

Can economic freedom promote growth via physical capital accumulation?

A study applying the augmented mean group (AMG) estimator for macro panel data analysis



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Abstract

The efficiency of physical capital accumulation plays a critical role for economic growth. This paper aims at examine if economic freedom promotes economic growth via physical capital accumulation. This is done by estimating a production function by replacing the inputs with institutional indices. The first input is GDP per capital growth rate which serve as a proxy for institutional aspects and the other input are the economic freedom indexes which will serve as proxies for physical capital accumulation. This is done by applying the augmented mean group (AMG) estimator that is designed for dealing with macro panel data analysis, including twenty developing countries where the economies have experienced a rapid growth, and the time period are between 1995 and 2017. The theoretical framework is based on the Solow growth model, institutional theory and marginal efficiency of capital (MEC). The results show that economic freedom promotes economic growth via physical capital accumulation where GDP per capital growth rate served as a proxy for institutional aspects and economic freedom indexes as proxies for physical capital accumulation. The results also show that the AMG estimator is the best fit for macro panel data analysis since it are designed for dealing with heterogeneity.

Keywords: AMG estimator, economic growth, physical capital accumulation, Solow growth, institutional theory, marginal efficiency of capital

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1. Introduction

Several researchers in economics during time have been studying what factors makes the economy in a country to thrive. The definition of economic growth is the increase in the amount of goods and services produced per head of the population over a period of time, also known as GDP which stands for gross domestic product (Nationalencyklopedin 2020). The reason for examining which factors that promotes economic growth is because economic growth enables, in a long-term perspective, an increase of the average material living standard within a country's population. Thus, people in a country will have a higher standard of living with increasing economic growth compared to economies that are not experience economic growth. Therefore, it is important to examine what factors make the economy in a country to thrive.

In 1956 Robert Solow presented his theory called the Solow growth model where he finds that the presence of technological development increases productivity and therefore economic growth. Recently, researchers have focused on physical capital accumulation as a main driver for economic growth. Ghani and Suri (1999) argue that the banking system plays a critical role since they are allocating capital and chooses which projects should be selected in an economy. The main argument is that if the banking system does not allocate capital efficiently this could have a negative impact on the economic growth.

Mankiw, Phelps and Romer (1995) also stress the importance of the banking system as a financial institution and argue that countries with efficient financial systems tend to have higher growth rates, while countries with distorted markets tend to have lower growth rates. In other words frequency of financial crises and distortions in exchange rates could significantly impact the convergence rate. In other words, the banking system may have an important role to play in the modern economy by accelerating and transforming large savings into capital accumulation which could have an impact on economic growth.

Mokyr (1990) and Landes (1998) point out institutions of economic freedom as an important factor of economic growth. They argue that nations that promote the institutions of economic freedom since the beginning of the industrial revolution have grown and prospered while those nations that have not adopted the institutions of economic freedom have ended up in poverty.

Within theoretical econometrics Eberhardt (2012) argue that the study of panel data over the two last decades where both time-series (T) and the cross-sectional (N) dimension are moderate to large has been an active field amongst researchers. Furthermore, he points out that this literature is dedicated for macro panel dataset analysis where states or countries, provinces or regions within countries, typically represents the cross-section dimension. Thus, estimators developed for micro datasets dominates the analysis of macro panel datasets. Eberhardt implements three panel time-series estimators, allowing for heterogeneous slope coefficients across group members and therefore relax the assumption of parameter homogeneity across panel members maintained by the aforementioned micro panel estimators.

This paper aims at if economic freedom can promote economic growth via physical capital accumulation, where economic freedom indexes will serve as proxies for physical capital accumulation since physical capital accumulation is not observable. This paper carries out a statistical exercise with the quantitative secondary data collected from World Bank (WB) and the heritage index of economic freedom from Heritage. To be able to answer the research question in this paper we need to quantify the variables, and therefore the Augmented Mean Group (AMG) estimator has been applied since it is designed to deal with heterogeneity and macro panel data analysis. The AMG model deals with panel data that consists of twenty developing countries, endured rapid economic growth recently, during the period 1994-2017 and are designed to deal with heterogeneity. Studenmund (2017) argues that more observations gives a more reliable result compared to if the analysis would have contained fewer observations. Therefore, the time period consisting of 34 years has been selected in this paper.

The dependent variable used in this econometric analysis is a measure of the average annual GDP per capital growth for the period 1994-2017. The first explanatory variable is physical capital accumulations via a proxy of institutional setting related to financial system, banking sector and investment environments etc., in other words economic freedom indicators. The second explanatory variable is the growth promoting institutions proxied by GDP growth. The residual will represent total factor of productivity (TFP).

1.1 Study Objective

The objective of this study is to examine if economic freedom can promote economic growth via physical capital accumulation. We attempt to answer this research question by using GDP growth as a proxy for institutional aspects and economic freedom indexes as proxies for physical capital accumulation since it is not observable and there is lack of data. Therefore, the research question to be answered in this study is formulated as follows:

Can economic freedom promote economic growth via physical capital accumulation where economic freedom indexes will serve as proxies for physical capital accumulation?

1.2 Delimitation

This thesis focus on the time period 1995-2017 due to lack of available data and have a sample of twenty developing countries that have had a rapid growth from 1995 until 2017. Therefore, no OECD countries are included in this study since these countries have a more regular growth trend near 2%. The selected developing countries that are included in this study are Armenia, Bangladesh, Cambodia, China, Cote d'Ivoire, Ethiopia, Ghana, Guinea, India, Indonesia, Ireland, Kenya, Libya, Mexico, Nepal, Philippines, Romania, Tanzania, Thailand and Vietnam.

1. Background

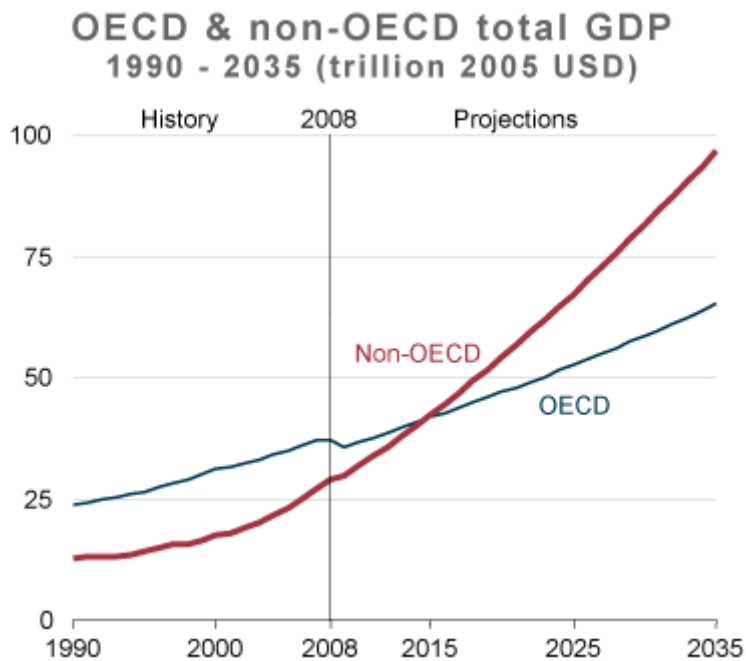
Ghani and Suri (1999) stress that the banking system plays a critical role in accelerating and transforming large savings into capital accumulation. It points out capital accumulation as a key driver of output growth in Malaysia. Ghani and Suri (1999) argue that a banking system which does not allocating capital efficiently could have a negative impact on output growth. Therefore, a rapid growth in bank lending is associated with decreasing total factor productivity growth. Furthermore, if bank lending is too fast, financial intermediaries such as project selection, monitoring capability of banks and risk management get compromised. Thus, it is difficult for the supervisors, and the managers of individual banks to ensure that capital is being allocated to the most productive activity in the face of rapid growth in lending. As a consequence, the productivity growth will be harmed because of a rapid build-up in bank credit which can lower the quality of investment projects.

