# Economic growth, institutions and corruption: An empirical study

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# Preface

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Abstract

This paper seeks to explore why differences in economic growth occur across countries. Firstly, two models of economic growth are reviewed: the Solow model and the Romer model. The Solow model predicts a convergence in economic growth rates between countries, while the Romer model predicts that rich countries with a large stock of technological know-how will experience a higher growth in technology, and therefore achieve faster economic growth than poor countries. Secondly, following the literature, a growth accounting exercise is undertaken to decompose the growth rate of GDP per capita into three constituent terms: growth rate of capital-output ratio, growth rate of human capital per capita and growth rate of total factor productivity (TFP). From the derived expression, two estimating models are formulated: one for the growth rate of GDP per capita and one for the growth rate of TFP. Thirdly, institutions and corruption are discussed in light of the economic models and how they enter the proposed models. The paper employs fixed effects estimation, using a cross-country panel dataset consisting of 170 countries over a time period of 17 years, from 2002 to 2019. The results suggest that corruption has a negative effect on the growth rates of both real GDP per capita and TFP. This effect seems to be larger in poorer and more corrupt countries. Further, the results give evidence in favor of the hypothesis that corruption has beneficial effects on the growth rate of TFP in Southeast Asian countries. Three different software programs have been used in this study. *Python* and *Microsoft Excel* have been used to sort out and organize the dataset. *Stata* was used for estimating purposes.

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# 1 Introduction

In 1960 the world's total Gross Domestic Product (GDP) stood at 1,4 trillion US dollars, measured in constant 2010 US dollars (World Bank, 2021). At the time, this was among the highest registered levels of GDP in history. The unprecedented level of wealth had come as a result of continuous exponential growth over the last centuries since the start of the industrial revolution (Aghion & Durlauf, 2013). Only four years earlier, in 1956, the famous Solow-model of exogenous growth, developed by Robert Solow and Trevor Swan, became the dominant view among economists on how economic growth materialize. This is usually referred to as neoclassical theory of growth. Through accumulation of capital, a country could increase its economic output and wealth. Due to the diminishing marginal productivity of capital, the model predicted a convergence in economic growth. The countries that experienced low levels of economic output per capita due to low levels of capital per capita, should have a higher growth rate than countries with large per capita capital stocks. Consequently, there would be a convergence in per capita growth rates over time across countries (Solow, 1956).

In 2019 the world's total GDP stood at 87,7 trillion US dollars, almost 63 times that of the levels in 1960 (World Bank, 2021). Did the world experience a converge in economic growth that the Solow model had predicted? Some previously poor countries, like South Korea and Singapore, did in fact enjoy higher levels of economic output than before, but the majority of countries did not. In general, the countries that were poor in 1960 are the same countries that are poor today, and many face GDP levels which are only a fraction of those seen in industrialized countries like USA and several European countries. Even though accumulation of capital is still considered a major factor in economic growth, the Solow model cannot explain the wide divergences in growth rates between countries.

Since the first appearance of the Solow model of economic growth, several other contributions have been made to improve the model's shortcomings in explaining differences in growth rates. One important contribution was made by the economist Paul Romer in 1986, who integrated technology and productivity into the model in a meaningful way. The traditional neoclassical growth model did incorporate technological changes, but it was treated exogenously. The new approach by Romer (and others) transformed this aspect of the model into an endogenous component. Differences in technology and productivity were seen as the main driver of economic growth. This *improved* version of growth theory achieved greater success in explaining differences in economic growth between countries (Sørensen & Whitta-Jacobsen, 2010). Creation of new technology was now considered the source of growth in the long run. Due to the non-rival nature of technology, countries with already larger stocks of knowledge could create more new knowledge and enjoy higher growth rates compared to those with smaller stocks. In the theory of economic growth, the aspect of technology and productivity is referred to as *total factor productivity* (TFP). Differences in this is considered by many economists as the key reason to why some countries experience high growth and some not.

Since differences in TFP is being treated as the dominant factor in explaining the divergences in economic growth, there has been a growing focus on why some countries have more TFP than others. The quality of institutions and the prevalence of corruption has been highlighted as being important factors in this regard. In order to have a functioning innovative environment, which is necessary for technological growth, there needs to be a certain level of quality in institutions, such as enforcement of property rights and government effectiveness. Without this, the expected return of innovative activities become low and uncertain. One of the reasons some countries lack this is the presence of corruption, as it could have a damaging effect on institutions. High quality institutions are also important for any investment, activities in order to make returns on investments more certain, raising the investment rate and consequently capital accumulation. Countries with good institutional quality and absence of corruption would therefore enjoy a higher growth in capital accumulation and TFP, and subsequently higher economic growth.

This paper seeks to further explore into the subject of institutional quality, corruption, innovation and economic growth, and hopefully add to the literature. The neoclassical theory of economic growth predicts that poor countries should be able to obtain higher growth rates, while the Romer model predicts higher technological growth for rich countries, and subsequently higher economic growth. Empirically, the notion of convergence and rapid growth does not perform particularly well (Roland, 2016; Sørensen & Whitta-Jacobsen, 2010). Since the theories do not perform very well, there could be other factors that explain the divergences in economic growth. Institutions and corruption are important in this respect (Acemoglu, Johnson, & Robinson, 2001; Mauro, 1995). While there has been micro-evidence of a negative effect of corruption on growth, macro-evidence has been more ambiguous (Roland, 2016). Some argue that corruption impacts countries in different ways (Mahagaonkar, 2008). "Greasing the wheels" is a hypothesis that states that corruption could have a beneficial impact on growth in some countries, by speeding up bureaucratic processes. This is believed to be true for countries in Southeast Asia (Campos, Lien, & Pradhan, 1999). In opposition is the "sanding the wheel" hypothesis, which states that corruption has a negative impact on growth. This is believed to be true for sub-Saharan countries (Gyimah-Brempong, 2002). The motivation for this paper is to explore the factors that drive differences in growth rates. A better understanding of these is important for devising policies of economic growth and development for the poor/developing countries in the world. Inspired by this motivation, this paper will try to answer the following research questions. What effect does corruption have on economic growth? Does the effect differ between rich and poor countries? Is the "greasing the wheel" and "sanding the wheel" hypothesizes true for Southeast Asian countries and Sub-Saharan countries, respectively? Does the data give support for convergence in growth rates? And finally, do rich countries have faster growth in TFP/technology than poor countries, as the Romer model predicts? These questions will be tried to be answered by examining a cross-sectional panel dataset on 170 different countries over the time period 2002 to 2019. Corruption is found to have a significant negative impact on the growth rate of both GDP per capita and TFP. The results also suggest that better institutional quality could mitigate this effect. Corruption is found to have a larger effect on poorer countries. For the Southeast Asian countries, the results give some evidence for a positive effect of corruption on growth in TFP. Further, the results give support for the convergence hypothesis. However, evidence was not found in support of higher growth in TFP for richer countries. A possible explanation is the fact that poor countries could simply copy new technology that has been developed through a long process of research and development in rich countries. In general, the results suggest that differences in institutional quality and corruption could be important determinants of economic growth, and that the effect of corruption is larger for poorer countries.

The paper is set up as follows: Section 1 is the introduction. Section 2 reviews the relevant theory of endogenous growth. Section 3 gives an overview of the theory and literature concerning institutional quality, corruption, innovation and economic growth. Section 4 explains the data and methodology respectively. Section 5 goes through the results and discussion. Section 6 concludes.

# 2 Economic theory

This section aims to give an overview of the prevailing theories of economic growth. Firstly, a summary of the neoclassical growth model is presented, as it will work as a foundation. Secondly, a walkthrough of the endogenous growth theory will be made, in order to highlight the importance of the concepts of "total factor productivity" and "technological progress". These models are beneficial when exploring the effects of corruption and institutional quality on growth and development. Lastly, by utilizing the concept of growth accounting, an expression for growth will be decomposed into an equation, which will serve as a basis for the econometric analysis in section 4.

## 2.1 Neoclassical theory of growth

Neoclassical theory of growth seeks to explain economic growth through three factors: capital, labor and technology. The theory is represented by the Solow model, which is a dynamic equilibrium model (Solow, 1956). It is assumed that the economy is closed and that the markets for inputs are perfect, which implies that prices are treated as given. Further, discrete units are time indexed and the capital stock is assumed to depreciate at a constant rate, ƌ. It is also assumed that the household sector saves a constant fraction of income, s, and that the population grows at a constant level. The entire production side of the economy can be thought of as being represented by a single firm. The relationship between the three factors, and the aggregate output is represented by a traditional production function, as equation (1) below.

$$Y = F(K_t, L_t) = AK_t^{\alpha} L_t^{1-\alpha}, \alpha \in [0,1] \quad (1)$$

Y represents the aggregate(economy-wide) production, usually measured as GDP, $K_t$ is the stock of physical capital and $L_t$ is labor. A represents TFP, which can be interpreted as the level of technological know-how. The subscript t stands for time, which implies that the levels of K and L evolves over time. A is considered a constant following Solow's original specification.

F denotes the functional form, which is specified as a Cobb-Douglas production function. α is a parameter which reflects the share of capital in GDP. There are two important implications from the Cobb-Douglas specification. The first one is that production function exhibits decreasing marginal productivity to both capital and labor. Mathematically, this implies positive first derivatives of equation (1) with respect to the inputs, $F_K>0$ and $F_L>0$, as well as negative second derivatives $F_{KK}<0$ and $F_{LL}<0$. The second implication is that the function has constant returns to scale, which means that a doubling of both inputs also doubles the output.

Equation (1) along with the assumptions have a number of implications. Since the economy is closed, all savings are invested domestically to create more capital for next period. The savings rate will therefore equal the investment rate, $S_t = sY_t = I_t$. The additional capital for the next period will therefore be equal to the sum of the current capital stock and investment, less the amount that has depreciated, $K_{t+1}$ = (1- ƌ)$K_t$ + $sY_t$. Dividing this by labor, $L_t$, gives an expression for how capital per capita evolves over time, $k_{t+1}$ = (1- ƌ)$k_t$ + $sy_t$. Since capital faces diminishing marginal productivity, the increase in output worker gets smaller for each additional unit of capital. Investments therefore faces diminishing returns as output per worker increases relatively less than capital per worker. Because capital depreciates at a constant rate and the population growth is constant, there will be a point in time where the additional capital per capita from investment, will be exactly offset by the amount that has depreciated and vanished due to population growth, meaning: $k_{t+1} = k_t$. Growth in capital per capita and consequently output per capita, will therefore cease in the long run. This level of capital and output per capita are the equilibrium levels, referred to as the steady state values. The model therefore has two important implications. Firstly, growth in GDP per capita, which is explained by capital accumulation through investment, is zero in the long run. Secondly, the model predicts a convergence, as poor countries with low levels of capital per capita should experience higher returns to capital, and consequently higher growth in GDP per capita, than those with high levels. Poor countries will eventually catch up with the rich countries according to the model. This hypothesis will be explored in the empirical section of the paper.

Empirically, there is support of the notion that higher savings and investments rates, and thus higher capital accumulation, is associated with higher growth (Sørensen & Whitta-Jacobsen, 2010)**.** Corruption could be an influencing factor in this respect, as widespread corruption makes returns to investment more uncertain. However, the theory still has some glaring shortcomings. Contrary to the prediction of the neoclassical model, historical data show that the developed rich countries have not experienced zero growth in the long run and a substantial part of poor and developing countries have not seen higher growth rate relative to rich countries. (Sørensen & Whitta-Jacobsen, 2010). To address this shortcoming, Solow included growth in TFP as an exogenous component. If the TFP or A is assumed to change/grow at a constant rate, then the GDP per capita will also grow at the same constant rate in steady-state equilibrium. The source of this growth is then attributed to continuous technological advancement. However, the model does not explain how technology materializes.

The basic Solow model explains growth through capital accumulation. However, it is possible to expand the model in order to include other possible important contributing factors. Such expansions could be to include human capital as an input of production, or by allowing the economy to be open to foreign trade and investment. Even though these extensions could give deeper insights in different aspects of growth, the Solow model does provide an important understanding of the basic underlying fundamentals.

