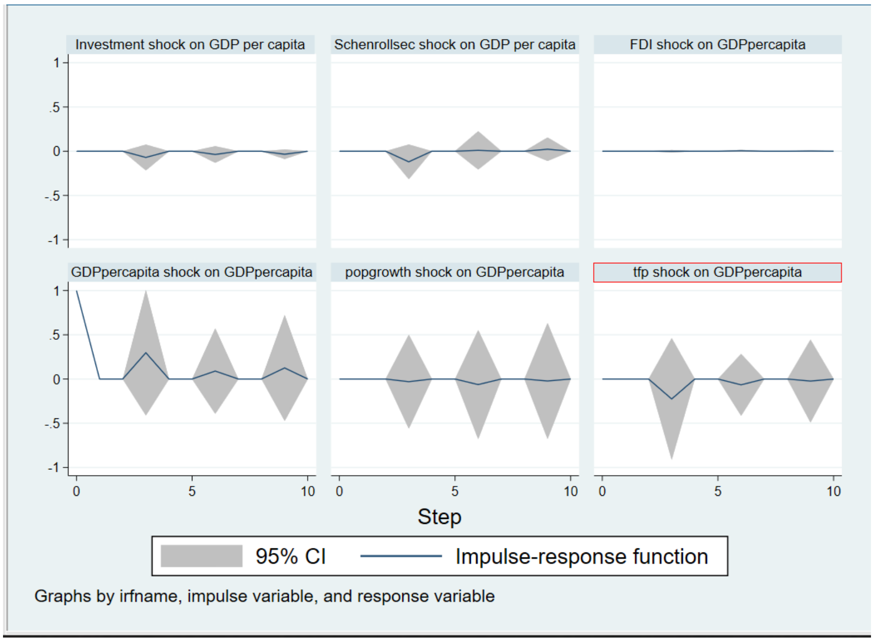
Null hypothesis	Chi-square Statistics [Marginal Significance Value]	Direction
IR does not Granger-cause GDPpc	0.89713 [0.344]	
IR does not Granger-cause SE	4.6701 [0.031]**	IR → SE
IR does not Granger-cause FDI	11.839 [0.001]**	IR → FDI
IR does not Granger-cause TFP	0.65986 [0.417]	
IR does not Granger-cause PG	0.11305 [0.737]	
FDI does not Granger-cause GDPpc	0.00656 [0.935]	
FDI does not Granger-cause SE	16.428 [0.000]**	FDI → SE
FDI does not Granger-cause IR	0.00595 [0.939]	
FDI does not Granger-cause TFP	0.01189 [0.913]	
FDI does not Granger-cause PG	0.16247 [0.687]	
SE does not Granger-cause FDI	10.228 [0.001]**	SE → FDI
TFP does not Granger-cause GDPpc	0.4136 [0.520]	
TFP does not Granger-cause SE	0.02142 [0.884]	
TFP does not Granger-cause IR	0.01528 [0.902]	
TFP does not Granger-cause FDI	0.26396 [0.607]	
TFP does not Granger-cause PG	1.575 [0.209]	
ALL does not Granger-cause SE	23.016 [0.000]**	ALL → SE
ALL does not Granger-cause FDI	22.554 [0.000]**	ALL → FDI

** p < 0.05

Based on the test, none of the explanatory variables included in the model Granger-causes GDP per capita, at a 5% significance level. However, the test results show that the investment rate and FDI Granger-causes secondary school enrollment, at a 5% significance level. This implies that investment rate and FDI consistently and predictably changes before secondary school enrollment changes. Meaning that IR and FDI can be useful to predict future values of education at secondary level in the population. Further on school enrollment Granger causes FDI, at a 5% significance level. This indicates that the relationship between FDI and school enrollment goes both ways. For FDI, all variables are jointly significant at a 5% level. This indicates that the amount of foreign direct investment depends on the current situation in the country. The test also shows that investment rate Granger-causes FDI.