One fundamental cause of the long-run economic growth that has been identified is the institutions, according to Williamson (1985), North (1990) and Acemoglu et al. (2005). Institutions are viewed as the social and legal rules that govern economic systems, and due to this intrinsic nature, the institutions embody societies structure of incentives. Furthermore, the institutional theory of development aims at understanding how different norms and rules reward growth-enhancing activities and the creation of markets.

Gwartney et al. (1996) argue that individuals have economic freedom when (a) the property they acquire is protected from physical invasions by others and without the use of force, theft or fraud and (b) when they are free to exchange, use or give the property which they own to another as long as their actions do not violate the identical rights of others. It states that the fundamental function of government is limited in the area of enforcement of contracts and the protection of private property, in other words an economically free society. Gwartney et al. (1996) point out that a government violates the economic freedom of its citizens when it establishes restrictions that limit voluntary exchange, fails to protect private property or takes property itself without full compensation. Therefore, it argues that institutional arrangements that increase transaction costs, restrain trade, create uncertainty and weaken property rights will reduce the incentive of individuals to engage in productive activities since these arrangements will reduce the realization of gains from trade.

Figure 1 illustrates total GDP in OECD and non-OECD countries between the period of 1990 until 2035 which in the non-OECD has been increasing in a faster pace than in the OECD countries.

Figure 1 OECD & non-OECD total GDP



Source: International Energy Outlook (2019)

In figure 1 we can see that since 2015 total GDP are higher in non-OECD countries than in OECD countries. Therefore, it is important to study the drivers behind economic growth in developing countries also called non-OECD countries.

2. Literature Review

Sturm and De Haan (2001) examine how robust the relationship between economic freedom and economic growth are by using various indicators for economic freedom. It concludes that increases in economic freedom are robustly related to economic growth, and even if the impact of outlying observations is taken into account the conclusion still holds, but that the level of economic freedom is not related to growth.

Ghani and Suri (1999) examine how the East Asian miracle turned into one of the worst financial crisis of the century by addressing the question using Malaysia as a case study. They argue that many discussions of the East Asian crisis address short-run causes and proximate of the crisis, such as the current account deficit, exchange rate misalignment, and disproportionate short-run external debt relative to foreign exchange reserves. Ghani and Suri stress that these indicators of vulnerability are themselves endogenous outcomes of deeper institutional features and point out that some long-term features of the development strategy that helped sustain high growth in the first place also contributed to the economy's increasing

vulnerability. Furthermore, high output growth was driven by rapid growth in capital stock, for example. The authors find that physical capital accumulation is a key driver of economic growth in where the banking system plays a critical role in accelerating and transforming large savings into capital accumulation. Ghani and Suri point out that if banking systems, which are financial institutions does not allocating capital efficiently it could have a negative impact on economic growth.

Lu et al. (2007) argue that by facilitating capital accumulation and by improving productivity, the development of the financial sector may contribute to economic growth. In their study it examines empirically the contribution that financial development could make to these two alternative drivers of economic growth in China applying annual data for the period 1952 to 2005. They examine the relationship between financial development and, respectively, capital accumulation and productivity by using cointegration and Granger-causality testing in a time-series vector autoregression (VAR) framework. Lu et al. substantive findings include that either Granger causality runs from capital accumulation to financial development or that there is bi-directional Granger causality between financial development and capital accumulation, depend on how financial development and capital accumulation are measured.

Rioja and Valev (2004), study the effects of financial development on the sources of growth in different groups of countries. It bases on the recent theoretical work and shows that financial development may affect capital accumulation and productivity in different ways in developing versus industrial countries. This hypothesis is tested by using the Generalized methods of moments (GMM) dynamic panel techniques with a panel data of 74 countries. It findings events for supporting the hypothesis: the effect of finance on economic growth occurs primarily through capital accumulation in less developed economies. In more developed economies finance has a strong positive influence primarily on economic growth.

Jun (2012) investigates the relationship between economic growth and financial markets in a paper for a panel of 27 Asian countries over 1960-2009. To test and estimate the long-run equilibrium relationship between financial development proxies and real GDP, the paper utilizes the recently-developed panel cointegration techniques. Based on various panel unit roots test and panel cointegration tests, financial development and real GDP variables are cointegrated. By using three distinct methods of panel cointegration estimation, Jun finds that there is a statistically significant positive bi-directional cointegrating relationship between economic growth and financial development. Therefore, suggests that financial market

development promotes economic growth and in turn growth stimulates further financial development.

King and Levine (1993) present cross-country evidence consistent with Schumpeter's view that the financial system can promote economic growth by using data on 80 countries over the 1960-1989 period. The findings show that various measures of the level of financial development are strongly associated with the rate of physical capital accumulation, real per capita GDP growth, and improvements in the efficiency with which economies employ physical capital. Furthermore, the predetermined component of financial development is robustly correlated with future rates of economic growth, economic efficiency improvements and physical capital accumulation.

To sum up several studies concludes that economic freedom has a positive effect on economic growth by applying different methodologies such as the GMM various panel unit roots test and panel cointegration tests and Granger-causality testing in a time-series vector autoregression (VAR). Nevertheless, heterogeneity has not been dealt with. This paper adopts the augmented mean group estimator to overcome the weakness and contribute to the research field explaining the effect economic freedom and institutions has on capital accumulation and what effect these factors has on economic growth.

3. Theoretical framework

In this section, the aim is to provide a theoretical framework to explain if economic freedom could promote economic growth via physical capital accumulation. The aim of this theoretical framework is to estimate production function by replacing the inputs with institutional indices. This section will begin with the Solow Growth Model that explains the link between economic growth and physical capital accumulation. It is then continued with the Marginal Efficiency of Capital (MEC) which will explain how economic freedom indexes can serve as proxies for physical capital accumulation since it is not observable. Finally, the institution theory is applied which will explain how GDP growth can serve as a proxy for growth promoting institutions.

4.1 Economic Growth Theory

In a seminal article *A Contribution to the Theory of Economic Growth*, the famous economist and Nobel Prize Laureate Robert M. Solow (1956) presented a coherent dynamic model with an explicit description of the process of capital accumulation by which investment and saving become new capital. In this model, also called the Solow model, output in each period is

determined by the available supplies of labour and capital implied by the competitive clearing of factor markets. In addition, Solow stresses that the labour force is assumed to grow at a given rate and that total investment and saving is assumed to be an exogenous fraction of total income.

Birch Sorensen and Whitta-Jacobsen (2010) point out that the Solow model incorporates the dynamic link between the flows of investment and savings and the stock of capital which is the essential additional feature of the model. They argue that the stock of capital will increase by an amount equal to gross investment minus depreciation on the initial stock between any two successive periods, which is accounted for in the Solow model. Furthermore, Birch Sorensen and Whitta-Jacobsen argue that the Solow model describes how the labour force evolves as a result of population growth, how total production and income evolves as a consequence of the evolutions of the total inputs of labour and capital and how capital evolves as a result of capital accumulation. Therefore, they point out that the model involves a certain evolution of income per worker as well and thereby contributes to answering the fundamental question of what determines the “wealth of nations”, thus meaning economic growth.