## 2.2 Endogenous growth theory

Endogenous growth theory is an extension of the neoclassical growth theory. While TFP was included in the neoclassical theory, it was treated as exogenously given. The endogenous theory incorporates TFP as an endogenous component. Growth is then achieved through technological change, which is a result of entrepreneurial innovation (Roland, 2016; Romer, 1994). The theory was first introduced in 1986 by the economist Paul Romer, and his model has been an important contribution to the field of economic growth.

### 2.2.1 Ideas

Romer's model maintains all the basic assumptions of the Solow model, although with some important modifications. Ideas as an economic good is now incorporated into the model, and can be thought of as a technology enhancing product. This requires that it is possible to produce ideas which in turn generate higher output. In practice, this is done in two ways. Firstly, there are pure research and development (R&D) companies that produce ideas which in turn is sold off to other companies. This is usually done by selling patents or licenses. Secondly, regular businesses may have segments of their business dedicated to innovation, which can then increase their productivity and subsequently their income. Their idea can then be patented (Roland, 2016; Sørensen & Whitta-Jacobsen, 2010). Patent laws and its enforcement ensures that the owner of the patent obtain monopoly power. There will therefore be imperfect competition, making it possible for the innovators to extract monopoly profit. The driver behind technological growth is therefore the search for profit among innovators (Romer, 1994).

Ideas are non-rival in nature, which means that once produced, there is no limit to how much that idea can be used by others. One firm's usage of the idea does not prevent other firms from using it. An important aspect of non-rival goods is that the marginal cost of producing an extra unit is low and near zero. This has great implications for the form of the cost curves the firm faces. Another important aspect of ideas is that they are excludable. This is defined as the possibility of excluding others from using your economic good. This is crucial in order to have a favorable climate for innovation within an economy. Because the marginal cost is close to zero, there would be no innovation taking place without the possibility of excluding others from utilizing the idea. A functioning system of patenting and a strict enforcement of patent laws is therefore important. Technological progress can be vulnerable to corruption in the following sense. Corrupt officials demanding bribes against issuing patents or weak protection of patents by the authorities will imply that the potential profits from new innovations are reduced. If widespread corruption reduces the expected payoff for innovation, it can reduce the growth rate of TFP. Subsequently, growth in GDP can be affected considerably.

### 2.2.2 The endogenous model

The endogenous growth model begins with the same standard framework as the neoclassical one. However, there are some adjustments, which is shown in equation (2) and (3) below. These are based on the Romer model and gathered from Roland (2016).

$$Y_t = K^{\alpha}(A_t L_{Yt})^{1-\alpha} \quad (2)$$

$$g_{At} = \frac{\Delta A_t}{A_{t-1}} = \delta L_{At} \qquad (3)$$

Equation (2) is the production of final goods. The TFP term is now time indexed and put together with the labor term, making the equation (1) a labor augmented production function. The labor term is now indexed $L_{Yt}$, reflecting the amount of the labor force working in the goods sector. The total amount of labor is $L_t = L_{Yt} + L_{At}$, where $L_{At}$ is the amount of labor working in R&D. Equation (3) defines the growth rate of TFP and states that technology growth depends on the amount of labor in the R&D sector multiplied with $\delta$, which represents the efficiency of research in producing ideas. In this model, the stock of knowledge increases over time. If the stock is large, the additional knowledge next period will be higher than if the stock was small. An implication from this is that the economy will experience increasing returns to scale according to the model (Roland, 2016). Technology therefore plays an important role as it can allow for high growth in GDP per capita, even in the long run. Differences in economic growth between countries can then be thought to stem from differences in technology. In light of this implication and the discussion from section 2.2.1, a functioning innovative environment is crucial for generating economic growth.

Empirically, TFP has been found to be the most important driver of economic growth (Bauer, 1990; Hall & Jones, 1999; Jones, 2016; Lagos, 2006). According to Hall and Jones (1999) formulation, output per worker is determined by three factors: capital intensity (K/Y), human capital per worker and TFP. The authors show that a large part of the differences in output per worker between countries is explained by the differences in the contribution from TFP. Countries like Kenya and India had only a fraction of that of the level in USA, while physical and human capital levels were only slightly smaller (Hall & Jones, 1999). This substantiates the importance of technological growth.

## 2.3 Growth accounting

This section will decompose a modified version of the production function, to derive a model which will serve as a baseline for the econometric model in section 4. It is inspired by the growth accounting exercise done by Jones (2016). It starts off with a slightly modified version of the production functions from equations (1) and (2).

$$Y_t = F(A_t M_t, K_t, H_t) = [A_t M_t] K_t^{\alpha} H_t^{1-\alpha},\ \alpha \in [0,1] \quad (4)$$

$$H_t = L_t e^{\phi(Ed_t)} \quad (5)$$

In equation (4), the term in brackets is the TFP. $A_t$ represents the technology level and $M_t$ represent every other factor which could impact TFP. $H_t$ is human capital augmented labor, where $Ed_t$ is the average years of education in the labor force. The parameter $\phi$ represents the productivity level of labor with $Ed_t$ years of education. This is relative to those with no education. In order to decompose the expression, each side of equation (1) is divided by $Y_t^{\alpha}$ and rearranged to obtain equation (6).

$$Y_t = H_t [A_t M_t]^{\frac{1}{1-\alpha}} \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} = H_t Z_t \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} \quad (6)$$

$$Z_t \equiv [A_t M_t]^{\frac{1}{1-\alpha}} \quad (7)$$

Here, $K_t/Y_t$ is the capital-output ratio which is roughly proportional to the investment rate in the long run (Hall & Jones, 1999; Jones, 2016). The TFP term is gathered into $Z_t$, which is displayed in equation (7). The capital-output ratio is usually independent of TFP in the long run (Ahsan & Ahsan, 2018). Further, by dividing each side of equation (6) with $L_t$, one obtains an expression for GDP per capita, which is displayed in equation (8).

$$y_t = \left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} h_t Z_t \quad (8)$$

Here, $y_t \equiv Y_t/L_t$ is GDP per capita and $h_t \equiv H_t/L_t$ is human capital per unit of labor. From the expression, it can be seen that $y_t$ depends on capital intensity, human capital and TFP. Equation (8) can be transformed into "growth form" by using log-differentiation, to obtain equation (9).

$$g_t^y = \frac{\alpha}{1-\alpha} g_t^{KY} + g_t^h + g_t^Z \qquad (9)$$

The terms here are the growth rates of the different variables, $g^X_t=[(1/X_t)/(dX_t/dt)]$ where $X\equiv [y, K/Y, h, Z]$ and KY is the capital output ratio. Growth in GDP per capita, y, is then determined by the growth rates in the capital-output ratio, growth in human capital and growth in TFP. The model then allows for differences in economic growth to be determined by differences in one of these three factors. It then provides a convenient framework for exploring and discussing the factors that drive differences in economic growth.

If institutional quality and corruption have an impact on growth, these must work through the components of growth, namely K/Y, h and Z. As discussed in section 2.1, TFP is thought to be the main driver of economic growth in the long run. Therefore, it is interesting to investigate the causes behind differences across in this factor. Inspired by the paper "Corruption and Economic Growth" by Pak Hung Mo (2001), the transmission channel can be mathematically expressed as below (Mo, 2001).

$$g_t^Z = g_t^Z(Corruption, \vartheta) \qquad (10)$$

Equation (10) simply states that the growth rate in TFP is a function of corruption and other influencing factors, $\vartheta$. These other influencing factors will be discussed in detail in section 4. In summary, the model provides a framework in which differences in economic growth can be explored. Corruption, institutional quality and other factors that could influence growth, enters the model through the transmission channels, which are the different components present in equation (9). Especially the effects they might have on growth in TFP is interesting. The next section will discuss how institutional quality and corruption enters into equation (9) and (10).

# 3 Institutions, corruption and growth

This section will discuss institutions and corruption, and what role these may play in economic growth and development. The concepts will be defined and explained in light of the economic theory presented in the previous section. As discussed, TFP is arguably the most important component in economic growth (Bauer, 1990; Hall & Jones, 1999; Hsieh & Klenow, 2010; Huang & Yuan, 2021; Islam & McGillivray, 2020; Jones, 2016; Klenow & Rodriguez-Clare, 1997; Roland, 2016). Special attention will therefore be paid into exploring the possible relationship that may exist between corruption and technological development. Finally, the section will include a discussion of previous literature on the subject.

## 3.1 Institutions

Institutions is defined by Nobel laureate Douglas North as constraints designed by humans to shape and restrict human behavior (North, 1990). These constraints guide how people interact and behave, like following the traffic rules or showing up on time at work. Institutions can be thought of as the game rules in a society (North, 1992). Primarily, institutions contribute to society and the economy by lowering transaction costs (North, 1992). There are two kinds of institutions: formal and informal. The former encompasses rules that are written down, and the latter addresses the social norms that dictate how people should behave (Casson, Della Giusta, & Kambhampati, 2010; Ruiter, 2001). Formal and informal institutions have intricate interactions and the latter usually reflect the cultural and social norms prevailing in a society (Roland, 2016; Tabellini, 2008). Democracy is a type of political institution that falls in the category of formal institutions (Roland, 2016). It has been found to positively influence growth, as it enhances governance and subsequently institutional quality (Rivera-Batiz, 2002). Further, law enforcement, regulations, judicial system, governance, monetary/fiscal institutions and tax administration has been identified in the literature as institutions that affects growth (Siddiqui & Ahmed, 2013). Institutions is argued by some economists to be one of the key reasons as to why some countries have developed more than others (Acemoglu, Johnson, & Robinson, 2002; Baland, Moene, & Robinson, 2010; North, 1990). There has been much research on the topic, and the evidence suggests that there is a strong causal link from institutions to growth (see for example, Acemoglu, Johnson, & Robinson, 2001). It has been argued that it affects growth through property rights, transaction costs and incentive structures (Mauro, 1995; North &

Thomas, 1973). By lowering transaction costs and increasing trust, good institutions can channel resources towards activities with high returns (Shirley, 2005).

In relation to the discussion in section 2.2.1, institutions evidently have an important function. For a country to have functioning innovative environment, solid institutions need to be in place (Tebaldi, 2016). Institutions that handle property rights are especially important in this context (Chen & Puttitanun, 2005). Firstly, patent issuing office needs to function properly. If there is too much difficulty in obtaining patents, the innovators may be discouraged and cease the process (David, 1993). Secondly, subsequent to actually obtaining a patent, it is necessary for the agents to have confidence in the institutions that enforce the property right laws. Suppose, an innovator, after having incurred large R&D expenditures, has obtained a patent on a new idea/innovation. This does not automatically imply that the innovator will earn monopoly profits, if the competitors are allowed to copy the innovation without consequences (Chen & Puttitanun, 2005; Sørensen & Whitta-Jacobsen, 2010). This violates the excludability criteria, and would lower a country's TFP and economic growth (Olson, Sarna, & Swamy, 2000). Higher quality institutions therefore stimulate technological progress (Tebaldi, 2016). In relation to equation (10), it thus enters with a positive sign. Improved institutional quality should facilitate innovative activity, raising the TFP growth rate, $g^Z$. Subsequently, growth in output, $g^Y$, should increase. Remembering that differences in TFP explain the major part of productivity differences between poor and rich countries, institutional quality seems to be one of the most important factors in explaining divergences in economic growth (Hall & Jones, 1999).

In light of the economic theory from the prior section, institutions enter equation (9) through its impact on either $g^{KY}$, $g^h$ or $g^Z$. Concerning the capital-output ratio, or the investment rate, higher quality of institutions in a country should ease the process of doing business (Gwartney, Holcombe, & Lawson, 2006). Strong protection of property rights is especially important (Mauro, 1995). This should affect economic growth ($g^Y$) positively by increasing the investment rate, $g^{KY}$. Further, higher institutional quality increases the expected return on investments in human capital (Dias & Tebaldi, 2012). This affects growth through two channels. Firstly, the higher returns induce workers to attain more education, making each unit of labor more productive (Black & Lynch, 1996). According to the model, $g^h$ would then rise which causes $g^Y$ to rise. Secondly, increased human capital give rise to more R&D (Del Mar Salinas-Jiménez & Salinas-Jiménez, 2011; Dias & Tebaldi, 2012; Miller & Upadhyay, 2000). The increased investment in human capital then affects $g^Y$ indirectly as well through $g^Z$.