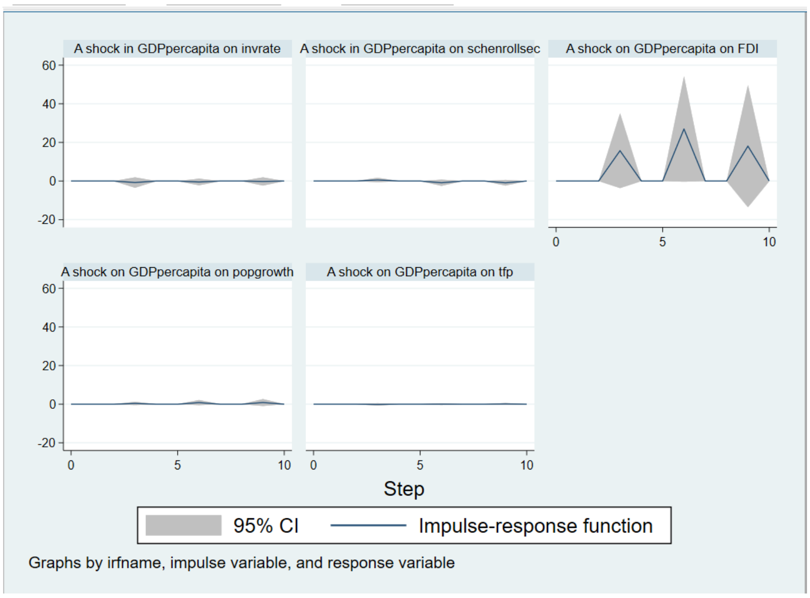
Impulse-response function

An impulse-response function shows how an exogenous shock affects the path of which an endogenous variable evolves over time (D'Amico, 2021). The most exogenous variable in the model should go first (JD Economics, 2021, 2:11). The most exogenous variable refers to the variable in the model expected to be the least influenced or the least dependent on the other variables in the model. Meaning it is assumed to be mostly influenced by exogenous factors. The decision of the order in the impulse response function is based on the Granger-causality test above. The test indicates that GDPpercapita, IR, TFP, population growth can be considered to be exogenous. FDI and school enrollment are considered to be endogenous in the model. The magnitude of the shock is one standard deviation, and the gray area is standard error confidence band (JD Economics, 2021, 8:22)



Impulse-response on GDP per capita for a 10 year period from shocks in the independent variables.

The figure above illustrates the effect of different shocks on GDP per capita over a 10 year period. From the graph, interestingly, a one standard deviation shock in school enrollment leads to a decrease in the GDP per capita in the 5 year period, but a small increase in the 10 year period. Next, we can see that a one standard deviation shock in GDP per capita, will have a positive long term effect on the level of GDP per capita. A shock of one standard deviation in investment rate predicts three smaller reductions in GDP per capita in a 10 year period.



Impulse-response on the independent variables for a 10 year period from a shock of one standard deviation in GDP per capita.

The graphs show that a shock in GDP per capita of one standard deviation has a low effect on the explanatory variables, except for FDI, which is why we will only discuss the case with FDI. A shock on one standard deviation in GDP per capita predicts three relatively large increases in FDI, of approximately 20%. The effect of the shock is not observed until a couple of years after. However, interestingly after 10 years, the effect of a shock in the GDP per capita on FDI is still not stabilized. This shows that there is a relationship between GDP per capita and FDI, that the level of GDP per capita affects the amount of FDI. Whether the relationship between GDP per capita and FDI is negatively or positively related is controversial.

Variance decomposition

"Variance decomposition measures the proportion of variation in a dependent variable explained by each of the independent variables" (D'Amico, 2021). It can therefore say something about the relevance of the independent variables, and to which degree they affect the dependent variable.

