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The Role of International Trade in Economic Growth: Results from Bayesian Model Averaging of Dynamic Panels

DOI: 10.26399/meip.4B(83).2024.26/d.czyzewski

Introduction

Economic growth plays a crucial role in the development process of a country. The theory concerning it has been developing over the years and until now there does not exist one perfect answer to the question what the main determinants of economic growth are. As there are many of them, the following paper addresses the issue connected with the way in which such determinants can be identified and classified based on the confidence level of the variable. Moreover, it also compares the results obtained with the ones of Moral-Benito (2016) as the same framework has been applied.

The results of this paper show that out of the five potential determinants used four of them turned out to be statistically significant in explaining economic growth. In addition to this, the results also support the hypothesis that international trade has a positive impact on economic growth. Out of the remaining three statistically significant variables, only one of them was found to have a negative impact on economic growth.

The paper is structured in the following way. Chapter 2 contains a review of the literature concerning the different growth theories and connections between international trade and economic growth are. Chapter 3 presents the methodology behind all the estimations as well as the description of the data used. Chapter 4 focuses on interpreting the results which were obtained in the estimations. Chapter 5 is dedicated to discussion, where the results obtained are compared with the results of the similar, already existing paper. In addition to this, it contains some personal reflections on

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what can be done or undertaken to increase economic growth. Chapter 6 is about the limitations of the work. Chapter 7 presents the summary of the paper with the ideas of what can be done in the future to expand this topic.

Literature review

The topic of economic growth was a point of interest for many well- known economists for many years. Snowdon and Vane (2005) describe the origins of the growth theories as well as how those economic theories have been changing over time. In addition to this, they highlight the factors which shaped them in particular periods and provide an information why certain theories were changed or simply what they lacked. What is more, while talking about economic growth we need to distinguish between two terms, extensive growth and intensive growth. The first term refers to the state in which the GDP increase purely results from the population increase and has no reflection in the per capita income increase. On the other hand the intensive growth presents the situation in which the GDP increase is beyond the increase resulting from the population increase and the rise in living standards can be observed by the changes, for example, in real income per capita.{ Furthermore, when it comes to intensive growth, Eric Jones (2000) has pointed out two of its forms: one of them being called "Smithian growth" and the other one "Promethian growth". The first one is based on the increases in productivity which can occur from things such as "division of labour, specialization and trade". The "Promethian growth" reflects changes in technology and innovation. Additionally, it is important to discuss the difference between proximate and fundamental causes of growth. Proximate causes are the ones associated with factor inputs (capital or labour) and all the variables that impact the productivity of mentioned above inputs. On the other hand, fundamental causes are connected with the variables responsible for the capability of a country to gather the factors of production. The authors also mention three models which had an influence on the growth theory in the second half of the twentieth century. They are listed as follows:

1. the neo-Keynesian Harrod–Domar model,
2. the Solow–Swan neoclassical model,
3. the Romer–Lucas-inspired endogenous growth models.

The neo-Keynesian Harrod-Domar model (1946) bases the output growth on the relation between the savings rate and the capital output ratio which is fixed in the model. The main assumption of this model is that savings lead to investment and investment leads to changes in capital stock. Therefore, for the economy to grow an increase in capital stock is required. Such an increase is achievable through an increase in the savings rate. The Romer-Lucas-inspired endogenous growth models (Romer, 1994) are based on the endogenous growth theory, which states that technological progress is something that can be described within the model. In addition, it highlights the importance of the role played by technological progress in the economic growth process of a country.

The model on which we will focus is the Solow Growth Model also known as the Solow-Swan model described in e.g. Snowdon and Vane (2005) as well as Solow (1956). The model consists of two inputs which are capital and labour, and both combined are used to produce the output. This implies that the size of output is dependent on the increase or decrease in any of the inputs. As output is positively correlated with inputs, an increase in either capital or labour will result in the output increase. The size of the capital variable depends on the gross investment and the depreciation of the capital by the variable μ, which stands for the depreciation rate. When it comes to the labour variable, its size is connected with the growth rate of population denoted as. A very important aspect of the model is the introduction of the variable, which represents the state of the technology. The general idea behind the model is that no matter where the economy is at the current moment, its goal is to achieve steady state. This is the point at which the growth rate of capital and output per effective worker are equal to zero. When the economy reaches this point, we do not want to change the inputs unless there are some exogenous events which force us to do so. In addition, at the steady the further development of the economy is purely driven by the technological progress. This shows us the importance of in the economic growth process.