Solow (1956) states that in neoclassical economy some assumptions are necessary to make. The assumption of the market that is in equilibrium, i.e. perfect competition prevails where supply equals demand. The other assumption is that the production function is a Cobb-Douglas production function and provides constant returns to scale (CRS).

$$Y_t = F(K_t, L_t) = \bar{A}K_t^{1/3}L_t^{2/3} \quad (1)$$

The third assumption is that since $0 < \alpha < 1$, each input factor has decreasing returns to scale and the fourth assumption is that all firms produce one homogenous good. Furthermore, the economy is closed, hence, money that is not consumed is saved, and as capital cannot come from abroad, savings equals investment.

$$C_t + I_t = Y_t \quad , \quad Y_t - C_t = I_t \quad (2)$$

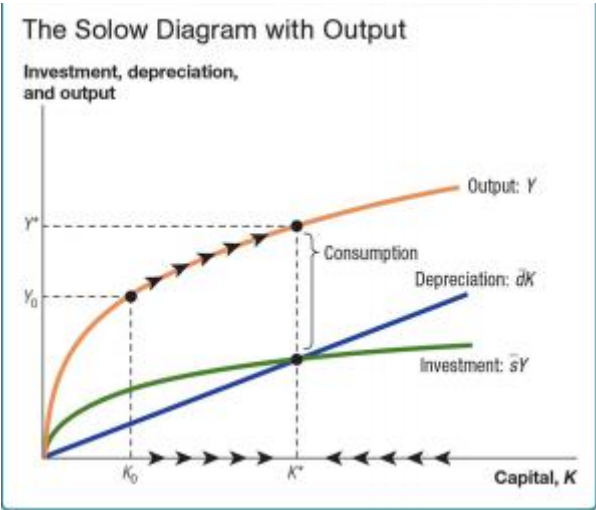
Finally, there is no power of disrupting the market since there does not exist any government. Therefore, the basis of the Solow model analysis is the motion function of capital:

$$K_t = \frac{dk}{dt} = sAk_t^\alpha - (\delta + n)k_t \quad (3)$$

Carlin and Soskice (2006) point out that in the motion of function (equation 3) the output increases since the capital stock increases with the productivity and the savings ratio, while the capital stock decreases with the growth in labor force and the rate of depreciation. They argue that in the Solow equilibrium both the output per worker and the capital per worker are constant, as the labor force and capital grow at the same rate, also known as steady state growth. This state could be written as following:

$$sAk_t^{\alpha} = (\delta + n)k_t^* \tag{4}$$

2 The Solow Diagram with Output



Source: Jones (2014)

Carlin and Soskice (2006) point out that the idea behind the steady state is that the economy itself will return to this level of output. They state that if the capital per worker is larger than k^* , the population growth and the depreciation of capital is larger than the capital per worker, making the motion function of capital negative. Carlin and Soskice stress this will ultimately lead to a decrease in the level of capital per worker and the economy will return to its steady state level of output in the long run. If the capital per worker is instead less than k^* this would lead to the opposite. They state that an increase in the savings ratio also could lead an economy to reach its steady state while yielding higher output per worker as the curve shifts upwards. Furthermore, when this steady state is reached the steady state growth rate is increased if the savings ratio is increased. Finally, Carlin and Soskice argue that this will decrease the total consumption and according to neoclassical theory, maximizing consumption is the objective, why there is a golden rule stating the steady state growth that maximizes consumption.

Jones (2008) argue that this equilibrium, in the long run, is a stationary state, characterized by stable and low growth, provided only by increases in factor productivity through technological progress. Thus, the only variable increasing the growth is the total factor productivity (TFP), holding the savings ratio and capital at the steady state level and assuming no influence of the population growth and the rate of depreciation from policy makers. This variable is also known as the “Solow residual” and is often considered as a measure of technology, but it really captures the influence of all factors other than those explicitly present in the production function, among these; technology.

Jones (2008) states that a rise in the investment rate will lead capital to accumulate over time and will lead to a rise in output as well due to this higher capital. He argues that the output increases from its initial steady-state level Y^* to the new steady state Y^{**} . Jones points out that output grows fastest immediately after the change in the investment rate, and then, over time, the growth rate of output falls and the economy will smoothly converge to its new steady state. Furthermore, the increase in the investment rate causes the economy to grow over time, at least until it will reach its new steady state. Therefore, in the long run, both steady-state production and steady-state capital are higher. Jones points out that because labor is constant; this also means the level of output per person is permanently higher as well.

4.2 Extending the model

To be able to answer the research question in this paper, we will replace physical capital accumulation with two proxies. Instead, the efficiency of the investment per worker will be examined where the economic freedom indexes will be served as proxies for physical capital accumulation. This will show the effect that physical capital accumulation has on economic growth by observing if the efficiency of the investment increases the only variable that is not held constant which is the total factor of productivity, also called the Solow residual which is mentioned later on in this paper.

Scientists have argued that economic freedom is crucial in analyzing economic growth across nations. Gwartney and Lawson (2002) argue that economic freedom refers to the degree to which a market economy exists. They point out that the components of economic freedom are an environment favoring a voluntary exchange, protection of persons and property, free competition and a limited degree of interventionism in the form of government ownership, taxes and regulations. Furthermore, Gwartney and Lawson argue that economic growth is correlated with economic freedom indicators. Overall, studies by Goldsmith (1997), Ali and

Crain (2002) and Vega-Gordillo and Alvarez-Arce (2003) have found that the level of economic freedom exerts a positive and significant effect on economic growth.

In accordance with previous authors, North (1993) argues that institutional factors are crucial to explain the “Solow residual” in analyzing economic growth across nations. He points out that the key driver of economic growth is an institutional environment favorable to productive economic activity, and that the rule of law and trade freedom have great effects on economic growth.

To be able to explain the impact physical capital accumulation have on economic growth the economic freedom indexes will serve as proxies for physical capital accumulation since it is not observable to be able to measure the institutional aspects.

In 1936 John Maynard Keynes introduced the rate of return approach, Marginal Efficiency of Capital (MEC), to economic calculation. In this approach investors use the marginal efficiency of capital to rank investment projects. Keynes argue that a man purchases the right to the series of prospective returns, when he buys an investment or capital-asset, that he expects to obtain from selling its output, after deducting the running expenses of obtaining that output, during the life of the asset. He points out the convenience of calling this series of annuities Q_1, Q_2, \dots, Q_n the prospective yield of the investment.