Variance Decomposition						
Lags	GDP per capita	Investment rate	TFP	Population growth	School enrollment	FDI
	GDP per capita					
0	0	0	0	0	0	0
1	1	0	0	0	0	0
2	1	0	0	0	0	0
3	1	0	0	0	0	0
4	0.943082	0.009304	0.014871	0.001116	0.031391	0.000236
5	0.943082	0.009304	0.014871	0.001116	0.031391	0.000236
6	0.943082	0.009304	0.014871	0.001116	0.031391	0.000236
7	0.917566	0.015084	0.014401	0.005565	0.030418	0.016967
8	0.917566	0.015084	0.014401	0.005565	0.030418	0.016967
9	0.917566	0.015084	0.014401	0.005565	0.030418	0.016967
10	0.908097	0.021356	0.014254	0.006075	0.031127	0.01909
…						
30	0.906319	0.022283	0.014747	0.006189	0.031259	0.019203

Explanatory variables as impulse factors and response on GDP per capita.

The table illustrates how much of the variation in GDP per capita can be explained by the different explanatory factors. 2,2% can be explained by the investment rate, 1,4% by TFP, 0,6% by population growth, 3,1% by school enrollment (secondary) and 1,9% by FDI. The lagged values of GDP per capita explains 90% of the value of GDP per capita. This is in accordance with the Granger-causality test, where the result showed that none of the explanatory variables in the model Granger caused GDP per capita at a 5% significance level.

However, both the impulse response function and the variance decomposition, indicates that the current values of GDP per capita is explained by previous values of GDP per capita. These results suggest that there may be other factors affecting economic growth not included in the model. The results from the autoregressive regression also supports this claim, with a statistically significant beta-coefficient of 0.96. Important to note that this is the only explanatory variable with statistically significant estimates from the AR model.

Variance Decomposition					
Lags	GDP per capita				
	Investment rate	TFP	Population growth	School enrollment	FDI
0	0	0	0	0	0
1	0.643789	0.550925	0.025794	0.03049	0.008264
2	0.643789	0.550925	0.025794	0.03049	0.008264
3	0.643789	0.550925	0.025794	0.03049	0.008264
4	0.643568	0.565015	0.011666	0.323973	0.077337
5	0.643568	0.565015	0.011666	0.323973	0.077337
6	0.643568	0.565015	0.011666	0.323973	0.077337
7	0.63392	0.549544	0.042528	0.290872	0.119698
8	0.63392	0.549544	0.042528	0.290872	0.119698
9	0.63392	0.549544	0.042528	0.290872	0.119698
10	0.628316	0.532687	0.059229	0.29472	0.126793
…					
30	0.599749	0.455632	0.068311	0.252724	0.101218

GDP per capita as impulse factor and response on explanatory variables.

The table shows how much the variation in GDP per capita explains the explanatory variables, meaning that GDP per capita is the impulse-function. The variation in GDP per capita explains almost 60% of investment rate, 46% of TFP, 6.8% of population growth, 25.3% of school enrollment and 10,12% of FDI. The results indicate that GDP per capita has an explanatory power of the other variables. Supporting our hypothesis that a bidirectional relationship exists.

7. Discussion

This section will discuss the most relevant results from our regression models in light of our research hypothesis, with main focus on FDI and TFP.

MLR results

The results showed that an increase in total factor productivity will decrease GDP per capita. This is contradicting the Solow and the Romer model, as well as what several previous studies have found, which predicts a positive relationship between productivity and GDP per capita growth. We saw a positive relationship between investment and GDP per capita, and education and GDP per capita, meaning an increase in both will lead to economic growth. Population growth is expected to have a negative effect on economic growth. This is in accordance with the predictions of the Solow model, where an increase in population holding capital fixed, creates lower output per worker. Further implications of this negative relationship, given that things are fixed, is that the standard of living is expected to decrease. Lastly, FDI did have a positive effect on economic growth, which is what we expected from previous research such as Thangavelu (2009) and OECD (1999).

When we included the time trend aspect to our MLR regression, we found different results. We observed a positive relationship between TFP and economic growth. The reasoning behind this is that given the same size of labor force, productivity is expected to increase. For example, in agriculture a higher TFP implies a higher production of food, without having to increase the land or number of workers. This can, for example, be a result of new and better technology, or better grain which produces a higher yield than before (Kraipornsak, 2009).