Throughout the years, there have been many economic papers that aimed to establish whether there is a connection between the international trade and economic growth e.g. Berg and Schmidt (1994), Busse and Koeniger (2012) Kali (2007), Kotlewski (2013), Makki and Somwaru (2004), and Singh (2010). Although the methods used in the research studies varies all of the papers have one thing in common. In each case, the authors confirm that indeed international trade is one of many factors that influence economic growth. In addition, it is clearly stated that it has a positive effect on economic growth. In their research, Berg and Schmidt (1994) point out that effects coming from the trade in the short run are rather low but they increase over time. Therefore, any policies made to increase the trade should be long time oriented. Busse and Koeniger (2012) have found evidence that an expansion of trade can have an influence on the access to new technologies which as was mentioned above in the Solow model, plays an important role in the economic growth process. In addition, they have also found out that trade has an impact on income growth. Kali, Méndez and Reyes (2007) focus on the aspect of trade partners. Their research has confirmed that there is a positive correlation between the number of trade partners and the growth across all the countries. Based on their results, Caleb, Mazani, and Dhoro (2014) have indicated that there exists a cointegration between GDP and such variables as inflation, export, and import, which are connected with trade. Similar research was also conducted by Mishra (2012). The cointegration test also indicated long-run relationship between imports and economic growth. In addition, import was found to have an effect on well-being in the developing country. It is connected with the fact that via importing products or new technology, the productive capacity of a country can increase. This results in the possible improvements in the economy. Yanikkaya's (2003) results support the hypothesis that trade is connected with economic growth. Moreover, they also confirm that trade promotes growth through, for example, technology transfer. Furthermore, he points out that population density has a positive effect on trade, in particular the trade volumes. With the increase in density, the volume of trade increases as well. Ulasan (2012) has found a positive connection between the ratio of trade volume with the growth of the economy.

Methodology

This section consists of two subsections: subsection 3.1 and 3.2. The first one describes the data used in the paper as well as the reasonings behind the process of its collection. In addition, it presents the variables which will be used. The second subsection focuses purely on the estimation process and all the methods that were applied to achieve the results. Moreover, it also provides the information how the obtained results in Section 4 can be interpreted in terms of the significance level.

Data description

The dataset used in the paper consists of 129 countries from all around the world. The general idea while creating the database was to gather as much countries as possible. All the data used in the paper was taken from Penn World Table (Feenstra 2015). The maximum number of potential countries offered by Penn World Table is 183. However, 54 of them had to be rejected due to either lack of data in some of the periods or no data for certain variables at all. The next step is to establish the time period. In this case, the data from the period of 1975-2015 was taken. There is an exception for one of the variables for which the period of 1970-2010 was taken. Although the dataset takes into consideration a 40-year period, in order to have a better illustration of a long-run economic growth, there are 5 year intervals within each period. This provides a total of 9 periods out of the starting 40 periods attached to each one of the 129 countries giving the total of 1161 observations. The last period is the year 2015 as for the time being the data in Penn World Table is not avaiable for the year 2020, making it impossible to include any further periods beyond the year 2015.

The model consists of a total of 7 variables. Starting from the dependent variable, which is GDP per capita denoted as GDP_pc. The variable was calculated by dividing the real GDP at the constant national prices by the population of a country in a particular year. Unlike GDP, which presents only the total amount of goods and services produced, GDP per capita also accounts for the population. It is an important variable while discussing the economic growth topic. As was mentioned above, the economic growth can have two forms: extensive and intensive (Snowdon and Vane, 2005). While talking about the GDP per capita, we purely focus on the intensive growth because we track both the changes in GDP and the population, so the growth depends solely on, for example, an increase in productivity, and changes in technologies. Moreover, GDP per capita is easier to compare between countries when we want to determine the living standards in a particular country. The are 6 explanatory variables in the model which are presented in the following order:

- lagged GDP per capita – the only variable for which the exception was made in terms of the time period because it consists of the data from the period of 1970–2010. The only difference is the fact that the starting period is 1970 instead of 1975 and the same applies to the last period which is 2010, whereas in the case of the other variables it is 2015.
- share of gross capital formation at current PPPs – the variable is presented as the ratio of investment to GDP. In the neoclassical growth model framework, e.g. Solow (1956), investments were connected with the savings rate. Any changes in investments would lead to either an increase (when the investments rise) or a decrease (when the investments decrease) of output per effective worker, which impacts the state-state level of the economy. The variable is denoted as csh_i.
- share of government consumption at current PPPs – this variable is connected with the government expenditures and illustrates the impact of government on the economic growth process. The government can, for example, influence changes in the savings level through taxation. As before, the variable is presented as the ratio of government consumption to GDP and is denoted as csh_g.
- share of merchandise exports and imports at currenct PPPs – this is a mix of 2 smaller variables (csh_x – share of merchandise exports and csh_m – share of merchandise imports) which are combined in one variable. As was already discussed, both these variables represent the volume of trade and have a positive effect on the growth rate e.g. Ulasan (2012), Yanikkaya (2003) The variable is denoted as csh_xm.