Keynes (1936) argue that over against the prospective yield of the investment we do not have the market-price at which an asset of the type in question can actually be purchased in the market, but the supply price of the capital-asset. He points out that this is sometimes called its replacement cost since the supply price would just induce a manufacturer newly to produce an additional unit of such asset. Keynes stresses that the relation between the prospective yield of one more unit of that type of capital and cost of producing that unit, furnishes us with the marginal efficiency of capital of that type. Finally, he defines the marginal efficiency of capital as being equal to that rate of discount which would make the present value of the series of annuities given by the returns expected from the capital-asset during its life just equal to its supply price. Thus, the marginal efficiency of capital is the sum of all present values of future expected returns, which are functions of institutional factors. Therefore, if R_i , increases, the marginal efficiency of capital (MEC) also increases.

$$PV = \sum_{i=1}^n \frac{R_i}{(1+r)^i} \quad (5)$$

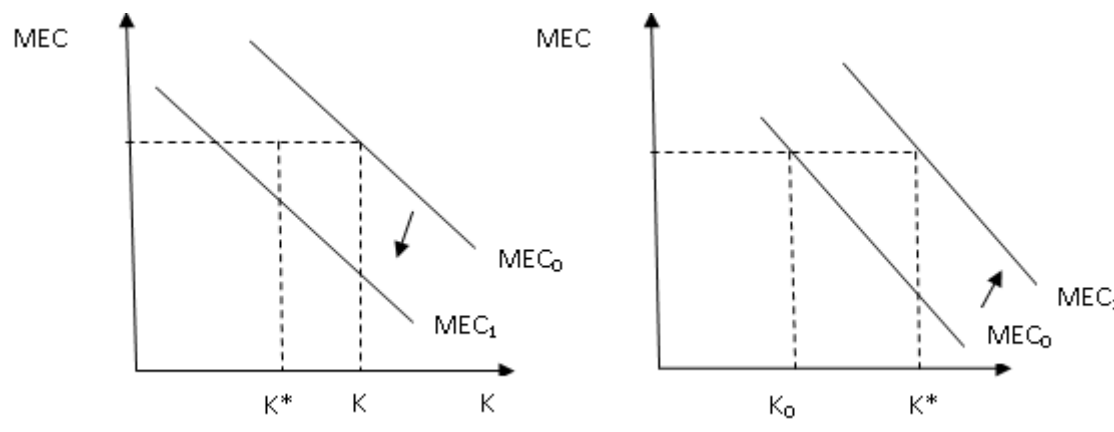
$$C_k = \sum_{i=1}^n \frac{R_i}{(1+MEC)^i} \quad (6)$$

Keynes (1936) points out that the marginal efficiency of capital is defined in terms of the expectation of yield and of the current supply price of the capital-asset. Thus, it does not depend on the historical result of what an investment has yielded on its original cost if we look back on its record after its life is over, but rather on the rate of return expected to be obtainable on money if it were invested in an asset that was newly produced.

If there is an increased investment in any given type of capital during any period of time, Keynes (1936) argues that as the investment in it is increased, the marginal efficiency of that type of capital will diminish. He points out this is partly because as a rule pressure on the facilities for producing that type of capital will cause its supply price to increase, and partly because the prospective yield will fall as the supply of that type of capital is increased. Furthermore, Keynes argues that the first of these factors is usually the most important one when producing equilibrium in the short run, but the longer period in view the more does the second factor take its place. Thus, he stresses that for each type of capital we can build up a schedule that shows by how much investment in it will have to increase within the period, in order that its marginal efficiency should fall to any given figure. Furthermore, Keynes argues that to provide a schedule relating the rate of aggregate investment to the corresponding marginal efficiency of capital in general which the rate of investment will establish, we can aggregate the schedules for all the different types of capital. This schedule is called the investment demand-schedule or in other words, the schedule of the marginal efficiency of capital.

Finally, Keynes (1936) stresses that the actual rate of current investment will be pushed to the point where there is no longer any class of capital-asset of which the marginal efficiency exceeds the current rate of interest. Thus, the rate of investment will be pushed to the point on the investment demand-schedule where the marginal efficiency of capital in general is equal to the market rate or interest. When marginal efficiency of capital (MEC) increases, k also increases.

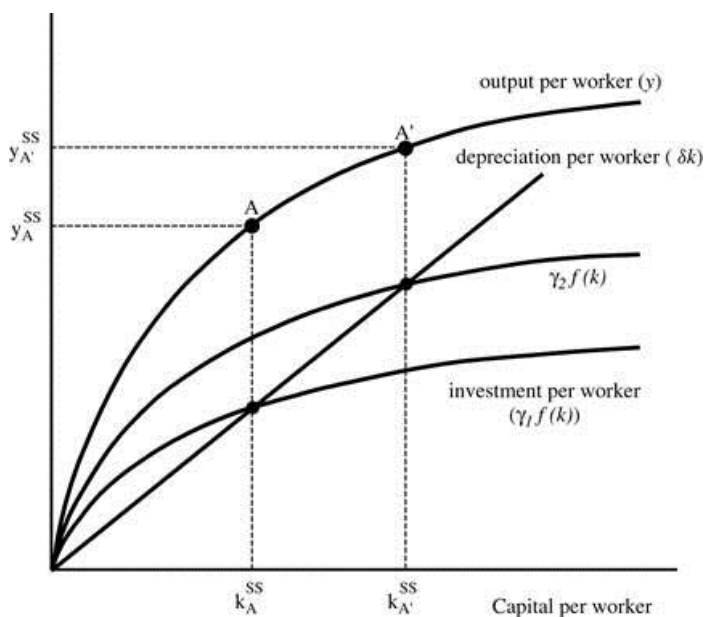
3 Marginal Efficiency of Capital



Source: Uonbi (collected 2020)

When economic institutions, such as economic freedom and financial freedom, would shift out the MEC curve from K_0 to K^* , it leads to higher volume of investment given the same long-run rate of interest. This shift can be identified in the Solow model:

4 Solow Model of Economic Growth



Source: Rampages (collected 2020)

Due to an up-shifting of $\gamma_2 f(k)$, where $f(k)=I=sY$, the graph shifts from k_A to $k_{A'}$. The parameter γ_2 is reflecting institution effects and the change from γ_1 to γ_2 is largely because again the institution setting of the freedoms which make investments more efficient resulting in a larger stock of capital. Thus the steady state changed. It is also because the impacts of freedoms are mainly via the channel of capital accumulations. Thus, in the

empirical exercise, we will replace capital with the economic freedom indexes and the r with GDP/capital growth.

In this paper the Solow model will be extended with the investment decisions as a function of economic freedom. So enhancing economic freedom would shift the Marginal Efficiency of Capital (MEC) curve above. Therefore, given the same interest rate, the cost of investment, more projects, actual investment, will be made. Thus contribute more capital accumulation and higher stock in steady state and economic growth.

In the beginning of this section we mentioned that the marginal efficiency of capital is used to rank investment projects. Fuller (2013) points out that by comparing the marginal efficiency of capital to the interest rate, investment decisions are made in the Keynesian rate of return framework. He states that if the marginal efficiency of capital is greater than the interest rate, an investment project should be accepted. In other words, the MEC rule is to accept an investment project if the rate of return is greater than the cost of capital, and to reject an investment project if the rate of return is less than the cost of capital.

In accordance with Keynes, Fuller (2013) points out the importance of expectations in Keynes's theory. Furthermore, he stresses Keynes's argument that the cause of an economic crisis is due to a collapse of the marginal efficiency of capital. Fuller points out that the marginal efficiency of capital collapsed when there is a collapse in cash flow expectations because the marginal efficiency of capital is completely determined by the investor's expectations about the size and timing of future cash flows.

In 1993 Douglas North was awarded the Nobel Prize in economics and is considered a pioneer since he has promoted and identified a new direction of research in new institutional economics which has focus on the role of the institutional framework in the process of formation and becoming of modern economies (Iolanda Voda & Andreea-Oana Iacobuță, 2009).

Douglas North (1991) states that there are two different kinds of institutions; informal and formal, and he argues that institutions are constraints created by humans and that the purpose is to structure political, social and economic interaction. Furthermore, he points out that informal institutions consists of norms in the society as for example codes of conduct, sanctions and traditions while formal institutions consists of rules such as property rights, constitutions and laws and stresses that the purpose with creating institutions is to create order

and reduce uncertainty in exchange. North argue that institutions define the choice of set together with the standard constraints of economics and therefore determine production and transaction costs and hence the feasibility of engaging in economic activity due to the profitability. He points out that history in consequence is largely a story of institutional evolution in which the historical performance of economies can only be understood as a part of sequential story since institutions connects the past with the present and the future and therefore evolves incrementally. North concludes that in an economy, institutions provide the incentive structure and points out that as this incentive structure evolves by time it change the directions of the change in the economy towards stagnation, growth or decline.