## 3.2 Corruption

Corruption is potentially a key driver behind divergences in economic growth (Mauro, 1995). In light of the economic model derived in section two, corruption can only influence growth through its impact on either investment, human capital or TFP. There are several different channels through which corruption can affect these three (Mo, 2001).

### 3.2.1 Corruption and institutions

Corruption is defined by the World Bank as "the abuse of public office for private gain" (World Bank, 2020), and it is a widely used definition in economic literature. Although the definition does not include all occurrences of corruption, like corruption in the private sector, it does provide a good framework. Common activities that are usually considered corrupt consist of bribery, patronage agreements, misuse of power or authority, as well as favoritism when contracts are awarded (Jain & Jain, 1998). It can occur as grand corruption or petty corruption (Mashali, 2012). An example of the first one is firms paying a politician for him or her not to support legislation that could be harmful to the firm. Petty corruption could be a bureaucrat accepting payment for issuing licenses or speeding up the bureaucratic process of issuing one for the paying party. Since corruption is inherently illegal, the acts are most often conducted in secrecy (Sandholtz & Koetzle, 2000). Corrupt acts are consequently difficult to reveal/expose (Roland, 2016). Corruption can be pernicious in that they can undermine laws, regulation and the general function of institutions (Lederman, Loayza, & Soares, 2005). This aspect of corruption is encompassed in the economic model and equation (9) and (10) through its influence on institutional quality. Political institutions and corruption seem to have a strong link (Bhattacharyya & Hodler, 2010; Jetter, Agudelo, & Hassan, 2015). Generally, countries with a more authoritarian rule seem to have a higher level of corruption (Rivera-Batiz, 2002). This link can be attributed to the fact that more political competition make politicians more vulnerable to public pressure (Shleifer & Vishny, 1993). If they are perceived as corrupt or get caught, they can be voted out of office. The concept of corruption is an important factor to explore when investigating the causes of divergences in economic growth between countries, as it seems to weaken institutions.

### 3.2.2 Corruption – efficient or detrimental?

There are two opposing views in the economic literature on how corruption affects economic growth (Huang & Yuan, 2021; Lee, Wang, & Ho, 2020; Mauro, 1995). The first one states that corruption might have a positive effect on growth and is usually referred to as the "greasing the wheels" hypothesis (Aidt, 2019). The essence of the argument is that when there are many bureaucratic instances before a license or permit is finally issued, a payment to one of the public officials could speed up the process. This is especially prevalent in countries with inefficient institutions (Nur-tegin & Jakee, 2020). Corruption could therefore reduce bureaucratic inefficiency and raise the investment rate (Méon & Sekkat, 2005). The second view, often referred to as the "sanding the wheel" hypothesis, stands in opposition to the efficiency argument and states that corruption will cause inefficiency (Aidt, 2019). According to this argument, corrupt officials are often unpredictable and may behave arbitrarily. For example, instead of providing services, as agreed upon, in return for a bribe, they may delay their work (of issuing permits, etc.) in order to extract additional bribes (Aidt, 2019; Roland, 2016). This could add uncertainty to the investment climate. In relation to investment, corruption could reduce the expected returns from an investment, especially long irreversible ones (Campos et al., 1999). Imagine an investor having bribed a public official to issue a permit for the construction of a mall. Once the mall has been built, there is no simple way of reversing the investment without incurring losses. Knowing this, the official can extract large bribes and the return on the investment would be reduced for the mall builder. This could lead investors to pursue more reversable, but less profitable projects (Aidt, 2019). This would reduce the $g^{KY}$ term and subsequently $g^{Y}$. There has been much research on the topic, and the results appear to suggest that the latter, more pessimistic view of corruption is the most plausible one (Mauro, 1995; Méon & Sekkat, 2005; Nur-tegin & Jakee, 2020). However, some evidence has been found that support the notion that corruption facilitates certain types of transactions (Mahagaonkar, 2008; Nur-tegin & Jakee, 2020). For example, Campos et al. (1999) found evidence in favor of "greasing the wheels" hypothesis in the Southeast Asian countries. This is in contrast to Sub-Saharan Africa, where corruption is thought to have a strong detrimental effect (Gyimah-Brempong, 2002; Lambsdorff & Cornelius, 2000; Mahagaonkar, 2008).

Section 4 will explore empirically into this contrasting empirical outcomes for Sub-Saharan Africa and Southeast Asia.

One last note is that there is a possible endogeneity problem (Mauro, 1995). While corruption possibly has a negative impact on economic growth, it could also be the case that low economic growth breeds corruption. Civil servants with low income could be tempted to engage in corrupt activities in order to increase their meager income, meaning low economic growth could be a source for corruption. In other words, there is possibly a bidirectional causality between corruption and poverty (Mauro, 1995; Roland, 2016).

### 3.2.3 Corruption and innovation

TFP is, as argued by Hall and Jones (1999) and others, the most important factor in explaining differences in economic growth between countries. TFP reflects the technological level within an economy and it is therefore interesting to examine how corruption might affect the process of innovation and technological progress. Firstly, widespread corruption could distort the rule of law and thereby weaken the institutions that are needed to enforce patent laws (DiRienzo & Das, 2015). This would weaken the incentives to innovate and corruption would enter as a negative effect in equation (10), reducing $g^Z$ (DiRienzo & Das, 2015). An implication from this is that potential innovators may now spend their time and resources on rent seeking activities instead of innovation (Del Mar Salinas-Jiménez & Salinas-Jiménez, 2011). Secondly, there is also another misallocation of resources as time and money is used on paying bribes instead of on other productive activities (Aidt, 2019). Thirdly, innovators faced with excessive corruption could enter the informal sector of the economy where there is less productive technology, or become corrupt bureaucrats themselves (Roland, 2016). Fourthly, corrupt politicians could spend monetary foreign aid earmarked for R&D on other more politically popular policies (Mungui-Pippidi, 2015). Lastly, corruption can be thought to have a negative effect on *foreign direct investment* (FDI) due to more uncertainty and lower expected returns (Al-Sadig, 2009). FDI is believed to have positive spill-over effects on the host country technology (AlAzzawi, 2012). Corruption can therefore have a negative indirect influence on innovation through its effect on FDI. All these different ways corruption can affect innovation enters into equation (10) with a negative sign, lowering $g^Z$. Subsequently, from equation (9), economic growth should be negatively impacted. This will be explored in section 5.

## 3.3 Other factors

The level of corruption within a country could be a reflection of the prevailing culture in that country (Barr & Serra, 2010). Corrupt acts are often thought of as morally wrong. However, this may not apply uniformly to all countries and across all cultures. Certain acts or behaviors which are considered corrupt in one culture may not be viewed similarly in other cultures. Corrupt acts could be a result from deliberate evaluation of the benefits and costs arising from the act, or it could be the result of intrinsic motivation (Barr & Serra, 2010). This motivation stems from the traditions, values and social norms which prevails in a society. When certain corrupt acts have their roots in the society's cultural values, it may prove to be difficult to control these corrupt acts. Like cultural values, people's attitude to corruption may take a long time to change. This explains why corruption has long staying power in some countries (Barr & Serra, 2010).

## 3.4 Empirical overview of institutions, growth and TFP

There are numerous empirical studies that have attempted to find links between institutions, corruption and growth. This section will give an overview over some literature on the subject. Firstly, studies on the link between institutions, corruption and growth will be presented. Studies on institutions, corruption and innovation will follow thereafter.

Mauro (1995) wrote an interesting paper entitled "Corruption and Growth". This is an influential paper which has inspired a great deal of further research on economic growth and corruption. He explored the relationship between corruption, GDP and investment, using a dataset consisting of 58 countries. The dependent variable used was investment to GDP for the period 1960-1985 and corruption indices from *Business International* as independent variables. He also addressed the endogeneity problem by using IV-regression with an index of ethnolinguistic fractionalization as instrument. His results showed that corruption has a negative effect on GDP and investment (Mauro, 1995).

Gründler and Potrafke (2019) wrote a paper entitled "Corruption and economic growth: New empirical evidence", using a dynamic panel data regression to study the effects of corruption on economic growth. The *Corruption Perception Index* (CPI) is used as a measure of corruption for a sample of 175 countries. In their paper, they included a critical review of earlier empirical studies which had used CPI as a variable in their analysis. The index, which is developed and released yearly by Transparency International, was reconstructed in 2012. A new methodology was applied to improve the accuracy of the corruption measure as well as it's comparability across countries. According to the authors, the new methodology has made the index incomparable over time periods before and after 2012. Therefore, one cannot use the index values before and after the new methodology was employed. They argue that earlier studies have ignored this. Consequently, much of the literature is flawed. Gründler and Potrafke have therefore limited their dataset to only include observations from after 2012. They use a dynamic panel regression approach, lagging the CPI variable. Their result shows a negative relationship between corruption and growth. This effect seems to be larger for autocracies compared to non-autocracies. Further, they state that the effect of corruption is transmitted to economic growth through decreasing FDI and increasing inflation (Gründler & Potrafke, 2019).

"The effect of institutions on economic growth: A global analysis based on GMM dynamic panel estimation" is a paper by Siddiqui and Ahmed (2013). They study how the quality of institutions affect economic growth. By using over 30 different indices for institutional quality, they employ generalized method of moments estimation (GMM) and panel ordinary least square (OLS) estimation. Their findings suggest that stronger institutions have a positive effect on economic growth.

Rivera-Batiz (2002) wrote the paper "Democracy, Governance, and Economic Growth: Theory and Evidence". He explored how democracy and governance affected economic growth in the long run. By laying out a theoretical groundwork, he derived a regression baseline which is quite similar to equation (9) discussed above. The data used was gathered from the Penn World Tables, which is also the dataset used in this thesis. He also emphasized the importance of TFP and studied how it is affected by democracy and governance. In contrast with the analysis done in this paper, only two time periods were employed by Rivera-Batiz, 1990 and 1960. The variables he used are measured as the average change between these time periods, essentially making the analysis a cross section study. He found that democracy has a significant positive effect on growth in TFP and GDP.

Pak Hung Mo (2000) found a significant negative effect of corruption on economic growth, using cross country data. He used CPI as the independent variable and growth in total GDP as the dependent variable. The method used is ordinary least squares estimation. In relation to this paper, the framework is similar. His empirical substructure is based on a growth accounting exercise which yields an estimation equation close to the one derived in equation (9). The main difference is that total GDP is used instead of GDP *per capita*. He included initial GDP per capita as an independent variable to capture convergence, as predicted by the neoclassical theory. This variable is found to have a significant negative coefficient, which means the result favors the convergence hypothesis (Mo, 2001).

A study that looked at the relationship between corruption and innovation is "Innovation and role of corruption and diversity: A cross-country study", written by DiRienzo and Das (2015). They used cross-country data to explore the relationship, and they included measures of cultural and religious diversity in the model. They emphasized the importance of innovation for economic growth and the lack of empirical research on cross-country analysis on the subject. In their study, the Global Innovation Index and CPI were used as proxies for innovation and corruption, respectively. The regression equation is similar to the one derived in this paper. The regression results showed that corruption has a significant negative effect on innovation. However, this effect is smaller for wealthier countries (DiRienzo & Das, 2015).

Another paper that studied the relationship between corruption and innovation is "Country governance, corruption, and the likelihood of firms' innovation", written by Lee et al. (2020). The data used is firm level and is collected from the *World Bank Enterprise Survey* and consists of a sample of firms for the period 2006-2016. They used the World Governance Indicators (WGI) from the World Bank as measurement of institutional quality. Three different aspects of bribery are used as a proxy for corruption: frequency, depth and incidence. Interestingly, they found that the sectors in the economy with the worst governance are more vulnerable to corruption and the effect is larger. This includes e.g., the manufacturing sector. In summary, corruption seems to affect innovation negatively at the firm-level and better governance mitigates this effect (Lee et al., 2020).