- population – presents the population of a country. This variable is connected with the extensive growth term (Snowdon and Vane 2005). According to the theory, as the population increases, the GDP increases as well, which indicates its impact on the GDP.
- human capital index – this is an index which was calculated in Penn World Table (Feenstra 2015) using the Barro and Lee (2013) database. The index takes into consideration years of schooling and life expectancy. In his research, Moral-Benito (2016) used education and life expectancy as separate variables. Here, both of them will be combined in one variable denoted as hc.

Model estimation

Although we can find many economic models trying to explain the determinants of growth, e.g. Domar (1946), Romer (1994), and Solow (1956), till this day, there does not exist one perfect ideal model to follow. Each of the already existing models has limitations, assumptions and even sometimes treats different variables as the main driving force of economic growth. Knowing this, we cannot be sure whether the currently picked set of variables is the ideal one. Therefore, we have to account for the model uncertainty. This will enable us to identify whether the mentioned above variables are statistically significant in explaining economic growth. An important thing to point out is that even if most of the variables turn out to be statistically significant, it does not negate the fact that there might be far more variables that may also contribute to economic growth. In addition, Moral-Benito (2016) states that all the variables used in this paper are weak exogeneity regressors. This means that we should account not only for model uncertainty but also for reverse causality. The latter means that, for example, not only trade has an effect on economic growth but also economic growth has an impact on trade, boosting the power of the equation as a result.

In order to deal with the mentioned issues, the Moral-Benito (2016) framework will be used[1]. First of all, the baseline growth regression can be presented in the following way:

$$y_{ijt} = \alpha y_{ijt-1} + \beta x_{ijt} + \eta_{ij} + \zeta_t + v_{ijt} \quad (1)$$

where $\alpha = (1 + c)$, y_{ijt-1} is the GDP per capita measure between countries *i* and *j* at time *t*, is β a parameter vector, x_{ijt} is a matrix of potential GDP per capita determinants, η_{ij} is a country specific fixed effect, ζ_t is a period-specific shock that is common to all the countries, v_{ijt} is a shock to GDP per capita. The second equation

1 The method is relatively new; however, it was already applied in the analysis of the determinants of economic growth (Moral-Benito 2013 and 2016), business cycle synchronization (Beck, 2019, 2021a, 2021c, 2021d, 2022) and structural convergence (Beck, 2021b).

will ilustrate how the weak exogeneity assumptions can be expressed. They can be formalized in the following way:

$$\mathbb{E}\left(v_{it}\middle|y_t{}^{t-1}, x_i{}^t, \eta_i\right) = 0, (\mathrm{i} = 1,..,\mathrm{N}; \mathrm{t} = 1,..,\mathrm{T}) \quad (2)$$

where $y_t{}^{t-1} = \left(y_{i0}, \ldots, y_{it-1}\right)'$ and $x_t{}^t = \left(x_{i0}, \ldots, x_{it}\right)'$.

The next step is to establish the likelihood function for panel models with weakly exogenous regressors. Moral-Benito (2013)labeled as sub-system LIML (ssLIML has already such a function based on equation (1) and (2). In order to do so, Moral-Benito augments equation (1) with additional reduced form-equations that capture the unrestricted feedback and presents it as follows:

$$x_{ijt} = \gamma_{t0}y_{ij0} + \gamma_{t,t-1}y_{ij,t-1} + \Lambda_{t1}x_{ij0} + \Lambda_{t,t-1}x_{ijt-1} + c_t\eta_{ij} + \vartheta_{ijt}, \quad (3)$$

where $t = 2, \ldots, T$ and c_t is the $k \times 1$ vector of parameters. For $h < t$, γ_{th} is a $k \times 1$ vector $\left(y_{th}{}^1, \ldots, y_{th}{}^k\right)'$, $h = 0, \ldots, T-1$. Λ_{th} is a $k \times k$ matrix of parameters; and ϑ_{it} is a $k \times 1$ vector of prediction errors. The mean vector and the covariance matrix of the joint distribution of the initial observations and individual effects η_i are unrestricted:

$$y_{ij0} = c_0\eta_{ij} + v_{ijt} \quad (4)$$

$$x_{ij1} = \gamma_{10}y_{ij0} + c_1\eta_{ij} + \vartheta_{ijt} \quad (5)$$

where c_0 is a scalar and c_1 and γ_{10} are $k \times 1$ vectors. Given the model setup in equations (1) and (3)–(5), the natural logarithm of the likelihood function under Gaussian errors can be presented as:

$$\log f\left(\mathrm{data}\middle|\theta\right) \propto \frac{N}{2}\log\det\left(B^{-1}D\Sigma D'B'\right)^{-1} - \frac{1}{2}\sum_{i=1}^{N}\left\{R'i\left(B^{-1}D\Sigma D'B'\right)^{-1}Ri\right\} \quad (6)$$