North (1994) argues that institutions help explain market failures and provide explanations for the government's role in the economy since institutions are essential for economic development. In a study Aron (2000) states that to be able to measure institutions you need to measure social capital, quality of institutions, political and social features and political instability. Several studies in this field have verified that social capital and the quality of institutions have a positive effect on economic development, while political instability and social features have a negative effect, while for the political features of institutions is not defined the significant interdependence in relation to economic growth.

In this paper the institutional theory will be applied to explain growth promoting institutions proxied by GDP growth. Therefore, the model of this paper will be the following:

$$\ln GDP/Capital_{it} = a_{it} + b_1 * \Delta(\ln GDP/capital)_{it} + b_2 * (indices)_{it} + \mathcal{E}_{it} \quad (7)$$

where

$GDP/Capital_{it}$ is the GDP per capital growth which will measure economic growth, $\Delta(\ln GDP/capital)_{it}$ is the GDP per capital growth rate which will serve as a proxy for institutions promoting growth, $indices_{it}$ is the economic freedom indexes and will serve as a proxy for physical capital accumulation,

\mathcal{E}_{it} is an error term that captures the influence of all factors other than those explicitly present in the production function and are known as the Solow Residual and is often considered as a measure of technology and will represent total factor productivity (TFP) in this paper.

4. Methodology

In this study the panel time-series data will be estimated with heterogeneous slopes. To be able to answer the research question we will apply the augmented mean group estimator

which is an estimator that allow for unobserved correlation across panel members, also called cross-section dependence, and are designed to deal with heterogeneity. To be able to measure if economic freedom can promote capital accumulation that could promote economic growth we will include Armenia, Bangladesh, Cambodia, China, Cote d'Ivoire, Ethiopia, Ghana, Guinea, India, Indonesia, Ireland, Kenya, Libya, Mexico, Nepal, Philippines, Romania, Tanzania, Thailand and Vietnam. These countries are all developing economies and are not members of OECD (Organization of Economic Cooperation and Development) and are also known for have had a rapid growth since 1995 until 2017.

The first explanatory variable GDP growth will serve as a proxy for growth promoting institutions. This will show which effect institutions has on economic growth. If the explanatory variable is positive it has a positive effect on growth and if the explanatory variable is negative it will show a negative effect on growth.

To be able to measure the effect physical capital accumulations has on economic growth we will include the variables property rights, government integrity, tax burden, government spending, business freedom, monetary freedom, investment freedom and financial freedom. These variables are all included in the heritage index of economic freedom and will serve as proxies of institutional setting for physical capital accumulation. There are some variables that are excluded in this study that also are included in the heritage index of economic freedom which will be explained later on in this paper.

In appendix 1 you can find the results from the fixed effects model which has been executed to demonstrate that the AMG estimator is a better fit for examining the research question of this paper.

5. Data

The data being used in this study consists of a panel time-series data of 480 observations in twenty different developing countries. The data is collected from World Bank (www.worldbank.org) that is an independent supranational institution consisting of 189 member countries where the aim is to fight poverty worldwide through sustainable solutions and where one of the founders was John Maynard Keynes, a prosperous economist during the 19th century. The data is also collected from Heritage which provides index of economic freedom which covers twelve freedoms from property rights to financial freedom in 186 countries and has done so for twenty-six years. Therefore, it is a reliable source to collect the data from.

6.1 Explanations of the variables

GDP_Capita = GDP per capita (current US\$)

GDP = GDP per capita growth (annual %)

P_rights = Property rights (economic freedom indexes)

G_integrity = Government integrity (economic freedom indexes)

T_burden = Tax burden (economic freedom indexes)

G_spending = Government spending (economic freedom indexes)

B_freedom = Business freedom (economic freedom indexes)

M_freedom = Monetary freedom (economic freedom indexes)

I_freedom = Investment freedom (economic freedom indexes)

F_freedom = Financial freedom (economic freedom indexes)

6.2 Specifications of the variables

6.2.1 GDP per capital (Current US\$)

The dependent variable in the regression model is GDP per Capital and the data is collected from the World Bank (WB) database (2020). The GDP per capita is measured in current US\$ and the observations are between the periods 1994 until 2017.

6.2.2 GDP per capital growth (annual %)

The variable GDP per capita growth is going to be applied as a proxy to be able to measure the effect institutions have on economic growth. The data for this variable is collected from the World Bank database (2020) and are measured in annual percentage growth rate of GDP per capita based on local currency.

6.2.3 Economic freedom indexes

The heritage index (heritage) measure economic freedom and are based on 12 qualitative and 12 quantitative factors which are grouped in four pillars of economic freedom. These four pillars are (i) Rule of law which is measured by property rights, government integrity and judicial effectiveness (ii) Government size which are measured by government spending, tax burden and fiscal health, (iii) Regulatory efficiency measured by business freedom, labor freedom and monetary freedom and (iv) Open markets measured by trade freedom, investment freedom and financial freedom.

The variables property rights, government integrity, government spending, tax burden, business freedom, monetary freedom, trade freedom, investment freedom and financial freedom will be applied in this paper due to the lack of data between the chosen time period

1996 until 2017 in this study. Therefore, judicial effectiveness, fiscal health and labor freedom will not be included in this paper. The data is collected at the Heritage Index database and the variables will serve as proxies for physical capital accumulation to be able to measure the effect of economic freedom via physical capital accumulation on economic growth.

6.3 Expected outcome

In this section the expected outcome of the result will be presented in table 1. The expected outcome are based on and explained in the theoretical framework in this paper.

Table 1: Overview of the regression variables and expected outcome

Variable	Description	Source	Expected outcome
$\ln GDP/Capital_{it}$	GDP per Capital growth	World Bank	Dependent variable
$\Delta(\ln GDP/capital)_{it}$	GDP per Capital growth rate	World Bank	+
$indicies_{it}$	economic freedom indexes	Heritage	+

6.4. Summary Statistics

Table 1 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Observation	479	240.6263	138.8257	1	480
Country	0				
Year	480	2005.5	6.929408	1994	2017
GDP	474	3.738907	7.811701	-62.22509	122.9683
p_rights	455	38.16088	18.61394	6.8	90
g_integrity	455	30.06462	13.92134	4	85
t_burden	454	74.61189	11.55776	32.3	95
g_spending	454	80.40661	14.922	0	95.9
b_freedom	454	57.16211	13.16891	20	93.7
m_freedom	454	71.59441	11.5328	0	91.1
t_freedom	453	63.46402	17.28736	0	90
i_freedom	454	46.51982	18.96327	5	95
f_freedom	453	46.13687	17.04624	10	90
GDP_Capita	480	4247.027	10008.26	111.9272	69649.88
log_GDP	480	7.227638	1.344734	4.717849	11.15124
CountryNr	480	10.5	5.772297	1	20

6. Econometric Modelling

In 2010 Eberhardt and Teal introduced the augmented mean group estimator as an alternative to the Pesaran (2006) CCEMG estimator with macro production function estimation in mind. In cross-country production functions the unobservable common factor f_t represent TFP (total factor productivity), which is of particular interest for the empirical analysis, compared to CCEMG estimator where unobservables are treated as nuisance.