Another study that analyzed innovation and corruption using cross-country data is "Entrepreneurship, innovation and corruption" by Anokhin and Schulze (2009). They used data from 64 countries to analyze whether controlling for corruption increases innovation and entrepreneurship. One of the indicators from the WGI dataset, control of corruption, was used as a proxy for the level of corruption. This is the same corruption index which is used in this paper. Similar to Gründler and Potrafke, they emphasize on foreign direct investment and the role it plays. They find that a better control of corruption is associated with higher levels of innovation. This relationship is also found to be non-linear. They also find that FDI mitigates these effects. According to their results, institutional factors play a crucial role as to whether or not there will be innovative activity within a country. In an economy where institutional factors are non-existing, there will be no innovative activity (Anokhin & Schulze, 2009).

"Does political corruption impede firm innovation? Evidence from the United states" is a paper by Huang and Yuan (2021) that studies innovation and corruption in the US at the industry-level. His regressions were performed with OLS estimation and he include industry fixed effects and year fixed effect to address heterogeneity bias. The baseline equation is quite similar to the one used in this paper in both form and the fact that fixed effects are included. However, it does not include variables such as FDI and human capital. They find that corruption have a significant negative impact on innovation (Huang & Yuan, 2021).

# 4 Data, measures and methodology

This paper seeks to explore why there are such large variations in economic growth across countries. Section 2 and 3 have elaborated on the different factors that influence economic growth. The following section will go through the data that has been used in the analysis. All the data consists of yearly observations for each country. The timeframes of the different variables vary. Therefore, the timeframe is based on available observations from the corruption index that is used. Countries with large numbers of missing observations have been left out. In total, the dataset includes observations from 170 different countries over a time period of 17 years, from 2002 to 2019.

Two models will be estimated. One for growth in GDP per capita and another for growth in TFP. For growth in GDP per capita, the estimating model comes from the growth accounting exercise done in section 2.3, making equation (9) the basis for the estimating model. From the equation, per capita growth has been decomposed into three constituent parts: growth in K/Y, growth in per capita human capital and growth in technology. Variables that explain these growth terms will therefore be included in the estimating model. The estimating model for the growth rate in TFP/technology is based on the ad-hoc equation (10), an approach inspired by Mo (2001). This model will then include variables that affect technological progress within a country.

## 4.1 Data and measures

In what follows, a list of both the dependent and the independent variables is presented, along with their definition and rationale for why these are included in the estimating model. Descriptive statistics will also be presented.

### 4.1.1 Dependent variables

Two dependent variables are used in this analysis, one for each model. These are (i) the growth rate in GDP per capita and (ii) growth rate in technology/TFP. There are several different measurements of GDP. Real GDP is the appropriate measure in this cross-country study, as it is comparable across countries. It is gathered from the Penn World Tables and is measured in constant 2017 national prices (Feenstra, Inklaar, & Timmer, 2015). The variable is transformed to per capita form by dividing real GDP by the total number of employed citizens. Using the fact that changes in logarithmic values can be interpreted as percentage changes, the variable is operationalized as the first difference of the logarithmic values of real GDP per capita, which is approximately equal to $g^y$ from equation (9). This is a common approach in the literature concerning economic growth (see for example, Hasan & Tucci, 2010).

TFP is calculated by using the growth function similar to equation (1), TFP= $Y/(K^{\alpha}L^{1-\alpha})$. Y is the real GDP per capita from the paragraph above. K is the real capital stock, measured in constant 2017 national prices, and L is the labor force. Both are obtained from the World Penn Tables. The term α is the capital share, and is set to 0,3, which is widely thought to be an appropriate level (Feenstra et al., 2015; Sørensen & Whitta-Jacobsen, 2010). This approach is also used in Islam and McGillivray (2020). Using the same procedure as with growth in real GDP per capita, the TFP variable is operationalized as the first difference of its natural logarithm, which approximately equals $g^Z$ from equation (9) and (10). As discussed, TFP can be used as a proxy for technological progress within a country. It must be noted that TFP is calculated as a residual. The measures' accuracy is therefore dependent on how accurate the capital stock and labor share are measured. For some countries, especially less developed countries with missing data, such accuracy is often not the case (Islam & McGillivray, 2020).

### 4.1.2 Independent variables

The estimated model for growth in GDP per capita is, as discussed, based on equation (9), from section 2.3. The equation states that growth in GDP per capita is determined by growth in K/Y, human capital and technology. Variables that influence these factors should be included in the estimation model. For the corruption variable, the *Control of Corruption index* (cce), is a corruption index obtained from the *World Governance Indicators* (WGI) dataset, developed by the World Bank. It is a subjective measure of corruption, with data for each country since 1996. In the beginning it was only released every two years, so observations from 1997, 1999 and 2001 are absent. The index is constructed by using more than 30 underlying sources, based on expert assessments and survey perceptions (Kaufmann, Kraay, & Mastruzzi, 2011). The cce index takes values in the interval -2,5 and 2,5. Low values indicate high levels of corruption. For easier interpretation, the index has been reversed, meaning that an increase in cce indicates higher levels of corruption. This approach was inspired by Gründler and Potrafke (2019). Further, this variable has been transformed to only take positive values, $x \in [0,5]$. On the high end of the scale with high levels of corruption, one then typically find countries in Africa, Asia and South-America. On the low end of the scale, one typically find western countries. Another widely used corruption index is the *Corruption Perception Index* (CPI) developed by Transparency International (see for example, DiRienzo and Das, 2015). In 2012, the methodology used in constructing the index was changed. It is therefore not possible to compare CPI rankings from before and after 2012 (Gründler & Potrafke, 2019). Due to this fact, the cce index was preferred over CPI. One must note that the index is a subjective one. Although it is based on several different sources, which should increase the accuracy of the measure, it is still exposed to subjective bias. The survey participants could perceive countries that perform badly economically as more corrupt, even though that might not be the case (Roland, 2016). Even though the index may be subject to bias, it is still more comprehensive than other objective measures of corruption and will serve as an appropriate proxy.

In order to capture the convergence hypothesis, it is customary to include a measure of "initial GDP per capita" as an independent variable in the estimation of the per capita growth of GDP (see for example, Hasan & Tucci, 2010; Mo, 2001; Rivera-Batiz, 2002). Considering that a large initial value of GDP per capita (indicating a rich country) should mean lower rate of growth for that country, such a variable would capture this effect. However, this study applies *ordinary least squares* (OLS), using fixed effects transformation. An implication of this is that all time-invariant terms/variables drop out of the regression model. To control for this problem, a variable need to be added that varies over time and also captures the same effect. Lagged GDP per capita is such a variable (Islam & McGillivray, 2020). If the convergence hypothesis is true, then countries with large "initial" values of GDP per capita should have a lower growth rate than countries with small "initial" values of GDP per capita. The lagged natural logarithm of real GDP per capita is therefore added.

The estimating model for growth in technology/TFP is an ad-hoc model based on the formulation in equation (10), which follows Mo (2001). Variables that affect the technological progress in a country should be included in this model. These are factors that affects R&D efforts. The cce index will be used in this model as well, to capture the effect of corruption on growth in TFP. Lagged TFP is used instead of lagged GDP per capita in this model. By including this, Romer's hypothesis of higher technological growth for rich countries can be evaluated. Production of new technology is thought to be an important source for growth. However, technology can also be imported. This is especially important for poor countries, where innovating activities can be small or perhaps even non-existing. A more open economy could allow for more import of technology. A greater inflow of FDI could also bring about a higher technological growth rate in poor countries. It follows from equation (9) that variables that enter the estimating model for growth in TFP will naturally enter the model for growth in real GDP per capita, but not necessarily the other way around. However, lagged TFP will only be included in the TFP growth model.

### 4.1.3 Control variables

Following, a brief review of control variables will be presented. Firstly, the control variables that are only included in the model for growth in real GDP per capita is discussed. Secondly, the variables that are included in both models are discussed. Inflation is a variable that is usually controlled for in economic growth literature (see for example, Islam & McGillivray, 2020). Corrupt government may raise the government expenditure (fiscal policy) just before elections, in order to get more votes. Such expenditure could even include paying bribes to influential people or simply cash hand-out to the constituents. Higher expenditure could simply raise inflation. Further, inflation could enter the growth equation through its impact on investment. High inflation means returns from investments become more uncertain, creating a bad investment climate. Population growth is also added as a control, as it can influence growth in GDP per capita through other channels than just increasing the denominator in Y/L. For example, larger families could hamper the formation of human capital (Rosenzweig, 1988). In relation to equation (9), a measure capital-intensity will be included. The growth rate in capital per worker will be included as a proxy for investment. It is obtained from the Penn World Tables as well.

Next, variables that appear in both models will be discussed. A proxy for human capital is added, as it raises worker productivity, which subsequently should increase economic growth. Further, human capital is complementary to R&D, which can increase innovation. This results in more TFP and more growth. The variable is an index based on average years of schooling and the returns to education (Feenstra et al., 2015). It is also obtained from the Penn World Tables. Trade openness is another variable that could influence growth and technological progress, since much technology can be imported, as discussed. More openness also positively affect FDI inflows (Liargovas & Skandalis, 2012). Much of technological progress in a country occurs through FDI spillovers (Alfaro, Kalemli-Ozcan, & Sayek, 2009). The openness is measured as the sum of exports and imports as share of GDP, and is widely used as a control variable in literature (Anokhin & Schulze, 2009; Gründler & Potrafke, 2019). Trade openness and FDI are both collected from the World Bank (2021). FDI is measured as the natural logarithm. As discussed in the previous section, the level of democracy could also influence both GDP and corruption (DiRienzo & Das, 2015). A measure of democracy is obtained from a democracy index developed by Gründler and Krieger. They have used machine learning to get precise measures on the level of democracy in different countries. The index is continuous in the interval 0 to 1 (Gründler & Krieger, 2016).

Variables for governance and institutional quality are the remaining indicators in the WGI dataset, and will be included to analyze whether the effect of corruption varies with institutional quality and governance. These are *Voice and Accountability* (vae), *Political Stability and Absence of Violence and Terrorism* (pve), *Government Effectiveness* (gee), *Regulatory Quality* (rqe) and *Rule of Law* (rle). They are constructed the same way as the cce indicator, and only take values between -2,5 and 2,5. As before, they are transformed to only take positive values, $x \in [0,5]$, for easier interpretation. These are not reversed, so high scores indicate good governance and good institutional quality and lower scores indicate bad performance. The first one, Voice and Accountability, is a measure of the degree of freedom a country's citizens have, to participate in elections. It also includes to what degree freedom of expression and association, as well as free media is present. Political Stability and Absence of Violence measures the likelihood that a country will experience political instability, violence motivated by political reasons, as well as terrorism. Government effectiveness reflects the quality of a country's public and civil services and how independent it is from political pressure. Further, it captures how well policies are formulated and implemented and how credible the government is perceived in undergoing those policies. Regulatory Quality is a proxy for how well the government does in formulating and implementing policies and regulations that encourages and stimulates development in the private sector. Rule of Law captures the confidence citizens and other economic agents have in the prevailing laws and rules of the society, and to what degree they follow them (Kaufmann et al., 2011). As with the cce indicators, they lack observations for 1997, 1999 and 2001. Since the dependent variables are measured as first differences, every year before 2002 is left out of the dataset.

#### 4.1.4 Descriptive statistics

Table 1 displays a summarize of descriptive statistics for the relevant variables. Most of them have observations around 3000. The mean growth rate in real GDP per capita is 0,017, which implies that countries on average grows by 1,7% each year. The standard deviation is at 4,8%, meaning that there is a large variation in growth rates. This can also be seen with the large difference in the minimum and maximum values. The picture is similar for the TFP growth rate, although the mean growth rate is somewhat lower at 1,2% average each year. The corruption index, cce, has a mean value of 2,513. Remembering that cce takes values between 0 and 5, where the high end represents high levels of corruption, countries seem to have scores ranging in the middle of the index. The standard deviation along with the minimum and maximum values seem to indicate substantial variation in corruption levels between countries. Average scores for the remaining five governance indicators are spread around 2,5.