where $R_i = \left(y_{i0}, x_{i1}{}', y_{i1}, \ldots, x_{iT}{}', y_{iT}\right)'$ is a vector of observable variables, $\Sigma = \mathrm{diag}\left\{\sigma_\eta{}^2, \sigma_{v0}{}^2, \Sigma_{\vartheta 1}, \sigma_{v1}{}^2, \ldots, \Sigma_{\vartheta T}, \sigma_{vT}{}^2\right\}$ is the block-diagonal variance-covariance matrix of $U_i = \left(\eta_i, v_{i0}, \vartheta_i{}', v_{i1}, \ldots, \vartheta_i{}', v_{iT}\right)$, and B is a matrix of coefficients given by:

$$B = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 \\ -\gamma_{10} & I_0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 \\ -\alpha & -\beta' & 1 & 0 & 0 & \cdots & 0 & 0 & 0 \\ -\gamma_{20} & -\Lambda_{21} & -\gamma_{21} & I_k & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0 & -\alpha & -\beta' & 1 & \cdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \cdots & 0 & 0 & 0 \\ -\gamma_{T0} & -\Lambda_{T1} & -\gamma_{T1} & -\Lambda_{T2} & -\gamma_{T2} & \cdots & -\gamma_{T,\mathrm{t-1}} & I_k & 0 \end{bmatrix}, \quad (7)$$

and D is a matrix of coefficients given by:

$$D = \begin{bmatrix} [c_0 \; c_1{}' \; 1 \; c_2{}' \; 1 \; \ldots \; c_T{}' \; 1] \\ I_{T(k+1)} \end{bmatrix}. \quad (8)$$

Having the Gaussian likelihood in equation (7), we may apply the Bayesian model averaging method (BMA). In his research, Beck (2021a) has also applied BMA methodology to the above equations and provided further steps which will be followed in the paper[2]. The number of models that we are able to estimate is purely dependent on the number of variables used. The general approach to this is presented as 2^k, where k is the number of explanatory variables. As there are 6 variables, we are able to estimate $2^6 = 64$ models. After the models are estimated, each of them is assigned with the posterior model probability (PMP), which is described by the Bayes rule:

$$\mathrm{PMP}_m = \frac{L(\mathrm{data}\,|M_m)P(M_m)}{\sum_1 m64\left(L\left(\mathrm{data}\,\middle|M_m\right)P\left(M_m\right)\right)} \quad (9)$$

where $L(\mathrm{data}\,|M_m)$ is the value of the likelihood function for model $m(M_m)$ and $P(M_m)$ is the prior probability of model m. The next step is to calculate posterior mean and posterior standard deviation of coefficient β_k, where k was already discussed as the number of variables. In this case, k can take the value from 1 up to 6 $(k = 1, \ldots, 6)$. The posterior mean (PM) of this coefficient is calculated using the following expression:

$$\mathrm{PM}_k = \sum_{m=1} 64\mathrm{PMP}_m \widehat{\beta}_{km} \quad (10)$$

where $\widehat{\beta}_{km}$ is the value of coefficient β_k estimated for model m and k indexes the regressor.

We can obtain the posterior standard deviation (PSD) using this formula:

$$\mathrm{PSD}_k = \sqrt{\sum_{m=1}^{64} \mathrm{PMP}_m V(\beta_k|\,\mathrm{data}, M_m) + \sum_{m=1}^{64} \mathrm{PMP}_m \left(\widehat{\beta}_{km} - \mathrm{PM}_k\right)^2} \quad (11)$$

where $V(\beta_k|\,\mathrm{data}, M_m)$ denotes the conditional variance of the parameter in model M_m. Having all the formulas and calculations behind the results explained, it is time to discuss how we interpret the significance levels of the variables.

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2 For more on BMA see Beck (2017 and 2020a).

Using the mentioned above framework, the robustness of the variables will be discussed using the ratio of posterior mean (PM) to posterior standard deviation (PSD). In the simple model regressions, we often use the confidence intervals. In the current situation, we only have the ratio of PM to PSD. As the ratio can be negative, the absolute value of it will be the point of interest. Now, it is important to find a point of reference, so that we will be able to interpret the significance level of the variables based on this measure. Fortunately, literature provides us with the required information (e.g. Masanjala and Papageorgiou, 2008; Raftery, 1995; Sala-i-Martin et al., 2004). Raftery (1995) states that the variable can be considered to be robust if the absolute value of the ratio exceeds 1. This threshold tells us since when we can treat the variable to be an improvement to the model. On the other hand, Masanjala and Papageorgiou (2008) associate the ratio value of 1.3 to be equivalent of 90% confidence interval. Last but no least, Sala-i-Martin, Doppelhofer, and Miller (2004) suggest the ratio value of 2 as an equivalent to 95% confidence interval.