7.1 Heterogeneous panel estimators

Eberhardt (2012) assumes the following simple economic model: for $i=1, \dots, N$ and $t=1, \dots, T$ where:

$$y_{it} = \beta_i x_{it} + u_{it} \quad (8)$$

$$\text{where } u_{it} = \alpha_{1i} + \lambda_i f_t + \varepsilon_{it} \quad (9)$$

$$x_{it} = \alpha_{2i} + \lambda_i f_t + \gamma_i g_t + e_{it} \quad (10)$$

where x_{it} and y_{it} are observables, β_i is the country-specific slope on the observable regressor, and u_{it} contains the unobservables and the error terms ε_{it} . In the second equation the unobservables are made up of group fixed effects α_{1i} , that captures time-invariant

heterogeneity across groups, as well as an unobserved common factor f_t with heterogeneous factor loadings λ_i , that captures time-variant heterogeneity and cross-section dependence. The factors g_t and f_t can be nonstationary and nonlinear with obvious implications for cointegration and are not limited to linear evolution over time. Eberhardt points out that g_t is included to highlight that the observables x will also be driven by factors other than f_t . Because the regressors are driven by some of the same common factors as the observables additional problems arise where the presence of f_t in the second and the third equation induces endogeneity in the first equation. ε_{it} and e_{it} are assumed white noise in this economic model. Eberhardt stress that for simplicity this model includes only one covariate and one unobserved common factor in the first equation. Thus, the principle extends to multiple factors and covariates.

Furthermore, Eberhardt (2012) states that all mean group (MG) type estimators follow the same principle regarding methodology which are (i) to estimate N group-specific ordinary least-squares regressions and (ii) the estimators average the estimated coefficients across groups. The first step of methodology is made up of standard ordinary least square regressions where for the augmented mean group (AMG) and the common correlated effects mean group (CCEMG) estimators where each empirical equation is simply augmented with additional covariates. In the second step the (unweighted or weighted) average of country-specific estimates for β_i provides a first estimates benchmark of comparison for these heterogeneous parameter model results where this average will be viewed as the parameter of interest. Therefore, the average relationship across panel members will be indicated by the *xtmg* command results. A further dimension of inquiry, the analysis of the patterns and the ultimate source of this parameter heterogeneity will be opened up by allowing the slope coefficients to differ across panel members.

7.2 Mean Group Estimator established by Pesaran and Smith (1995)

Eberhardt (2012) points out that the Pesaran and Smith (1995) MG estimator assumes away $\lambda_i f_t$ and does not concern itself with cross-section dependence, or models these unobservables with a linear trend. Therefore, the first equation mentioned earlier is estimated for each member i including a linear trend to capture time-variant unobservables, which is optionally, and an intercept to capture fixed effects. Weights can be applied when the estimated coefficients $\hat{\beta}_i$ are subsequently averaged across panel members, but in the standard implementation this is just the unweighted average.

7.3 Common Correlated Effects Mean Group (CCEMG) estimator established by Pesaran (2006)

Eberhardt (2012) states that the Pesaran (2006) CCEMG estimator allows the empirical setup to be laid up as in the first, the second and the third equation mentioned earlier in this paper. The empirical setup induces time-variant unobservables with heterogeneous impact across panel members, cross-section dependence and problems of identification where β_i is unidentified if the regressor contains f_t . With a simple but powerful augmentation of the group-specific regression equation the CCEMG solves this problem since this equation now includes the cross-section averages of the dependent and independent variables, \bar{y}_t and \bar{x}_t as additional regressors to x_{it} and an intercept. The combination of \bar{y}_t and \bar{x}_t can account for f_t , the unobserved common factor. The heterogeneous impact λ_i is also given by construction because the relationship is estimated for each panel member separately. Thus, cross-section averages \bar{y}_t and \bar{x}_t is first computed for all observable variables in the model and then added as explanatory variables in each of the N regression equations. Therefore, different weights may be applied since the estimated coefficients $\hat{\beta}_i$ are averaged across panel members, subsequently.

Eberhardt (2012) states that obtaining consistent estimates of the parameters related to the observable variables are the focus of the estimator. He argues that, in an empirical application, the estimated coefficients on the cross-section-averaged variables as well as their average estimates are not interpretable in meaningful way since they are merely applied to blend out the biasing impact of the unobservable common factor. Chudik, Pesaran, and Tosetti (2011; Pesaran and Tosetti 2011) states that the CCEMG estimator is robust to an infinite number of “weak” factors and to the presence of a limited number of “strong” factors. The former can be associated with local spillover effects, whereas the latter can represent global shocks, such as the global financial crisis. Therefore, Kapetanios, Pesaran and Yamagata (2011) states that the estimator is robust to nonstationary common factors.

7.4 Augmented Mean Group (AMG) estimator established by Eberhardt and Teal (2010)

As an alternative to the Pesaran (2006) CCEMG estimator Eberhardt and Teal (2010) developed the AMG estimator with macro production function estimation in mind. The unobservable common factor f_t , is treated as a nuisance in the CCEMG estimator meaning that something to be accounted for that is not really of any interest for the empirical analysis. However, in cross-country production functions, unobservables represents total factor

productivity (TFP). Eberhardt (2012) stress that standard panel approaches to cross-country empirics are commonly based on a Cobb-Douglas form.

The data applied in this paper will be implemented through three different steps which will be explained in the following section.

The first step is to test for cross-sectional dependence by applying the Pesaran (2006) test before unit-root test:

*xtcdf log_GDP GDP t_freedom i_freedom f_freedom m_freedom b_freedom g_spending
t_burden g_integrity p_rights*

In this step the coefficients on the year dummies are collected through a pooled regression model augmented with year dummies estimated by first difference OLS. The coefficient year dummies represent an estimated cross-group average of the evolution of unobservable TFP over time. This process is known as the “common dynamic process” and the main purpose with this step is to check for cross section dependence (CSD). We use the second generation panel unit-root test if we reject the cross section dependence in this step. Otherwise, we apply first generation panel-unit root test.

In the second step we carry out the main regression by augmenting the group-specific regression model with the estimated TFP process by either (i) imposed on each group member with a unit coefficient by subtracting the estimated process from the dependent variable, or (ii) as an explicit variable. Each regression model includes an intercept that captures time-invariant fixed effects also called TFP levels. If heterogeneity of slopes is a concern and cross section dependence is not a problem, the mean group (MG) estimator should be applied. If there are nonstationary variables involved we need to carry out the Pesaran panel unit-root test of residuals with first panel-unit root test to check for cross section dependence. If both heterogeneity of slopes and cross section dependence are concerns, we need to apply the AMG estimator.

In the third step the group-specific model parameters are averaged across the panel where weights may be applied as in the MG and CCEMG estimators.