**Table 1**: Descriptive statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| GDPPC growth | 2890 | .017 | .048 | -.455 | .457 |
| TFP growth | 2873 | .012 | .044 | -.449 | .457 |
| cce | 3060 | 2.513 | 1.013 | .03 | 4.326 |
| K/L growth | 2873 | .018 | .036 | -.133 | .24 |
| Pop growth | 2890 | .015 | .016 | -.045 | .175 |
| HC | 2574 | 2.53 | .693 | 1.088 | 4.352 |
| Inflation | 2805 | 5.387 | 8.712 | -30.243 | 254.949 |
| Trade | 2837 | .898 | .563 | .002 | 4.426 |
| Democracy | 2986 | .689 | .349 | 0 | 1 |
| FDI | 3024 | .067 | .611 | -.672 | 20.009 |
| $LnGDPPC_{t-1}$ | 2890 | 10.182 | 1.122 | 6.744 | 12.227 |
| $LnTFP_{t-1}$ | 2873 | 6.722 | .752 | 3.796 | 8.294 |
| vae | 3054 | 2.449 | .967 | .241 | 4.301 |
| pve | 3056 | 2.423 | .937 | -.681 | 4.255 |
| gee | 3057 | 2.539 | .981 | .221 | 4.937 |
| rqe | 3057 | 2.552 | .957 | .136 | 4.761 |
| rle | 3060 | 2.47 | .983 | .178 | 4.6 |

Table 1 – GDPPC and TFP growth is the first difference of their logarithmic values.

Table 2 displays a correlation matrix. Growth in GDP per capita and TFP are seen to have a strong positive correlation. In light of the economic theory in section 2, this seems reasonable. Interestingly, corruption (cce) is positively correlated with growth in both GDP per capita and TFP, at around 0,133 and 0,107 respectively. There are some reasons why this positive correlation is observed. These will be discussed in section 5. Human capital show negative correlations with growth in TFP and GDP per capita. However, growth in capital has a positive correlation with cce, while human capital does not. Trade, democracy and FDI has negative correlations with cce, while inflation exhibits strong correlation with it.

**Table 2**: Correlation matrix

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) GDPPC growth | 1.000 | | | | | | | | | | | |
| (2) TFP growth | 0.963 | 1.000 | | | | | | | | | | |
| (3) cce | 0.133 | 0.107 | 1.000 | | | | | | | | | |
| (4) K/L growth | 0.461 | 0.204 | 0.132 | 1.000 | | | | | | | | |
| (5) Pop growth | -0.142 | -0.143 | 0.241 | -0.044 | 1.000 | | | | | | | |
| (6) HC | -0.089 | -0.043 | -0.662 | -0.178 | -0.492 | 1.000 | | | | | | |
| (7) Inflation | 0.028 | 0.021 | 0.369 | 0.033 | 0.147 | -0.303 | 1.000 | | | | | |
| (8) Trade | 0.003 | 0.038 | -0.313 | -0.112 | -0.068 | 0.304 | -0.158 | 1.000 | | | | |
| (9) Democracy | 0.028 | 0.077 | -0.383 | -0.152 | -0.452 | 0.447 | -0.182 | 0.022 | 1.000 | | | |
| (10) FDI | -0.031 | -0.038 | -0.158 | 0.009 | -0.040 | 0.084 | -0.063 | 0.263 | 0.093 | 1.000 | | |
| (11) $LnGDPPC_{t-1}$ | -0.212 | -0.176 | -0.715 | -0.189 | -0.268 | 0.772 | -0.339 | 0.312 | 0.232 | 0.109 | 1.000 | |
| (12) $LnTFP_{t-1}$ | -0.201 | -0.183 | -0.702 | -0.128 | -0.217 | 0.734 | -0.350 | 0.291 | 0.192 | 0.097 | 0.983 | 1.000 |

Table 2 - Correlation Matrix

## 4.2 Methods

The regressions in this analysis are all done using the statistical software program, Stata. Firstly, the different datasets were combined. Some observations did not match with each other and were subsequently dropped. As mentioned earlier, some countries had a severe lack of observations. They were therefore dropped, as they may lead to misleading and/or biased results. All years that did not include any observations for cce were also dropped. Next, the variables measured in million dollars, real GDP and the capital stock, were transformed to the actual amount of dollars. As discussed, the GDP per capita and TFP terms were transformed into growth rates using natural logarithms, and cce is reversed for easier interpretation (Gründler & Potrafke, 2019).

Because the dataset is a panel dataset, one can use different types of panel regressions in order to get more accurate estimates than if no panel regressions are used. Although there are several control variables included, it is plausible that there still are some unobserved factors that could affect the dependent variable. In particular, there could be unobserved, time invariant factors which are specific to a location, referred to as individual heterogeneity (Wooldridge, 2014). If this is not corrected for, the regression results could be biased. This is done by transforming the model. The model displayed in equation (11) is the baseline model where no transformation is made.

$$y_{it} = \gamma C_{it} + x'_{it}\beta + \alpha_i + \varepsilon_{it}, i = 1,2,\dots,170 \text{ } and \text{ } t = 1,2,\dots,17 \qquad (11)$$

$y_{it}$ is the dependent variable, and stands for either growth in GDP per capita or growth in TFP. $C_{it}$ is the cce corruption index with its coefficient, $\gamma$. $x_{it}$' is a vector of the control variables with the corresponding coefficients, $\beta$. The set of control variables depends, as discussed, on whether growth in GDP per capita or growth in TFP is being used as the dependent variable. $\alpha_i$ is the set of country specific effects that does not vary over time, or country fixed effects. These are factors that change slowly over time relative to other factors, and can be viewed as constants over time, e.g., culture and geography. These are specific to each country and are thought to have an effect on the dependent variable. This is the term that captures the unobserved heterogeneity. In light of the discussion in section 3.3, this seems important to control for. $\varepsilon_{it}$ is an idiosyncratic error term. To remove the effect of $\alpha_i$ out of the results, fixed effects estimations is applied. This is done by undertaking the within transformation, or fixed effects transformation (Wooldridge, 2014). Firstly, a new equation is set up where equation (11) is averaged over the time period, which is done in equation (12).

$$\overline{y}_i = \gamma \overline{C}_i + \overline{x}'_i\beta + \alpha_i + \overline{\varepsilon}_i \qquad (12)$$

$\alpha_i$ does not have a time subscript, t, and will therefore not have a time average. It will therefore show up in both equation (11) and (12). The term can be removed by subtracting equation (12) from equation (11). This is done in equation (13).

$$y_{it} - \overline{y}_i = \gamma(C_{it} - \overline{C}_i) + (x'_{it} - \overline{x}'_i)\beta + \alpha_i - \alpha_i + \varepsilon_{it} - \overline{\varepsilon}_i \qquad (13)$$

By rearranging, the model can be expressed as equation (14).

$$\tilde{y}_{it} = \gamma \tilde{C}_{it} + \tilde{x}'_{it}\beta + \tilde{\varepsilon}_{it} \qquad (14)$$

Here, $\tilde{y}_{it} = y_{it} - \overline{y}_i$, $\tilde{C}_{it} = C_{it} - \overline{C}_i$, $\tilde{x}'_{it} = x'_{it} - \overline{x}'_i$ and $\tilde{\varepsilon}_{it} = \varepsilon_{it} - \overline{\varepsilon}_i$ is the time demeaned data on y, C, x' and ε respectively. The individual (or country-wise) heterogeneity term, $\alpha_i$, has been removed. This implies that an OLS regression can be done on equation (14), which in turn can produce unbiased estimations. Alternatively, another similar approach could be used called *random effect estimation*. One would use this if the unobserved heterogeneity is thought to be uncorrelated with the explanatory variables. In this case of the present estimation, such an assumption seems not very plausible. In order to check which assumption is valid, a series of Hausman-tests were performed. They all rejected the null hypothesis (which is that the random effects estimates are consistent and efficient) by a large margin, which indicates that fixed effects should be the preferred method of estimation. Using these insights, a baseline model is constructed and laid out in equation (15).

$$y_{it} = \gamma C_{it} + x'_{it}\beta + \lambda_t + \varepsilon_{it} \tag{15}$$

The fixed effects transformation has been performed and time-specific dummies, represented by $\lambda_t$, has been included. These remove any effects that are specific for one individual year and makes the results more accurate. The marginal effect of corruption on growth in GDP per capita and TFP is then captured by γ. If corruption has a negative impact on growth, the $\gamma$ coefficient should have a significant negative value.

Equation (15) captures the overall effect of corruption for all the countries in the sample. Following DiRienzo and Das (2015) and Lee et al. (2020), one can argue that the effect of corruption might be different for different levels of economic wealth, as well as different levels of corruption. To test this, equation (15) is regressed three times, where the sample has been split into percentiles. One includes the 33% least corrupt countries, the second includes the 33% most corrupt countries and the last includes all the countries in between. The same exercise is done for the wealth level - here, the wealth ranking of countries is substituted for by the real GDP (per capita) ranking.

Further, regressions on equation (15) are done for different continents and sub-continents to test for whether corruption affects different parts of the world differently. Dummy variables for

Sub-Saharan Africa and Southeast Asia are created. Doing this, the hypothesis that corruption might be beneficial in Southeast Asia and detrimental in Sub-Saharan Africa, could be tested. A dummy variable for Latin America is also included.

$$y_{it} = \gamma C_{it} + x'_{it}\beta + \theta(D_i * C_{it}) + \lambda_t + \varepsilon_{it} \tag{16}$$

$$\frac{\partial y}{\partial C} = \gamma + \theta \tag{17}$$

Equation (16) is an extension of (15) where the dummy variables, $D_i$, have been included. $D_i$ takes on the value 1 if the country is in the relevant group. The dummy variables are multiplied with the corruption variable, $C_{it}$, to form an interaction term. This allows the predicted effect of corruption to vary between the different levels of wealth. The marginal effect of corruption has therefore changed, which is shown in equation (17) as the partial derivative of y with respect to C. It consists of both the coefficients γ and Θ. The net sum of these, determines the effect of corruption for rich, poor and middle-income countries respectively. If the value obtained in equation (17) differs between the groups, corruption can be thought to have different effects depending on the prevalent level of corruption or wealth.

Further, as discussed in several of the earlier studies, institutions might have an influence on the effect of corruption on growth in both GDP per capita and TFP (Gradstein, 2004; Gründler & Potrafke, 2019; Lee et al., 2020; Singh, 2019). When governance is good, the effect of corruption should be mitigated. In order to investigate the relationship, the model must include some new terms, as shown in equation (28).

$$y_{it} = \gamma C_{it} + x'_{it}\beta + \rho I_{it} + \phi(I_{it} * C_{it}) + \lambda_t + \varepsilon_{it} \tag{18}$$

$$\frac{\partial y}{\partial C} = \gamma + \phi I_{it} \tag{19}$$

Here, the new variable $I_{it}$ is the governance indicators from the WGI dataset. This has some implication for the interpretation of the model. Firstly, the parameter ρ allows the level of y to vary with the quality of institutions. Secondly, the new interaction term gives a new interpretation of the effect of corruption. Equation (29), i.e., the partial derivative of y with respect to C, is the marginal effect of C on y. It now depends on the level of institutional quality, $I_{it}$. The effect of corruption is therefore dependent on how well a country's institutions are performing. If institutions have a mitigating effect on corruption, $\phi$, should have a positive value.