Results

Table 1.
Results of the estimation

	PM	PSD	PM/PSD	
lag_GDP_pc	0,89	0,01	112,925	***
csh_i	3037,00	1634,00	1,858	**
csh_g	-4484,00	1739,00	-2,578	***
csh_xm	1895,00	324,20	5,845	***
pop	-0,75	1,07	-0,706	
hc	2595,00	250,80	10,347	***

Source: Author's own elaboration.

The results of the estimations are presented in Table 1. As can be seen, out of the six variables only variable population (pop) did not even meet the threshold of 1 as it comes to PM to PSD ratio, which according to Raftery (1995), is a requirement to consider the variable robust. Therefore, the variable will not be interpreted as it is statistically insignificant. Nevertheless, Moral-Benito (2016) has found the population to be one of the determinants of economic growth. However, the dependent variable used by him was GDP, whereas according to this paper, the dependent variable is GDP per capita. As GDP per capita consists of GDP that is divided by the population, this might be one of the explanations why the population turned out to be insignificant.

The first variable to interpret will be the lagged GDP per capita denoted as lag_GDP_pc. The PM/PSD ratio for this variable is equal to 112,925, leaving us with no doubt that the variable plays an important role in determining economic growth. In addition, we can see that the sign of the variable is positive, which was expected and can be easily explained. The higher the GDP per capita value in the previous period was the higher the expected increase in the upcoming period is. The determinant of the variable is equal to 0,89, which means that if the lag_GDP_pc increase by 1 unit, the GDP_pc will on average increase by 0.89$. The value of the determinant compared to the other results looks very low, but we need to remember that we multiply it by the lagged period GDP per capita value that is expressed in thousands.

The share of gross capital formation at current PPPs (csh_i) out of all the variables (not mentioning population as the variable is statistically insignificant) had the lowest PM/PSD equal to 1.858. Nevertheless, this result meets the 90% confidence interval threshold described by Masanjala and Papageorgiou (2008) and was close to the ratio value of 2 which would classify the variable in the 95% confidence interval. Having that in mind, the variable can be considered to be a strong determinant of economic growth. What is more, the sign of the coefficient is positive and equal to 3037, which signals the positive effect of investment ratio to GDP on GDP per capita. The coefficient is interpreted in the following way: if the ratio of Investments to GDP increases by 1 unit, the GDP per capita will increase by 3037$ on average. The sign of the variable can be explained by the fact that investments are often associated with the improvements of the current situation, like, for example, providing new workplaces by building new facilities and developing new technologies, which can increase productivity.

The share of government consumption at current PPPs (csh_g) is characterized by the -2,578 PM to PSD ratio. As was already discussed, we do not have to worry about the negative sign of the ratio as while interpreting, we focus on the absolute value of the ratio. Out of the % base variables, this one has the second highest ratio and according to Sala-i-Martin, Doppelhofer, and Miller (2004), having the ratio of 2 is the equivalent of 95% confidence interval. Having more than this value indicates that this variable is not only statistically significant, but that it is also a very strong variable in explaining GDP per capita.

The value of the coefficient is negative and equal to -4484. This means that increasing the ratio by 1 unit leads to the decrease of GDP per capita by 4484$ on average. One of the ways to explain the negative sign is the fact that the government can get the money via, for example, taxation. In order to increase consumption, the government may increase taxes to get more money, which negatively affects consumption of citizens or investments as people have to give more of their money to the government, therefore negatively impacting the GDP per capita.

When it comes to the share of merchandise exports and imports at current PPPs (csh_xm), we need to remember that this variable represents the volume of trade of a country. In addition to this, as was discussed in Chapter 3, it is a mix of two smaller separate variables presenting the impact of international trade. This variable has the third highest PM to PSD ratio, which is equal to 5,845. When it comes to the significance level of the variable, there is no doubt that the volume of trade plays an important role in determining economic growth. Moreover, the sign of the coefficient is positive and indicates that international trade positively impacts economic growth. If the ratio of trade to the GDP increases by 1 unit, the GDP per capita increases by 1895$ on average. International trade can provide better access to the newest technology and therefore, positively contribute to the growth in the future, which can be one of the explanations of the positive sign. Moreover, people can, for example, import better quality products such as vehicles or machines which can increase productivity as well export products and earn money while being the producer of such goods. All of those activities contribute positively to the economy of a country and impact economic growth.

Last but not least, we have the human capital index (hc). It has the second highest PM to PSD ratio equal to 10,347, which makes it a strong and statistically significant variable when discussing the economic growth. The sign of this variable was expected to be positive as the index is based on things such as life expectancy and years of schooling, which are likely to positively impact economic growth when improved. The value of the coefficient is equal to 2595 and we interpret it in the following way: if the human capital index increases by 1 unit, the GDP per capita will increase by 2595$ on average. When it comes to the justification behind the positive sign, one of the reasons can be the fact that an increase in life expectancy can be associated with an increase in wealth, which may indicate a better economic situation. In addition, one of the factors that contributes to this index is time of schooling. Better education enables people to undertake more demanding jobs that require a lot of knowledge, which may be also connected with earning more money.