In addition to the AMG estimator, the fixed effect model will be applied as well to demonstrate why the AMG estimator is a better fit for this paper rather than the fixed effect model. The result of the fixed effect model can be found in Appendix 1:

*xtreg log_GDP GDP t_freedom i_freedom f_freedom m_freedom b_freedom g_spending
t_burden g_integrity p_rights*

7. Result

	p_rights	g_inte~y	t_burden	g_spen~g	b_free~m	m_free~m	t_free~m	i_free~m	f_free~m
p_rights	1.0000								
g_integrity	0.6907 0.0000	1.0000							
t_burden	0.0598 0.2036	-0.0379 0.4209	1.0000						
g_spending	-0.1541 0.0010	-0.3746 0.0000	0.1182 0.0117	1.0000					
b_freedom	0.6059 0.0000	0.5805 0.0000	0.1320 0.0049	-0.1431 0.0022	1.0000				
m_freedom	0.1776 0.0001	0.1329 0.0046	0.1782 0.0001	0.1826 0.0001	0.1897 0.0000	1.0000			
t_freedom	0.2260 0.0000	0.3615 0.0000	0.3404 0.0000	-0.2592 0.0000	0.3845 0.0000	0.0623 0.1861	1.0000		
i_freedom	0.6087 0.0000	0.4977 0.0000	0.1343 0.0042	-0.1107 0.0184	0.5276 0.0000	0.1597 0.0006	0.3334 0.0000	1.0000	
f_freedom	0.5630 0.0000	0.4862 0.0000	0.1851 0.0001	-0.0728 0.1229	0.5349 0.0000	0.2509 0.0000	0.4035 0.0000	0.6837 0.0000	1.0000

In the correlation matrix we can observe that investment freedom and financial freedom seems to be highly correlated with each other. Therefore, the result will be presented with and without the investment freedom variable to see if the estimates are affected.

Step 1: Pesaran test before unit root test (cross-sectional dependence)

Variable	CD-test	p-value	average joint T	mean ρ	mean abs(ρ)
log_GDP	57.105	0.000	24.00	0.85	0.85
GDP	9.344	0.000	23.40	0.14	0.22
t_freedom	32.289	0.000	22.33	0.50	0.50
i_freedom	.77	0.441	22.43	0.01	0.39
f_freedom	-.785	0.432	22.23	-0.01	0.34
m_freedom	10.708	0.000	22.43	0.16	0.36
b_freedom	-2.177	0.030	22.43	-0.03	0.51
g_spending	8.07	0.000	22.43	0.12	0.32
t_burden	18.085	0.000	22.43	0.27	0.51
g_integrity	4.048	0.000	22.53	0.06	0.39
p_rights	14.503	0.000	22.53	0.22	0.43

P-values close to zero indicate data are correlated across panel groups. The estimates in this result show that data are correlated across panel groups meaning that there is cross-section dependence (CSD) in the data. The results show that international freedom and financial freedom have a higher p-value than all other variables, but still a p-value close to zero.

Step 2: AMG Estimator

All coefficients represent averages across groups (group variable: CountryNr)
Coefficient averages computed as outlier-robust means (using rreg)

```

Mean Group type estimation      Number of obs      =      446
Group variable: CountryNr      Number of groups   =       20

Obs per group:
                                min =      13
                                avg =     22.3
                                max =      23

Wald chi2(8)                   =     33.96
Prob > chi2                     =     0.0000

```

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
GDP	.010735	.0030336	3.54	0.000	.0047893	.0166807
t_freedom	.0012852	.0019075	0.67	0.500	-.0024535	.0050239
b_freedom	.0005123	.0035607	0.14	0.886	-.0064665	.007491
i_freedom	-.0000966	.0025664	-0.04	0.970	-.0051267	.0049335
g_integrity	.0038597	.0016204	2.38	0.017	.0006838	.0070355
f_freedom	.0050799	.0015126	3.36	0.001	.0021153	.0080446
p_rights	.0031619	.0017626	1.79	0.073	-.0002928	.0066165
g_spending	-.0024904	.0028061	-0.89	0.375	-.0079903	.0030095
_cons	6.008411	.4703524	12.77	0.000	5.086537	6.930285

Root Mean Squared Error (sigma): 0.0880

The results of this step indicate that all of the variables have a positive effect on economic growth except for investment freedom and government spending. The estimates show that financial freedom and GDP growth rate is significant at a 1% level and government integrity at a 5% level and that the estimates with a negative effect are not significant at any level. Therefore, we rerun the AMG estimator but remove investment freedom to see if it has a positive effect on the results since investment freedom and financial freedom may be correlated.

AMG when dropping i_freedom

```

Mean Group type estimation
Group variable: CountryNr

Number of obs      =      446
Number of groups   =       20

Obs per group:
    min =          13
    avg =         22.3
    max =          23

Wald chi2(7)      =       29.22
Prob > chi2       =       0.0001
    
```

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
GDP	.0096669	.0030556	3.16	0.002	.003678	.0156558
t_freedom	-.0000658	.0022136	-0.03	0.976	-.0044044	.0042728
b_freedom	.0008115	.0031398	0.26	0.796	-.0053424	.0069654
g_integrity	.0037575	.0011535	3.26	0.001	.0014968	.0060183
f_freedom	.00451	.0015849	2.85	0.004	.0014036	.0076163
p_rights	.0011849	.0021069	0.56	0.574	-.0029445	.0053143
g_spending	.0009322	.0027327	0.34	0.733	-.0044238	.0062882
_cons	7.485063	.5224943	14.33	0.000	6.460993	8.509133

Root Mean Squared Error (sigma): 0.1018

The result shows that when removing investment freedom out of the equation the government spending becomes positive and significant at a 10% level and trade freedom becomes negative and insignificant at any level. The Root Mean Squared Error went from 0.0880 to 0.1018.

Step 3: Pesaran test of residuals before unit root test (cross-sectional dependence)

Variable	CD-test	p-value	average joint T	mean ρ	mean abs(ρ)
GDP_resid	-2.032	0.042	21.64	-0.03	0.19

The result shows that there are cross-section dependence between the residuals meaning that since the p-value is close to zero the data are correlated across panel groups. In the next section we rerun the test without including investment freedom.

Without i_freedom

Ho: All panels contain unit roots
Ha: Some panels are stationary

Number of panels = 20
Avg. number of periods = 22.30

AR parameter: Panel-specific
Panel means: Included
Time trend: Not included

Asymptotics: T,N -> Infinity
sequentially

ADF regressions: No lags included

	Statistic	p-value	Fixed-N exact critical values		
			1%	5%	10%
t-bar	-3.7598		(Not available)		
t-tilde-bar	-2.8457				
Z-t-tilde-bar	-8.3204	0.0000			

The result without investment freedom after applying first generation panel-data unit-root test because there were indications of the existence of cross-section dependence between panel members shows that the p-value is close to zero and pay no attention to the cross-section dependence. The estimates indicate that all panels contain unit roots as in the previous section where investment freedom was included.

Without i_freedom

(A) Maddala and Wu (1999) Panel Unit Root test (MW)

	Specification without trend		
Variable	lags	chi_sq	p-value
resid_GDP	0	316.748	0.000
resid_GDP	1	134.710	0.000

	Specification with trend		
Variable	lags	chi_sq	p-value
resid_GDP	0	261.610	0.000
resid_GDP	1	124.868	0.000

(B) Pesaran (2007) Panel Unit Root test (CIPS)

	Specification without trend			
Variable	lags	Zt-bar	p-value	t-bar
resid_GDP	0	-7.362	0.000	.
resid_GDP	1	-4.290	0.000	.

	Specification with trend			
Variable	lags	Zt-bar	p-value	t-bar
resid_GDP	0	-6.243	0.000	.
resid_GDP	1	-3.778	0.000	.

The result without investment freedom after applying second generation panel-data unit-root test because there were indications of the existence of cross-section dependence between panel members shows that the p-value is close to zero and pay no attention to the cross-section dependence. The estimates indicate that all panels contain unit roots as in the previous section where investment freedom was included.

8. Analysis

The aim of this paper is to examine if economic freedom can promote economic growth via physical capital accumulation where GDP per capital growth rate has served as a proxy for the institutional aspects and economic freedom indexes as proxies for physical capital accumulation. We begin this analysis by discussing the results of the explanatory variable in the model, GDP per capital growth rate on economic growth.