The inclusion of the lagged dependent variables in the regression models creates some methodological issues. There is a simultaneity problem since the lagged variable appears on both sides of the equation. Fixed effects estimators could therefore become inconsistent if the time horizon is small, even if the idiosyncratic error term, $\varepsilon_{it}$, is not serially correlated. In the literature, this problem is often dealt with by using the system GMM estimator, which uses lagged differences of the dependent variable as instrumental variables. By using system GMM, unobserved heterogeneity and endogeneity problems are addressed and the estimator becomes consistent and efficient. However, if GMM is to be considered an appropriate estimator, it needs to fulfill Hansen-tests for overidentifying instruments, F-tests for joint significance as well as two other tests that considers serial correlations in the error term. In this paper, the GMM estimator was evaluated. The results were mostly in line with the results from the fixed effects estimator, but with weaker significance levels and reduced absolute values for the coefficients. However, the four tests mentioned above were not jointly fulfilled. GMM estimation was therefore not pursued. Regardless, the GMM results were mostly in line with the fixed effects results. The models were also estimated without the lagged dependent variables. Except for some coefficient estimates having a weaker significance level and lower absolute values, the results were virtually unchanged. Islam and McGillivray (2020) estimated a similar model, with the lagged logarithm of GDP per capita on the right-hand side of the equation. They applied OLS/fixed effects and drew similar conclusions as the present study. Although the estimators might be inconsistent in theory, it is not perceived as a major issue in this study.

# 5 Results and discussion

This section will present the regression results of the different specifications of models, equation (15) to (19), with the associated discussion. Starting off, Table 3 shows the regression results for equation (15) where growth in real GDP per capita is the dependent variable. Cluster robust errors are reported in parenthesis, as the standard errors are thought to be dependent within countries.

**Table 3**: Growth in real GDP per capita

| | (1)<br>GDPPC growth | (2)<br>GDPPC growth | (3)<br>GDPPC growth | (4)<br>GDPPC growth |
|---|---|---|---|---|
| cce | 0.00331*** | 0.00179 | -0.0239*** | -0.0241*** |
| | (0.000872) | (0.00131) | (0.00738) | (0.00754) |
| Inflation | | -0.0000891 | -0.000521** | -0.000497** |
| | | (0.000196) | (0.000216) | (0.000234) |
| Trade | | 0.00846*** | 0.0408*** | 0.0362*** |
| | | (0.00219) | (0.0120) | (0.0120) |
| FDI | | -0.0116*** | -0.00669 | -0.00731* |
| | | (0.00358) | (0.00409) | (0.00370) |
| Democracy | | 0.00916* | 0.0195 | 0.0188 |
| | | (0.00516) | (0.0120) | (0.0119) |
| HC | | 0.00429 | 0.000542 | -0.00788 |
| | | (0.00397) | (0.00971) | (0.0134) |
| K/L growth | | 0.484*** | 0.559*** | 0.612*** |
| | | (0.0419) | (0.0510) | (0.0469) |
| Pop growth | | -0.283** | -0.123 | -0.0192 |
| | | (0.116) | (0.292) | (0.257) |
| $LnGDPPC_{t-1}$ | | -0.00799*** | -0.0681*** | -0.0684*** |
| | | (0.00196) | (0.0114) | (0.0133) |
| _cons | 0.00898*** | 0.0668*** | 0.714*** | 0.739*** |
| | (0.00236) | (0.0188) | (0.105) | (0.136) |
| *N* | 2890 | 2166 | 2166 | 2166 |
| adj. $R^2$ | 0.005 | 0.273 | 0.270 | 0.341 |

Cluster robust standard errors in parentheses. Fixed effects OLS results are reported in column (3) and (4). Year fixed effects are included in column (4).
* p<0.10, ** p<0.05, *** p<0.010

Column (1) shows OLS estimates without the fixed effect transformation. Corruption, measured by cce, has a positive and significant coefficient. In relation to the discussion from section 2 and 3, this result stands in opposition to what one would expect to find. However, the adjusted R-squared is small, at 0,005, indicating that the model does not explain the variation in growth very well. Given that this model has a number of omitted variables/controls, and that the possible presence of unobserved heterogeneity has not been controlled for, the positive coefficient for corruption is most likely picking up the effects of certain omitted variable(s). In column (2), the different control variables and lagged GDP per capita are added. The coefficient for cce is still positive, but smaller and it is no longer statistically significant. Trade, growth in capital and democracy are seen to have positive coefficients, while FDI, population growth and lagged real GDP per capita are all negative and significant at the 1% level. Adjusted R-squared has increased. In column (3), the fixed effect transformation has been performed. The coefficient for cce has now changed signs and is statistically significant at the 1% level. Year fixed effects are added in column (4), making the coefficient slightly larger and still strongly significant. The model predicts a 2,41 percent decrease in the real GDP per capita growth rate, if the corruption index increases by 1 point. This gives support for the hypothesis that corruption is detrimental to economic growth. Trade and growth in capital still have positive and significant coefficients, while inflation and FDI both have negative and significant coefficients. Growth in capital per capita have large and strongly significant coefficients. The lagged GDP per capita has a negative coefficient, significant at the 1% level. One must note that most of the variation in this variable is over countries, and not time. The result therefore gives support to the notion that countries with large initial GDP per capita (rich countries) have lower growth rates, thus giving support for the convergence hypothesis.

Table 4 shows the same model, equation (15) with growth in TFP as the dependent variable and the associated control variables. In Table 4, the cce coefficient has a small but positive effect on TFP, significant at the 5% level. The adjusted R-squared is low, at 0,002. Adding the control variables in column (2), does not change the value, but it loses its statistical significance. FDI, trade and democracy are all significant, with trade having a positive value, and the other two having a negative one. Column (3) uses the fixed effects transformation and column (4) adds year fixed effects. The cce coefficient changes its sign and is significant at the 1% level. From the model, a one-point increase in the corruption index predicts a decrease in the growth rate in TFP by 2,21%. In light of the discussion in section 3.2.1, the results suggest that corruption, on average, has a detrimental effect on the creation of technology. Trade has a positive effect on TFP growth. It is only significant at the 10% level, but it gives some support that more openness to trade seems to increase the growth rate in TFP. The lagged TFP variable is negative and significant, indicating that a larger stock of knowledge does not increase the growth rate.

**Table 4:** Growth in TFP

| | (1)<br>TFP growth | (2)<br>TFP growth | (3)<br>TFP growth | (4)<br>TFP growth |
|---|---|---|---|---|
| cce | 0.00203** | 0.00241* | -0.0218*** | -0.0221*** |
| | (0.000817) | (0.00140) | (0.00738) | (0.00732) |
| FDI | | -0.00926*** | -0.00369 | -0.00472 |
| | | (0.00341) | (0.00382) | (0.00368) |
| Trade | | 0.00634*** | 0.0287** | 0.0247* |
| | | (0.00214) | (0.0126) | (0.0127) |
| HC | | 0.00646* | -0.00154 | -0.00276 |
| | | (0.00340) | (0.00854) | (0.0130) |
| Democracy | | 0.00958* | 0.0196 | 0.0194 |
| | | (0.00494) | (0.0129) | (0.0129) |
| $LnTFP_{t-1}$ | | -0.0117*** | -0.0762*** | -0.0723*** |
| | | (0.00306) | (0.0131) | (0.0131) |
| _cons | 0.00658*** | 0.0570*** | 0.543*** | 0.521*** |
| | (0.00221) | (0.0202) | (0.0826) | (0.0909) |
| *N* | 2873 | 2269 | 2269 | 2269 |
| adj. $R^2$ | 0.002 | 0.049 | 0.089 | 0.135 |

Cluster robust standard errors in parentheses. Fixed effects OLS results are reported in column (3) and (4). Year fixed effects are included in column (4).
* p<0.10, ** p<0.05, *** p<0.010

Again, a large source for technological progress for developing countries, could stem from trade and import of technology from developed countries. Rich countries, on the other hand, have to develop new technology through long and costly R&D efforts. They possibly already have possession of the latest and most advanced technologies, and when new technology is produced, the old technology is no longer as important. Poor countries with inferior technologies could then import the old technologies from rich countries, and subsequently experience a higher growth rate in TFP.

Next, the sample is split into three groups. These are 1) the 33% most corrupt countries, 2) the 33% least corrupt countries and 3) the countries in the middle. Equation (15) is then run for both growth in real GDP per capita and TFP, for all three samples. The results are displayed in Table 5.

**Table 5**: Grouped by cce percentiles

| | (1)<br>Most corrupt<br>GDPPC growth | (2)<br>Middle corrupt<br>GDPPC growth | (3)<br>Least corrupt<br>GDPPC growth | (4)<br>Most corrupt<br>TFP growth | (5)<br>Middle corrupt<br>TFP growth | (6)<br>Least corrupt<br>TFP growth |
|---|---|---|---|---|---|---|
| cce | -0.0515*** | -0.0193* | -0.00594 | -0.0424** | -0.0149 | -0.00856 |
| | (0.0154) | (0.00975) | (0.00807) | (0.0182) | (0.0101) | (0.00725) |
| Inflation | -0.000481 | -0.000134 | -0.00133** | | | |
| | (0.000342) | (0.000422) | (0.000625) | | | |
| Trade | 0.0400** | 0.0325** | 0.0228** | 0.0229 | 0.0329** | 0.0122 |
| | (0.0160) | (0.0150) | (0.00947) | (0.0221) | (0.0157) | (0.0102) |
| FDI | -0.103 | -0.115* | -0.00507 | -0.0373 | -0.0821 | -0.00208 |
| | (0.0662) | (0.0642) | (0.00495) | (0.0745) | (0.0523) | (0.00466) |
| Democracy | 0.0226 | -0.000694 | 0.000337 | 0.0263 | -0.000610 | 0.00318 |
| | (0.0145) | (0.00933) | (0.0200) | (0.0173) | (0.00989) | (0.0226) |
| HC | -0.0230 | -0.00196 | -0.0159 | -0.00578 | 0.0000704 | -0.0117 |
| | (0.0405) | (0.0223) | (0.0147) | (0.0403) | (0.0199) | (0.0156) |
| K/L growth | 0.676*** | 0.581*** | 0.630*** | | | |
| | (0.0735) | (0.0710) | (0.0926) | | | |
| Pop growth | 1.241 | -0.173 | -0.0185 | | | |
| | (0.982) | (0.247) | (0.352) | | | |
| $LnGDPPC_{t-1}$ | -0.128*** | -0.0575*** | -0.0708*** | | | |
| | (0.0270) | (0.0150) | (0.0177) | | | |
| $LnTFP_{t-1}$ | | | | -0.113*** | -0.0727*** | -0.0803*** |
| | | | | (0.0295) | (0.0179) | (0.0177) |
| _cons | 1.351*** | 0.620*** | 0.831*** | 0.813*** | 0.511*** | 0.633*** |
| | (0.270) | (0.167) | (0.196) | (0.186) | (0.134) | (0.133) |
| *N* | 695 | 742 | 729 | 752 | 783 | 734 |
| adj. $R^2$ | 0.353 | 0.402 | 0.468 | 0.104 | 0.225 | 0.291 |

Cluster robust standard errors in parentheses. All regressions apply fixed effects transformation and includes year fixed effects. Column (1) and (4) use the sample of the 33% most corrupt countries. Column (3) and (6) use the sample of the 33% least corrupt countries. Column (2) and (5) uses the sample of countries between the 33% and 66% percentiles.
* p<0.10, ** p<0.05, *** p<0.010

Column (1) to (3) display the regression results where growth in GDP per capita is the dependent variable. Growth in TFP is used as the dependent variable in column (4) to (6). For the most corrupt countries, in column (1), the results show a large significant negative effect of corruption on growth in GDP per capita. A one-point increase in the corruption index is predicted by the model to reduce the growth rate in GDP per capita by 5,15%. In column (2), which uses the sample of countries ranging in the middle of the cce ranking, the cce coefficient is still significant, but with a lower absolute value. In column (3), the effect is no longer significant. The results suggest that the effect of corruption is higher for the most corrupt countries, and that this effect is reduced as the level of corruption in a country becomes smaller. Trade is seen to have a positive and significant coefficient for all three samples, while inflation only has a small, but negative effect for the least corrupt countries. For the model using growth in TFP as the dependent variable, the cce coefficient is large and significant for the most corrupt countries as well. The coefficient gets smaller in column (5) and is no longer significant. In column (6) it becomes even smaller and not significant. Corruption seems to have a larger effect on growth in TFP for the more corrupt countries. Trade has a positive coefficient in the sample containing the countries in the middle of the cce ranking. The estimate is significant at the 5% level. As for the lagged variables, all exhibit significant negative coefficients. Again, this gives support for the convergence hypothesis and not for the prediction of higher technological growth in richer countries from the Romer model.