The important subject to mention while discussing the changes in the quoted above determinants is that some of the variables may also influence a few other variables. This happens when they are connected with the % share of GDP (csh_i, csh_g, csh_xm). It has to do with the fact that changing the ratio by changing the input also changes the GDP as inputs like export, import, government consumption, and investments contribute to the GDP. Therefore, a change in one of the ratios may also impact the % share in two other variables by the increase or the decrease in GDP. As the ratios for each of the mentioned above variables differ between the countries, we need to remember that the GDP per capita will always be differently affected by changes in the ratios.

Furthermore, this implies that, for example, an increase in government consumption can have an even more negative effect than the one explained by the coefficient. This may happen if the change in government consumption would conduce to a decrease in either investments or trade ratio. Similarly, increasing the investment ratio can have a different effect than the one resulting from the coefficient as an increase in this ratio could,for example, decrease the ratio of government consumption. This is very important especially while discussing the potential improvements that can be done to maximize GDP per capita.

Discussion

As the variables have been discussed, the next step is to compare the obtained results with those of Moral-Benito (2016) as the same methodology was applied as well the variables used are very similar. First of all, Moral-Benito used in his paper initial GDP, whereas in this paper, GDP per capita was used. This might be one of the reasons why in this dissertation, population turned out to be statistically insignificant, whereas in his case, the other way around. In addition to this, GDP was expressed in the natural log form. Therefore, the results of the coefficients obtained by him were much lower than the ones obtained here. While comparing the results, the human capital index will be compared with education and life expectancy variables. The sign of the coefficients are the same for all the variables. The only exception was the population variable, which was negative in this paper. However, it did not turn out to be statistically significant so we will not focus on explaining the reasoning behind such circumstances. Having compared the signs of the coefficients, it is time to take a look at the PM to PSD ratio associated with the variables. The comparison is presented in Table 2 below:

Table 2.
The comparison of the PM to PSD ratios

	PM to PSD ratio	
	current results	Moral-Benito 2016
	dependent variable GDP per capita	dependent variable natural logarithm of GDP
csh_i	1,858	1,016
csh_g	-2,578	-0,151
csh_xm	5,845	1,063
pop	-0,706	1,531

Source: Author's own elaboration.

First of all, the lagged variable of GDP per capita/ln(GDP) was not taken into consideration as in both cases, it turned out to be a strong variable with the ratio exceeding the 95% confidence interval. Moreover, the table does not consider the human capital index as we cannot assume that life expectancy and education variable will be the 1:1 equivalent of this index. Looking at the table, we can see without any doubt that the results obtained in this paper seem to be very good while comparing them with the Moral-Benito ones. Nevertheless, we should account for the fact that the dependent variables used are different. Therefore, we may speculate whether using GDP per capita in Moral-Benito's framework would provide us with similar results in terms of the ratios. However, we need to take into consideration that the amount of variables used in the papers are not the same what can also be one of the factors that may affect the results.

After the results have been compared it is time to discuss the potential actions that can be undertaken in order to maximize the GDP per capita value[3]. When it comes to the first variable presented in the model, which is lagged GDP per capita we can hardly do anything else than simply trying to maximize the GDP per capita in the current period in order to have a better starting point in the following period. The higher initial

[3] For more, see Beck (2011, 2014, 2020b, and Beck 2023), Beck and Jackson (2024), Beck and Nzimande (2023), Beck and Okhrimenko (2024), Beck and Stanek (2019), and Beck and Yersh (2022).

value of GDP per capita, the stronger the effect of the variable in the future period will be. The situation of % share variables was described in Chapter 4. Having that in mind and looking at the results, we can say without any doubt that the decrease in the government consumption ratio will have a positive effect on GDP per capita. It is due to the fact that lowering the ratio not only increases the GDP per capita based on the fact that we lower the variable, which negatively influences the dependent variable, but also it may lead to changes in investment and trade ratios which have a positive effect on economic growth. Therefore, the main task that the government can undertake is trying to lower its consumption if possible, which will lower the negative effect of the government consumption variable and consequently may boost the power of the other two variables. In the case of investments ratio and trade ratio, the situation depends on the % associated with all those variables within countries. The changes in each case may vary in terms of the positive effect associated with the change. Nevertheless, imposing policies that are aimed at providing people with more incentive to invest is one of the tasks which can be done to increase the GDP per capita. When it comes to the human capital index there are several options which can be undertaken. The first one is focusing on GDP per capita through the mentioned above variables and later on due to the increase, the index will naturally begin to increase. The index is calculated based on variables such as, for example, life expectancy and years of schooling. Both of those aspects can be compared with the wealther. If the number of wealther increases, the situation of those factors may also improve resulting in an increase of the index. The other way to look at this variable is that the government can try to aim at the improvements in this area with the future expectations of providing higher GDP per capita growth.