We expected a negative relationship between population growth and GDP per capita, based on the prediction of the Solow model. In the Solow model, the amount of capital is assumed to be constant, and that population growth leads to less capital per worker, which reduces the marginal productivity of labor. This causes lower output per worker. However, a fixed amount of capital is not a realistic assumption. It can also be the case that increased population size leads to larger markets, attracting both foreign direct investments and domestic producers. Creating growth and competition within the markets, can also lead to new innovations, stimulating economic growth. This aligns with the results from Furuoka (2009).

AR results

The autoregressive model estimates that investment rate plays a less significant role in explaining GDP per capita than the previous OLS model with and without time trend did. This suggests that how the regression model is estimated, will influence the estimated effect of the independent variables.

The most surprising result from the autoregression is the negative relationship between education and GDP per capita. This contradicts the predictions from the Solow model, and previous research. There is much evidence that education should lead to higher economic growth, as the population among other things becomes more capable of utilizing new technology (Nelson & Phelps, 1966). On the other hand, some research (Diao et al., 2005) states that in Thailand's case, an increase in human capital does not have the same effect as other developing countries. This is due to a labor-intensive labor force, meaning that human capital investments will have limited effects. Regardless, this is not a solid explanation for the observed negative relationship. However, the estimated effects in our analysis are not significant, and we cannot conclude that the results are legitimate and trustworthy.

VAR RESULTS

From the Granger-causality test, we found six significant relationships. To start off, we observed that the investment rate and FDI Granger-causes education at the secondary level. Research shows that larger investment in education leads to higher education levels within the population (Douangngeune et al., 2005). However, the variable for investment includes total investment, and not just in education. It is therefore not explicitly stated that it is only investment in education that can affect school enrollment. We can therefore not exclude the possibility that there can also be other forms of investment that can affect school enrollment. As this is not the primary focus of the thesis, we will not speculate further.

Continuing FDI and education Granger-causes each other. Nidhiprabha (2017) argues that FDI can create new jobs that potentially require skilled workers, which can be met through job training and education. At the same time, a highly educated workforce can attract more FDI, as investors seek countries with a skilled labor force. However, a large part of Thailand's labor force is employed in labor-intensive industries, such as textile, which does not require a high educational level. This can explain why Thailand struggles to attract FDI in jobs that require high human capital. The relationship between FDI and education can be discussed in light of the Romer model. The Romer model of endogenous growth theory emphasizes the importance of human capital in promoting long-term economic growth. The model suggests that investment in human capital, such as education and training, can increase productivity and innovation, leading to higher economic growth. The argument that FDI and education Granger-cause each other is consistent with the idea that investment in human capital can attract FDI and create new job opportunities that require a skilled workforce. FDI can bring new technologies and knowledge spillovers that can benefit domestic firms and workers, leading to increased demand for skilled labor. In turn, investments in education and training can improve the quality of the labor force, making it more attractive for foreign investors to set up operations in the country.

However, the observation that Thailand struggles to attract FDI in jobs that require high human capital due to its labor-intensive industries highlights the limitations of this model in practice. Despite its investment in education, Thailand's economy still heavily relies on low-skilled labor, which limits its ability to attract FDI in high-tech industries that require highly skilled workers. This suggests that other factors, such as infrastructure, political stability, and market access, may also play a significant role in attracting FDI. Overall, the relationship between FDI and education in the context of Thailand highlights the complex interplay between human capital investment, FDI, and economic growth. While the Romer model suggests that investment in human capital can drive economic growth, the reality is more nuanced and depends on a range of factors beyond education and training.

The finding that investment rate Granger-causes FDI suggests that domestic investment can attract FDI. This relationship is consistent with the Romer model, as investing in infrastructure and other forms of physical capital can create a conducive environment for economic growth and attract foreign investors. As mentioned by Falkus (1995), Thailand's investment in infrastructure such as highways, mass transit systems, and dams, as well as the tourism sector, helped to attract FDI.

The reverse relationship between domestic investment and FDI, where a higher investment rate implies a higher wage, is also consistent with the Romer model. As wages increase, domestic savings can increase, providing more financial capital for domestic investment. This can lead to an increase in the level of infrastructure and human capital, attracting more FDI. However, as noted by Nidhiprabha (2017), a high level of education may not always be sufficient to attract FDI, as the industry may not require high-skilled workers. In Thailand's case, the labor-intensive textile industry may not require a high level of education, leading to a lack of comparative advantage and a decline in FDI inflows.