In Table 6 on the next page, the same exercise as in Table 5 is done, but this time the sample is separated by real capita GDP per capita ranks instead. For the regressions using growth in GDP per capita as the dependent variable, cce is seen to have a large negative coefficient for the low-income countries, significant at the 1% level. In the middle-income countries, the coefficient is still negative and significant, but smaller. For the high-income countries, the effect is no longer significant. Inflation has negative and significant coefficients in column (2) and (3), while trade is seen to have positive and significant estimates for the low- and high-income countries. Interestingly, FDI has a negative coefficient for the low-income countries and a large positive one for the middle-income countries. Democracy has a positive coefficient for the low-income countries, albeit it is only significant at the 10% level. Growth in capital per capita has a significant positive coefficient for all. In the regressions using growth in TFP as the dependent variable, the cce estimate has a large negative coefficient for the low-income countries, significant at the 5% level. For the middle-income countries, the absolute value of the cce coefficient is reduced. The estimate is significant at the 1% level. For the high-income countries, the estimate is no longer significant. Trade is seen to have a positive coefficient for the high-income countries, significant at the 10% level. FDI has a large positive coefficient for the middle-income countries. The lagged variables all have negative and significant coefficients, except for the coefficient in column (3). The results indicate that corruption has a larger effect on poor countries, and that it is reduced as the income level improves.

**Table 6**: Grouped by real GDP per capita percentiles

| | (1)<br>Low income<br>GDPPC growth | (2)<br>Middle income<br>GDPPC growth | (3)<br>High income<br>GDPPC growth | (4)<br>Low income<br>TFP growth | (5)<br>Middle income<br>TFP growth | (6)<br>High income<br>TFP growth |
|---|---|---|---|---|---|---|
| cce | -0.0390*** | -0.0249** | -0.00902 | -0.0326** | -0.0252*** | -0.00977 |
| | (0.0127) | (0.00941) | (0.0100) | (0.0153) | (0.00939) | (0.00965) |
| Inflation | -0.0000237 | -0.00139*** | -0.00147** | | | |
| | (0.000238) | (0.000288) | (0.000728) | | | |
| Trade | 0.0507*** | 0.0145 | 0.0226** | 0.0377 | -0.000571 | 0.0185* |
| | (0.0166) | (0.0143) | (0.00885) | (0.0246) | (0.0142) | (0.0102) |
| FDI | -0.0899* | 0.140** | -0.00453 | -0.0410 | 0.147** | -0.00196 |
| | (0.0500) | (0.0633) | (0.00487) | (0.0509) | (0.0579) | (0.00476) |
| Democracy | 0.0252* | 0.00203 | -0.0146 | 0.0303 | -0.00269 | -0.000237 |
| | (0.0138) | (0.00528) | (0.0141) | (0.0189) | (0.00728) | (0.0136) |
| HC | -0.0117 | -0.00210 | -0.0149 | 0.00287 | 0.00663 | -0.00789 |
| | (0.0410) | (0.0194) | (0.0130) | (0.0406) | (0.0193) | (0.0132) |
| K/L growth | 0.616*** | 0.695*** | 0.509*** | | | |
| | (0.0613) | (0.0703) | (0.104) | | | |
| Pop growth | 1.865 | 0.153 | -0.112 | | | |
| | (1.715) | (0.345) | (0.357) | | | |
| $LnGDPPC_{t-1}$ | -0.0951*** | -0.0913*** | -0.0351 | | | |
| | (0.0255) | (0.0197) | (0.0240) | | | |
| $LnTFP_{t-1}$ | | | | -0.0757*** | -0.147*** | -0.0522** |
| | | | | (0.0242) | (0.0246) | (0.0198) |
| _cons | 0.896*** | 1.017*** | 0.459* | 0.501*** | 1.064*** | 0.423** |
| | (0.231) | (0.216) | (0.264) | (0.140) | (0.186) | (0.161) |
| *N* | 736 | 667 | 763 | 789 | 691 | 789 |
| adj. $R^2$ | 0.322 | 0.511 | 0.402 | 0.096 | 0.300 | 0.284 |

Cluster robust standard errors in parentheses. All regressions apply fixed effects transformation and includes year fixed effects. Column (1) and (4) use the sample of the 33% poorest countries. Column (3) and (6) use the sample of the 33% richest countries. Column (2) and (5) use the sample of countries between the 33% and 66% percentiles.
* p<0.10, ** p<0.05, *** p<0.010

In Table 7, the sample has separated again, this time by the different continents. Growth in real GDP per capita is the dependent variable. Oceania has not been included, due to an insufficient number of observations. Canada, Israel, Australia, New Zealand and the US have been included in the sample of European countries, as they are perceived as more connected and similar to the European countries.

**Table 7**: Grouped by continents (Growth in real GDP per capita)

| | (1)<br>All countries<br>GDPPC growth | (2)<br>Asia<br>GDPPC growth | (3)<br>South America<br>GDPPC growth | (4)<br>Latin America<br>GDPPC growth | (5)<br>Europe<br>GDPPC growth | (6)<br>Africa<br>GDPPC growth |
|---|---|---|---|---|---|---|
| cce | -0.0241*** | -0.0268** | -0.00598 | 0.00837 | -0.0112 | -0.0370** |
| | (0.00754) | (0.0111) | (0.00663) | (0.00977) | (0.00790) | (0.0159) |
| Inflation | -0.000497** | -0.000115 | -0.000785* | -0.00125*** | -0.00158*** | -0.000230 |
| | (0.000234) | (0.000459) | (0.000395) | (0.000193) | (0.000371) | (0.000212) |
| Trade | 0.0362*** | 0.00891 | 0.00150 | 0.0122 | 0.0287** | 0.0511*** |
| | (0.0120) | (0.00957) | (0.0246) | (0.0107) | (0.0108) | (0.0186) |
| FDI | -0.00731* | 0.238*** | 0.107** | -0.0127 | -0.00441 | -0.126** |
| | (0.00370) | (0.0634) | (0.0395) | (0.0180) | (0.00525) | (0.0590) |
| Democracy | 0.0188 | -0.00487 | -0.0271 | 0.0276** | 0.0537* | 0.0235 |
| | (0.0119) | (0.0116) | (0.0229) | (0.0100) | (0.0315) | (0.0184) |
| HC | -0.00788 | -0.0234* | -0.000956 | 0.0143 | -0.0388* | -0.0210 |
| | (0.0134) | (0.0120) | (0.0447) | (0.0272) | (0.0214) | (0.0429) |
| K/L growth | 0.612*** | 0.697*** | 0.963*** | 0.773*** | 0.488*** | 0.660*** |
| | (0.0469) | (0.0847) | (0.205) | (0.0684) | (0.107) | (0.0689) |
| Pop growth | -0.0192 | -0.173 | 1.417 | -1.499 | -0.516 | 2.323 |
| | (0.257) | (0.255) | (1.015) | (1.478) | (0.546) | (1.930) |
| $LnGDPPC_{t-1}$ | -0.0684*** | -0.0167 | -0.0884 | -0.139*** | -0.104*** | -0.101*** |
| | (0.0133) | (0.0181) | (0.0719) | (0.0259) | (0.0133) | (0.0265) |
| _cons | 0.739*** | 0.311 | 0.917 | 1.321*** | 1.228*** | 0.971*** |
| | (0.136) | (0.204) | (0.824) | (0.218) | (0.154) | (0.255) |
| *N* | 2166 | 514 | 142 | 187 | 692 | 615 |
| adj. $R^2$ | 0.341 | 0.431 | 0.607 | 0.654 | 0.473 | 0.338 |

Cluster robust standard errors in parentheses. All regressions apply fixed effects transformation and includes year fixed effects. The columns are marked for which continent the sample contains.
* p<0.10, ** p<0.05, *** p<0.010

The cce coefficient for the Asian sample in column (2) is negative and somewhat larger in absolute value than the cce coefficient for the whole sample, and is significant at the 5% level. For Africa, in column (6), the cce coefficient is large and negative, and significant at the 5% level as well. For the other continents, the coefficient is not significant. Corruption therefore seems to have a greater impact in Asia and Africa. Also, for the other continents, inflation has a small, but significant negative coefficient. Further, trade is seen to have a significant positive effect in Africa, whilst FDI has a significant negative effect. FDI has positive coefficients in the South-American and Asian sample. Growth in capital per capita is positive and significant for all. The lagged GDP per capita term is negative for all samples, but only significant for Latin America, Europe and Africa.

**Table 8**: Grouped by continents (Growth in TFP)

| | (1)<br>All countries<br>TFP growth | (2)<br>Asia<br>TFP growth | (3)<br>South America<br>TFP growth | (4)<br>Latin America<br>TFP growth | (5)<br>Europe<br>TFP growth | (6)<br>Africa<br>TFP growth |
|---|---|---|---|---|---|---|
| cce | -0.0221*** | -0.0142 | -0.0205 | 0.00572 | -0.0107 | -0.0435** |
| | (0.00732) | (0.0112) | (0.0204) | (0.00916) | (0.00657) | (0.0203) |
| FDI | -0.00472 | 0.251*** | 0.160*** | -0.0231 | -0.00295 | -0.0680 |
| | (0.00368) | (0.0483) | (0.0236) | (0.0275) | (0.00546) | (0.0570) |
| Trade | 0.0247* | 0.00817 | 0.0276 | 0.00833 | 0.0184 | 0.0443* |
| | (0.0127) | (0.0124) | (0.0382) | (0.0166) | (0.0129) | (0.0246) |
| HC | -0.00276 | -0.0152 | -0.0279 | 0.00918 | -0.0168 | 0.00752 |
| | (0.0130) | (0.0141) | (0.0206) | (0.0382) | (0.0215) | (0.0362) |
| Democracy | 0.0194 | -0.00900 | -0.128** | 0.0349*** | 0.0446 | 0.0346 |
| | (0.0129) | (0.0142) | (0.0496) | (0.00736) | (0.0272) | (0.0227) |
| $LnTFP_{t-1}$ | -0.0723*** | -0.0350* | -0.134 | -0.0764* | -0.135*** | -0.0894*** |
| | (0.0131) | (0.0184) | (0.0812) | (0.0386) | (0.0150) | (0.0249) |
| _cons | 0.521*** | 0.332** | 1.102 | 0.426** | 1.003*** | 0.610*** |
| | (0.0909) | (0.150) | (0.613) | (0.190) | (0.119) | (0.174) |
| *N* | 2269 | 544 | 165 | 204 | 692 | 648 |
| adj. $R^2$ | 0.135 | 0.140 | 0.314 | 0.264 | 0.438 | 0.112 |

Cluster robust standard errors in parentheses. All regressions apply fixed effects transformation and includes year fixed effects. The columns are marked for which continent the sample contains.
* p<0.10, ** p<0.05, *** p<0.010

Table 8 does the same exercise as in Table 7, but with growth in TFP as the dependent variable. Interestingly, the only significant coefficient for cce is in column (6), which contains the African sample. The results therefore suggest that corruption has a stronger effect on growth in TFP in this continent. FDI has large positive coefficients in column (2) and (3), significant at the 1% level, suggesting that FDI has a positive impact on TFP growth in Asia and South America. The lagged TFP variable has a negative coefficient for all samples. They are significant for all except South-America.