The results of the variable responsible for the volume of trade in a country (csh_xm) confirm the hypothesis that trade is connected with economic growth which are described in e.g Caleb (2014), Mishra (2012), and Yanikkaya (2003). We can see it based on, for example, the PM to PSD ratio, which is far over the 2 threshold (corresponding to 95% confidence interval) and is equal to 5.845. What is more, the result supported the assumption that trade has a positive impact on economic growth (e.g Busse and Koeniger, 2012; Ulasan, 2012). Knowing this, an increase in the volume of trade will lead to the modernizations in the economy. Therefore, while discussing the benefits from trade, we should look at a few aspects. First of all, what positives coming from it are, and secondly, how we can improve the volume. When it comes to the first aspect, trade can provide us with the access to new technology which may for example impact productivity. This access is especially beneficial for the countries which are less developed, and having such an opportunity can make it faster for them to make improvements in the economy. There are many steps which any government of any country can undertake to increase the power of this variable. One of them can be joining a trade union. This enables easier access to potential trade partners which according to Kali, Méndez and Reyes (2007), positively impacts growth since in their research, they found evidence that there is a positive relationship between the number of trade partners and the growth rate among countries. What is more, union partnership may also be associated with a lack of some additional costs connected with the transactions such as, for example, value added tax (VAT). This would mean that the government will generate less money from taxes compared to the situation in which people would have to pay this tax. Nevertheless, for some people, this additional cost associated with the transaction could mean that they would not make any of them at all. Therefore, cutting such costs may make people more willing to import products could bring an increase in the ratio. The same thing applies to the exporters of the country as they could export products to other member countries without some additional costs. In both of those cases, we would see an increase in the variable. However, we need to keep in mind that some countries for different personal reasons may not be willing to enter any unions. In such a situation, a country can make a trade agreement only with a country or countries that are the main trade partners. We also need to account for the fact that such agreements might be more beneficial for better developed countries because they may have much stronger bargaining power, resulting in a higher profit from such activity. The third option that may but does not have to require any communication with other countries is imposing a trade policy. As Berg and Schmidt (1994) have described in their research, the effects that come from trade are low at the start but increase over time. Knowing that, while imposing any trade policies, we should make them long term oriented in order to increase the effect coming from it.

Limitations

The main limitation of this paper is certainly lack of time. Having more time would enable the introduction of several other variables to the model. As the number of models that can be estimated is equal to, where k stands for the number of explanatory variables. The introduction of any additional variable would lead to a double increase in the number of models. This even further prolongs the required time to estimate the final results. It is also connected with computer limitations. Having better software and equipment would make it possible to include more variables. The number of countries could have been increased in order to take into higher % of the world GDP into consideration. However, this would mean that the time period would have to be rearranged due to the lack of data as some of the countries did not exist during the starting period of the paper. Nevertheless, it is possible to do so. All in all, this paper thruthfully presents all the information which (were taken into consideration.}was used.

Conclusion

The paper adressed the issue of model uncertainty and reverse causality while dealing with panel growth regressions. The first issue arises due to the fact that there does not exist one perfect unique set of variables that describes economic growth. Therefore, with each set of variables used, we have to create all the possible combinations of models. The problem of reverse causality arises when growth-related variables are considered to be weak-endogenous ones. This indicates that not only can they have an effect on economic growth, but they also can be influenced by it. As a result, boosting the power of the equation. Moral-Benito framework (2016) combined with bayesian model averaging method (BMA) enables us to deal with such problems as well as provide the information concerning the sign of the variables and their power in determining economic growth. The results have shown that with the dependent variable being GDP per capita, population turns out to be a statistically insignificant variable. This might be due to the fact that GDP per capita is explained by both GDP and population, because it is the ratio of those two inputs. The other four variables are statistically significant with one of them being significant at the 90% confidence interval and the rest being significant at the 95% confidence interval. The results are especially interesting due to the fact that Moral-Benito (2016) has stated in his paper that none of his variables which were potential determinants of growth is considered robust, whereas in this case, four of them turned out to be considered robust at the very high confidence interval. However, we need to take into consideration that the dependent variable used by him was different as well as the number of variables differed. Therefore, this might be one of the reasons behind the difference in results. Furthermore, the paper also upholds the hypothesis that international trade has a positive effect on economic growth. One of the potential improvements which might be made in the future using a similar framework is expanding the number of countries to consider even higher % of the World GDP. Nevertheless, the paper already takes into consideration a very high % of the World GDP. The same can be done to the period of time. However, we have to keep in mind that the starting point would have to be different as there is lack of data for some of the countries in the starting periods. In addition, we need to account for the potential bias in the upcoming data from years during the corona virus crisis as the results will be definitively lower than the ones from previous years.