From the impulse-response function, we first observed that a shock in education leads to a decrease in GDP per capita in the first five years, then a small increase in the ten year period. A possible explanation can be that an increase in school attendance can lead to lower output, as a result of less people attending the labor force. Because of labor intensive industries, the additional effect of further education is minimal, because the jobs they eventually get does not require a higher human capital. The effect of increased school enrollment is significantly small, and this is in accordance with the previous research mentioned above, where Thailand has not so far succeeded in developing more advanced and specialized industries that require higher human capital (Nidhiprabha, 2017).

Continuing, we saw that a shock in GDP per capita will have positive long-term effects on GDP per capita. This can be explained by multiplication effects, such as increased GDP per capita leads to increased domestic investments and savings, which again leads to higher GDP per capita and economic growth.

Lastly, we see that a shock in the investment rate predicts smaller reductions in GDP per capita during a ten year period. This contradicts what research and the Solow model suggests, that states that investment rate has a positive effect on GDP per capita. One possible explanation for the result we have obtained here, is that both GDP per capita and investment rate are considered exogenous in the Granger-causality test. Therefore, the effects of an exogenous shock in investment rate on GDP per capita, can imply that the test is not specified correctly, and that the results therefore are not that trustworthy. The effects of the shock are relatively small for GDP per capita, and can possibly be explained by the variation in the investment rate during the time period of the observations. However according to the graphs above illustrating the time trend for GDP per capita and investment rate, they follow much of the same paths. If the investment rate decreases, a reduction in GDP per capita is also reduced. The reduction in GDP per capita and investment rates are often seen in the same time periods as external shocks, as for example the COVID-19 pandemic and the Asian financial crisis (OECD, 2021).

From the impulse-response function where we saw the effects from the shock in GDP, the only clear effect of a shock in GDP was on FDI. There is no clear agreement about the direction of the relationship. One possible explanation can be cheap labor and low skilled workers that attract the kind of FDI that wants to reduce the production costs in their domestic country. As previously mentioned, when the wages in the textile industry increased, then the amount of FDI in the textile industry was reduced, because other countries could offer cheaper labor (Nidhiprabha, 2017). This example does not explicitly state that GDP per capita decreased, however, GDP per capita can be viewed as a measure of the living standard, hence the income per capita.

The variance decomposition showed that the explanatory variables have a minor influence in the variance of GDP per capita. The major factor explaining GDP per capita is GDP per capita itself. The results suggest there may be other factors affecting economic growth not included in the model. This could be work ethics and culture, or political factors such as stability and policy decisions.

8. Weaknesses and limitations

This section will highlight the weaknesses and limitations of this article. We have chosen to base our analysis on the Solow model and the Romer model. It is important to remember that it is impossible to give a complete description of an economy, but by using economic models as tools we can describe important characteristics of development in an economy.

While we have chosen certain variables to examine economic growth, it is important to acknowledge that there are other variables that could have been included to provide a more comprehensive analysis. Several research papers have also found significant effects of trade on economic growth. Trade liberalization and openness of the economy has been beneficial for economic growth in Thailand. The effects have been proved valid in both the long run and short run, enhanced by foreign spillover effects (Rattsø & Stokke, 2003). Continuing, there are many other exogenous factors affecting growth which are not as easy to measure, such as the political situation and culture. K.S et al. (1997) emphasize the significance of culture and tradition when explaining the varying degrees of economic growth observed among countries. An explanation of why Thailand has achieved less economic growth than for example Japan, Srivardhana and Cater (2006) emphasize that Thailand has a less competitive mindset, loosely structured social systems and a large belief in fatalism. Lastly, there is evidence arguing that good governance and political stability is a major factor for economic development. Kraipornsak states that countries with advanced economies are found within the high percentile rank of the World Governance Indicator (WGI). The indicator includes among other factors political stability, corruption, and effectiveness of government. Further, he argues that well working governance will positively affect capital per head and productivity growth, but also contribute to income growth per capita. This is supported by Nidhiprabha, who states that a political environment is needed to attract foreign direct investment and secure exports. Both of which are essential to future growth, but also explains past growth. Both Kraipornsak and Nidhiprabha, concludes that it is challenging for Thailand to increase income per capita and step into a high-income country, without governance improvements (Kraipornsak, 2018) (Nidhiprabha, 2009).