The results of the AMG estimator with investment freedom included show that the estimate of GDP per capital growth rate are significant at any level and have a positive effect on economic growth. When investment freedom is excluded the GDP per capital growth rate are still significant at any level and have a positive effect on economic growth. Current high growth indicates a good institution for promoting economic growth. In this paper the GDP per capital growth rate served as a proxy for the institutional aspects promoting economic growth. This result can be explained by North (1993) who points out the importance of institutional factors when analyzing economic growth across nations. He states that an institutional environment favorable to productive economic activity is the key driver of economic growth and also that trade freedom and the rule of law have a positive effect on economic growth.

Furthermore, the results can be explained by North (1991) who states that the incentive structure in an economy are provided by institutions and points out that as this incentive structure evolves by time it change the directions of the change in the economy towards stagnation, growth or decline. Thus, institutions define the choice of set together with the standard constraints of economics and therefore determine production and transaction cost costs and hence the feasibility of engaging in economic activity due to profitability. Therefore, the result indicates that the incentive structure in the economies observed should be great.

In a study, Aron (2000) states that several studies in this field have concluded that the quality of institutions and social capital have positive effects on economic development. This paper confirms that institutions proxied by GDP per capital growth rate have a positive effect on economic growth and are significant at any level.

In appendix 1 the result of the fixed effect model are attached and when applying this model the GDP per capital growth rate is not significant at any level. This result indicates that by applying the AMG estimator that is designed to deal with heterogeneity instead of the fixed effect model the results are more robust. This is in accordance with Eberhardt (2012) who

states the importance of applying an estimator that is designed for dealing with macro panel data analysis instead.

The results of testing cross-section dependence of the residuals indicates that the AMG estimator is a better fit than the fixed effects model since it takes care of the cross-section dependence. In the first step there is a cross-section dependence but the residual in the AMG estimator cannot reject the null hypothesis of cross sectional independence. This is in accordance with Eberhardt (2012) who argues that the research field is dominated by estimators that are designed for dealing with micro panel data analysis and are used for macro panel data analysis. Therefore, the result in this study is of high importance and a contribution to the research field.

If we discuss the result for the economic freedom indexes which can be viewed as proxies for physical capital accumulation the estimates show a positive result where financial freedom is significant at any level. The government spending and investment freedom show a negative impact but is not significant at any level. When the investment freedom variable is dropped the government spending change to a positive sign. If we compare these results with the results of the fixed effects model in appendix 1, we can observe that the signs of property rights and government spending are negative but only property rights are significant of these two and also trade freedom. Since the fixed effects model does not deal with heterogeneity and where the results indicates cross-section dependence across panel group members this shows that the AMG estimator is a better fit to this study.

The results indicate that physical capital accumulation promotes economic growth. This could be explained by Keynes (1936) who states that by enhancing economic freedom the marginal efficiency of capital curve will shift. Therefore, given the same interest rate, more projects, actual investments and the cost of investment will be made. This is in accordance with Ghani and Suri (1999) who points out capital accumulation as a key driver to economic growth. They argue that allocating capital efficiently have a positive effect on economic growth where the banking system is responsible for accelerating and transforming large savings into capital accumulation.

Gwartney and Lawson (2002) states that economic growth is correlated with economic freedom indicators. This is also shown in the result of this paper since there is a positive and significant correlation between the dependent and independent variables. Overall, studies by Goldsmith (1997), Ali and Crain (2002) and Vega-Gordillo and Alvarez-Arce (2003) also

have found that the level of economic freedom exerts a positive and significant effect on economic growth which is shown in the results.

Birch Sorensen and Whitta-Jacobsen (2010) point out that the Solow growth model contributes to answering the fundamental question of what determines economic growth, also called the “wealth of nations”. They stress the importance of how capital evolves as a result of capital accumulation. In this paper the results indicate that physical capital accumulation has a strong positive effect on economic growth which is in accordance with Birch Sorensen and Whitta-Jacobsen.

The results differ from Lu et al. (2007) who conclude that the link between productivity and financial development is found to be statistically weak. In the study Lu et al. examine the relationship between financial development and, respectively, capital accumulation and productivity by using cointegration and Granger-causality testing in a time-series vector autoregression (VAR) framework. By comparing the result in this paper with the result of Lu et al. we can observe that the estimates in this paper are highly significant. This could be explained by the AMG estimator that is designed for dealing with macro panel data sets and that provides a robust result in comparison to the applied method in the study of Lu et al.

Overall, the results show that the two inputs in the production function such as physical capital accumulation and institutional aspects have a positive effect on economic growth. We can also conclude that the AMG estimator is the best fit of this exercise since it is designed for dealing with macro panel data analysis and takes care of cross-section dependence in the estimates. Before, the AMG estimator was applied there was cross section dependence which was not the case when the AMG residual was checked for cross section dependence. Therefore, the AMG estimator is a better fit as an estimator for dealing with macro panel data analysis rather than using an estimator which is designed for dealing with micro panel data analysis that is dominated in this research field.

9. Conclusion

The aim of this paper is to examine if economic freedom via physical capital accumulation can promote economic growth where GDP growth and economic freedom indexes served as proxies for institutional factors and physical capital accumulation. The results indicate that economic freedom promotes economic growth via physical capital accumulation where GDP per capital growth rate served as a proxy for institutional aspects and economic freedom indexes as proxies for physical capital accumulation. The results also show that the AMG estimator is the best fit for macro panel data analysis since it are designed for dealing with heterogeneity.

Eberhardt (2012) argues that the analysis of macro panel data is still dominated by estimators developed for micro datasets. By applying the AMG estimator this study has contributed to the research field within economic growth and demonstrated the importance of applying an estimator that is designed for dealing with macro panel data analysis. It has also contributed by explaining how the AMG estimator deals with heterogeneity and have shown how researchers in the future can apply the method.

There are some aspects left in this paper that has not been treated. Therefore, suggestions for future research are to include OECD countries and make a comparison between the results or/and include more countries and other countries than those examined in this thesis.

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Appendix 1 Fixed Effects

```

Random-effects GLS regression           Number of obs   =       446
Group variable: CountryNr              Number of groups =       20

R-sq:                                   Obs per group:
    within = 0.4454                       min =           13
    between = 0.3666                       avg  =          22.3
    overall = 0.4023                       max  =           23

corr(u_i, X) = 0 (assumed)                Wald chi2(7)    =       60.80
                                                Prob > chi2     =       0.0000

```

(Std. Err. adjusted for 20 clusters in CountryNr)

log_GDP	Coef.	Robust Std. Err.	z	P> z	[95% Conf. Interval]	
GDP	.0069899	.0043564	1.60	0.109	-.0015485	.0155283
t_freedom	.0233929	.0044476	5.26	0.000	.0146757	.03211
b_freedom	.0160375	.0070183	2.29	0.022	.0022819	.0297931
g_integrity	.0117826	.0053622	2.20	0.028	.0012729	.0222922
f_freedom	.0054738	.004881	1.12	0.262	-.0040929	.0150404
p_rights	-.0142468	.0045319	-3.14	0.002	-.0231291	-.0053646
g_spending	-.0013338	.0064387	-0.21	0.836	-.0139534	.0112858
_cons	4.896146	1.011932	4.84	0.000	2.912796	6.879496
sigma_u	.89124273					
sigma_e	.44104354					
rho	.80328387	(fraction of variance due to u_i)				

CSD test of fixed effects

Variable	CD-test	p-value	average joint T	mean ρ	mean abs(ρ)
resid_FE	33.745	0.000	21.64	0.52	0.56