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Appendix

List of countries used in the estimation

Albania	Congo – Brazzaville	India	Mexico	Singapore
Algeria	Congo – Kinshasa	Indonesia	Mongolia	South Africa
Angola	Costa Rica	Iran	Morocco	South Korea
Argentina	Cyprus	Iraq	Mozambique	Spain
Australia	Denmark	Ireland	Myanmar	Sri Lanka
Austria	Dominican Republic	Israel	Namibia	Sudan
Bahrain	Ecuador	Italy	Nepal	Sweden
Bangladesh	Egypt	Ivory Coast	Netherlands	Switzerland
Barbados	El Salvador	Jamaica	New Zealand	Syria
Belgium	Eswatini	Japan	Nicaragua	Taiwan
Belize	Ethiopia	Jordan	Niger	Tanzania
Benin	Fiji	Kenya	Nigeria	Thailand
Bolivia	Finland	Kuwait	Norway	Togo

Albania	Congo – Brazzaville	India	Mexico	Singapore
Botswana	France	Laos	Pakistan	Trinidad and Tobago
Brazil	Gabon	Lesotho	Panama	Tunisia
Brunei	Gambia	Liberia	Paraguay	Turkey
Bulgaria	Germany	Luxembourg	Peru	Uganda
Burkina Faso	Ghana	Macao	Philippines	United Arab Emirates
Burundi	Greece	Madagascar	Poland	United Kingdom
Cambodia	Guatemala	Malawi	Portugal	United States
Cameroon	Guyana	Malaysia	Qatar	Uruguay
Canada	Haiti	Maldives	Romania	Venezuela
Central African Republic	Honduras	Mali	Rwanda	Vietnam
Chile	Hong Kong	Malta	Saudi Arabia	Zambia
China	Hungary	Mauritania	Senegal	Zimbabwe
Colombia	Iceland	Mauritius	Sierra Leone	

The Role of International Trade in Economic Growth: Results from Bayesian Model Averaging of Dynamic Panels

Abstract

This paper addresses issues connected with economic growth, how the theory on it has changed and also what its potential determinants are. In order to do so, the panel data was constructed for 129 countries with the time period of 1975-2015. In addition to this, the paper also accounts for the model uncertainty as well as reverse causality issues that may arise while dealing with such data. The methodology applied in the research consists of the Moral-Benito (2016) framework combined with the bayesian model averaging method (BMA). Out of the five variables, only one turned out to be fragile. The other four appeared to be robust with three of them at the most restrictive level. What is more, the paper also presents the potential reasoning behind obtained results and upholds the hypothesis that international trade has a positive impact on the economic growth.

Keywords: function, regressors, likelihood, coefficient, variable, threshold, formula

Wpływ handlu międzynarodowego na wzrost gospodarczy: wyniki bayesowskiego uśredniania modeli paneli dynamicznych

Streszczenie

Niniejsze opracowanie porusza kwestie związane ze wzrostem gospodarczym, z tym, jak zmieniała się teoria na jego temat, a także jakie są jego potencjalne determinanty. W tym celu skonstruowano dane panelowe dla 129 krajów z lat 1975–2015. Uwzględniono również niepewność modelu, a także kwestie odwrotnej przyczynowości, które mogą pojawić się podczas pracy z takimi danymi. Metodologia zastosowana w badaniu obejmuje ramy Moral-Benito (2016) w połączeniu z bayesowską metodą uśredniania modelu (BMA). Spośród pięciu zmiennych tylko jedna okazała się niepewna. Pozostałe cztery są solidne, a trzy z nich na najbardziej restrykcyjnym poziomie. W opracowaniu przedstawiono również możliwe uzasadnienie uzyskanych wyników i podtrzymano hipotezę, że handel międzynarodowy ma pozytywny wpływ na wzrost gospodarczy.

Słowa kluczowe: funkcja, regresory, prawdopodobieństwo, współczynnik, zmienna, próg, formuła

Cytuj jako:

Czyżewski D., *Wpływ handlu międzynarodowego na wzrost gospodarczy: wyniki bayesowskiego uśredniania modeli paneli dynamicznych,* „Myśl Ekonomiczna i Polityczna” 2024, nr 4B(83), s. 38–58 DOI: 10.26399/meip.4B(83).2024.26/d.czyzewski

Cite as:

Czyżewski D. (2024). ‘The Role of International Trade in Economic Growth: Results from Bayesian Model Averaging of Dynamic Panels’. *Myśl Ekonomiczna i Polityczna* 4B(83), 38–58 DOI: 10.26399/meip.4B(83).2024.26/d.czyzewski