Another weakness in this article is the data limitations. We started with 50 observations, which is already small. Further, we have limited the data with the first-difference of the variables and included lags, which may have affected the results. Biasedness in a regression can also occur because of a low sample size. If the sample size is too low, then the estimation will not be credible and trustworthy. We have also used the logarithm of the variables, which were already in percent, and this has resulted in the values of the different variables becoming very small. It is also important to note that TFP is an index, which makes the results more difficult to interpret.

We have chosen GDP per capita as a measure of economic development, but it is important to note that this is not the perfect measure. While GDP per capita provides a measure of economic activity, it does not account for non-monetary factors such as health, education, and inequality, which are also important aspects of development (Anielski, 2002). Further, it does not include the social and cultural factors affecting well-being and development (Brinkman &

Brinkman, 2011). An alternative measurement of development is the human development index (HDI), which ranks the countries from zero to one, with one being the highest score. The index captures socioeconomic development through education, health and adjusted real income per capita (Todaro & Smith, 2020, p. 46). While both GDP per capita and HDI are useful measures of development, they capture different aspects of development and have their own strengths and limitations. GDP per capita provides a measure of economic activity and growth, while HDI provides a more holistic measure of development that takes into account non-economic factors.

In addition to this, we could have written more about the effect of population growth on economic growth, poverty trap, and the Malthusian model, but due to the scope of this article we chose to limit the focus to certain variables.

9. Conclusion

This study has explored the relationship between factors that are said to secure economic growth in Thailand from 1972-2021. We had the following research question: *"Is the relationship between the prominent factors that are said to secure economic growth a one-way relationship, or do the variables jointly affect each other?"* By estimating several different regression models, we can conclude that it is important to consider the time aspect. The relationship between the explanatory variables and the explained variable differ between regression models, and to which extent the explained variables help predict the explained variable. When estimating the MLR we received results mainly aligning with the Solow model. However, the expected negative effect of TFP was surprising. Both MLR and the AR model illustrate that the relationship between population growth and economic growth is ambiguous, as we expected from previous empirical studies.

Other surprising results were the negative effects of education and TFP in the AR model. This deviates from both the Romer and Solow model predictions, as well as previous literature. The results from the Granger-causality test showed a two-way relationship between FDI and school enrollment, they jointly Granger-causes each other. In addition, we found that all the variables included in the model collectively affect FDI and school enrollment. This suggests that the variables are endogenous. These results contribute to support endogenous growth theories, such as the Romer model.

From the variance decomposition and the impulse response function we saw that previous values of GDP per capita is important to determine current values. It was surprising to see that our chosen explanatory variables explained little of the variance in GDP per capita, but that GDP per capita explained much of the variance in the explanatory variables. These results indicate that the relationship between the explanatory and explained variables does not have a one-way relationship. The impulse response function showed that a shock in GDP per capita led to a long term increase in FDI, which indicates that fluctuations in the economy affects the attractiveness of the country.

Overall, our findings highlight the complex interplay between FDI, TFP, education, population growth, and economic growth in Thailand. While some relationships align with theoretical expectations, others demonstrate the need for considering additional factors such as infrastructure, political stability, and market access in attracting FDI and driving economic growth. Some results have supported the theory behind exogenous growth models, while other results have supported endogenous growth models. This highlights the limitations associated with using economic models, when analyzing the real world. The variance decomposition analysis indicated that there may be other unaccounted factors influencing economic growth in Thailand. The limitations of the models used and the need to consider additional factors suggest opportunities for future studies to provide a comprehensive understanding of Thailand's economic development. Interesting future research would be to explore factors we introduced in the limitations, such as culture and political stability.

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