**Table 9**: Sub-Saharan Africa versus Southeast Asia versus Latin America

| | (1)<br>GDPPC growth | (2)<br>GDPPC growth | (3)<br>TFP growth | (4)<br>TFP growth |
|---|---|---|---|---|
| cce | -0.0241*** | -0.0224*** | -0.0221*** | -0.0206*** |
| | (0.00754) | (0.00848) | (0.00732) | (0.00769) |
| Inflation | -0.000497** | -0.000506** | | |
| | (0.000234) | (0.000236) | | |
| Trade | 0.0362*** | 0.0370*** | 0.0247* | 0.0264** |
| | (0.0120) | (0.0126) | (0.0127) | (0.0130) |
| FDI | -0.00731* | -0.00702* | -0.00472 | -0.00437 |
| | (0.00370) | (0.00367) | (0.00368) | (0.00364) |
| Democracy | 0.0188 | 0.0200 | 0.0194 | 0.0215* |
| | (0.0119) | (0.0121) | (0.0129) | (0.0123) |
| HC | -0.00788 | -0.00942 | -0.00276 | -0.00564 |
| | (0.0134) | (0.0134) | (0.0130) | (0.0131) |
| K/L growth | 0.612*** | 0.604*** | | |
| | (0.0469) | (0.0478) | | |
| Pop growth | -0.0192 | -0.0294 | | |
| | (0.257) | (0.257) | | |
| $LnGDPPC_{t-1}$ | -0.0684*** | -0.0684*** | | |
| | (0.0133) | (0.0132) | | |
| DSEA*cce | | 0.0129 | | 0.0334* |
| | | (0.0152) | | (0.0189) |
| DSSA*cce | | -0.0133 | | -0.0212 |
| | | (0.0193) | | (0.0200) |
| DLA*cce | | 0.0160 | | 0.0190 |
| | | (0.0135) | | (0.0120) |
| $LnTFP_{t-1}$ | | | -0.0723*** | -0.0749*** |
| | | | (0.0131) | (0.0128) |
| _cons | 0.739*** | 0.741*** | 0.521*** | 0.544*** |
| | (0.136) | (0.135) | (0.0909) | (0.0881) |
| *N* | 2166 | 2166 | 2269 | 2269 |
| adj. $R^2$ | 0.341 | 0.342 | 0.135 | 0.140 |

Cluster robust standard errors in parentheses. All regressions apply fixed effects transformation and includes year fixed effects. Interaction terms with dummy variables are included. These are Southeast Asia (SEA), Sub-Saharan Africa (SSA) and Latin America (LA).
* p<0.10, ** p<0.05, *** p<0.010

In Table 9, equation (16) is estimated with dummy variables for Sub-Saharan Africa, Southeast Asia and Latin America, in order to explore if the effect of corruption is different in these sub-continents. The first two columns display the model for growth in GDP per capita and the two last columns display the model for growth in TFP. Column (1) and (3) show the regression without the dummy variables, for easier comparison. Most of the coefficients for the interaction terms are insignificant. In column (4), the interaction term for Southeast Asia, is both positive and significant at the 10% level, making the marginal effect of corruption positive. This gives some evidence for a "greasing the wheel" effect of corruption on growth in TFP. Evidence for "sanding the wheel" hypothesis in Sub-Saharan Africa is not found. Further, all the lagged variables have negative coefficients, significant at the 1% level.

Next, Table 10 and 11 display the regressions results for equation (18), where the WGI indicators are included together with their interaction terms with the cce coefficient. Table 10 shows the results for the growth in GDP per capita model, whilst Table 11 shows the results for the growth in TFP model.

In Table 10, all the WGI and cce interaction terms are positive, indicating that higher level of institutional quality mitigates the effect of corruption on growth in GDP per capita. However, only some are statistically significant. These are *voice and accountability* (vae), *government effectiveness* (gee) and *rule of law* (rle). When these indicators are high, close to 5, the marginal effect of corruption, as defined in equation (19), is close to zero. However, at low levels, close to 0, the model predicts a substantially larger and negative effect of corruption on growth in GDP per capita. The lagged GDP per capita term is negative and significant at the 1% level in all the columns.

**Table 10**: WGI (Growth in real GDP per capita)

| | (1)<br>GDP growth | (2)<br>GDP growth | (3)<br>GDP growth | (4)<br>GDP growth | (5)<br>GDP growth | (6)<br>GDP growth |
|---|---|---|---|---|---|---|
| cce | -0.0241*** | -0.0418*** | -0.0332** | -0.0464*** | -0.0369** | -0.0506*** |
| | (0.00754) | (0.0146) | (0.0142) | (0.0149) | (0.0157) | (0.0171) |
| Inflation | -0.000497** | -0.000465* | -0.000413* | -0.000436* | -0.000405* | -0.000463* |
| | (0.000234) | (0.000239) | (0.000218) | (0.000239) | (0.000238) | (0.000237) |
| Trade | 0.0362*** | 0.0354*** | 0.0384*** | 0.0364*** | 0.0363*** | 0.0364*** |
| | (0.0120) | (0.0121) | (0.0122) | (0.0121) | (0.0125) | (0.0124) |
| FDI | -0.00731* | -0.00650* | -0.00665* | -0.00618 | -0.00654* | -0.00515 |
| | (0.00370) | (0.00371) | (0.00367) | (0.00374) | (0.00369) | (0.00368) |
| Democracy | 0.0188 | 0.0116 | 0.0157 | 0.0180 | 0.0170 | 0.0161 |
| | (0.0119) | (0.00966) | (0.0101) | (0.0116) | (0.0108) | (0.0103) |
| HC | -0.00788 | -0.00818 | -0.00613 | -0.00692 | -0.00594 | -0.00471 |
| | (0.0134) | (0.0134) | (0.0136) | (0.0132) | (0.0135) | (0.0137) |
| K/L growth | 0.612*** | 0.617*** | 0.610*** | 0.613*** | 0.614*** | 0.614*** |
| | (0.0469) | (0.0470) | (0.0466) | (0.0465) | (0.0471) | (0.0465) |
| Pop growth | -0.0192 | -0.00241 | -0.0301 | -0.0190 | 0.0156 | -0.0189 |
| | (0.257) | (0.249) | (0.264) | (0.264) | (0.259) | (0.265) |
| $LnGDPPC_{t-1}$ | -0.0684*** | -0.0712*** | -0.0698*** | -0.0721*** | -0.0771*** | -0.0710*** |
| | (0.0133) | (0.0145) | (0.0135) | (0.0145) | (0.0154) | (0.0148) |
| vae | | -0.0180 | | | | |
| | | (0.0120) | | | | |
| vae*cce | | 0.00832* | | | | |
| | | (0.00452) | | | | |
| pve | | | -0.00517 | | | |
| | | | (0.0105) | | | |
| pve*cce | | | 0.00489 | | | |
| | | | (0.00398) | | | |
| gee | | | | -0.0195** | | |
| | | | | (0.00969) | | |
| gee*cce | | | | 0.00943** | | |
| | | | | (0.00410) | | |
| rqe | | | | | -0.00451 | |
| | | | | | (0.0108) | |
| rqe*cce | | | | | 0.00692 | |
| | | | | | (0.00455) | |
| rle | | | | | | -0.0295** |
| | | | | | | (0.0125) |
| rle*cce | | | | | | 0.0100* |
| | | | | | | (0.00544) |
| _cons | 0.739*** | 0.817*** | 0.758*** | 0.828*** | 0.826*** | 0.846*** |
| | (0.136) | (0.150) | (0.145) | (0.148) | (0.160) | (0.158) |
| *N* | 2166 | 2166 | 2166 | 2166 | 2166 | 2166 |
| adj. $R^2$ | 0.341 | 0.344 | 0.348 | 0.345 | 0.346 | 0.345 |

Cluster robust standard errors in parenthesis. All regressions apply fixed effect transformation and includes year fixed effects. Interaction terms with the WGI indicators are included.
* p<0.10, ** p<0.05, *** p<0.010

**Table 11**: WGI (Growth in TFP)

| | (1) TFP growth | (2) TFP growth | (3) TFP growth | (4) TFP growth | (5) TFP growth | (6) TFP growth |
|---|---|---|---|---|---|---|
| cce | -0.0221*** | -0.0291 | -0.0357** | -0.0398** | -0.0246 | -0.0405** |
| | (0.00732) | (0.0185) | (0.0145) | (0.0179) | (0.0199) | (0.0204) |
| FDI | -0.00472 | -0.00413 | -0.00387 | -0.00380 | -0.00419 | -0.00355 |
| | (0.00368) | (0.00379) | (0.00366) | (0.00380) | (0.00365) | (0.00379) |
| Trade | 0.0247* | 0.0247* | 0.0270** | 0.0249* | 0.0248* | 0.0252* |
| | (0.0127) | (0.0126) | (0.0129) | (0.0128) | (0.0130) | (0.0130) |
| HC | -0.00276 | -0.00261 | -0.00124 | -0.00174 | -0.00125 | -0.000574 |
| | (0.0130) | (0.0130) | (0.0133) | (0.0128) | (0.0131) | (0.0132) |
| Democracy | 0.0194 | 0.00944 | 0.0157 | 0.0186 | 0.0187 | 0.0165 |
| | (0.0129) | (0.00961) | (0.0113) | (0.0127) | (0.0120) | (0.0113) |
| $LnTFP_{t-1}$ | -0.0723*** | -0.0756*** | -0.0750*** | -0.0754*** | -0.0792*** | -0.0763*** |
| | (0.0131) | (0.0138) | (0.0135) | (0.0137) | (0.0141) | (0.0144) |
| vae | | -0.00203 | | | | |
| | | (0.0163) | | | | |
| vae*cce | | 0.00457 | | | | |
| | | (0.00602) | | | | |
| pve | | | -0.0104 | | | |
| | | | (0.0108) | | | |
| pve*cce | | | 0.00686* | | | |
| | | | (0.00403) | | | |
| gee | | | | -0.0169 | | |
| | | | | (0.0120) | | |
| gee*cce | | | | 0.00734 | | |
| | | | | (0.00539) | | |
| rqe | | | | | 0.00565 | |
| | | | | | (0.0145) | |
| rqe*cce | | | | | 0.00343 | |
| | | | | | (0.00616) | |
| rle | | | | | | -0.0167 |
| | | | | | | (0.0162) |
| rle*cce | | | | | | 0.00846 |
| | | | | | | (0.00646) |
| _cons | 0.521*** | 0.547*** | 0.559*** | 0.587*** | 0.535*** | 0.587*** |
| | (0.0909) | (0.0993) | (0.0943) | (0.0935) | (0.101) | (0.100) |
| *N* | 2269 | 2269 | 2269 | 2269 | 2269 | 2269 |
| adj. $R^2$ | 0.135 | 0.137 | 0.143 | 0.137 | 0.139 | 0.138 |

Cluster robust standard errors in parenthesis. All regressions apply fixed effect transformation and includes year fixed effects. Interaction terms with the WGI indicators are included.
* p<0.10, ** p<0.05, *** p<0.010

In Table 11, all the interaction terms have positive coefficients. However, only *political stability and absence of violence/terrorism* (pve) is statistically significant, at the 10% level. This suggests that more political stability positively influences the relationship between corruption and growth in TFP. The results do not seem to give much evidence for a mitigating effect of institutional quality on the effect of corruption on TFP growth. In all the columns, lagged TFP has a significant negative coefficient. This further indicates that the hypothesis of faster technological growth in rich countries is not true.

In general, the results show that corruption in general has a negative effect on both growth in real GDP per capita and growth in TFP. The effect seems to be larger for more corrupt countries, as well as low-income countries. For the least corrupt countries, as well as the high-income countries, the effect is not statistically significant. One must note that many of the same countries are present in both groups, i.e., some countries are both in the sample of the least corrupt countries and the sample of high-income countries. For the different regions of the world, the evidence suggests that the effect of corruption on growth in real GDP per capita and TFP is substantially larger in Africa. In the Southeast Asian countries, the results give support for a “greasing the wheel” effect of corruption on growth in TFP. Throughout the regressions, the lagged logarithm of real GDP per capita and the lagged logarithm of TFP, both exhibit significant negative coefficients. The results therefore give support to the convergence hypothesis. For Romer’s prediction of higher technological growth for rich countries with already high levels of TFP, this paper gives no evidence. In fact, the results point to the contrary, that lower levels of technology yield a higher growth rate in TFP. Again, this result can be attributed to the fact that poorer countries obtain much technology from trade, while rich countries have to develop new technology through the long process of research and development. For the WGI indicators, the results indicate that better governance and institutional quality reduces the effect of corruption on both growth in real GDP per capita and growth in TFP, although the evidence is not overwhelming. To test the robustness of the estimates for the main hypotheses, the regressions were run several times, where the different control variables were added/dropped. The corruption coefficient did not change much in this exercise. This indicates that the results are robust.

# 6 Conclusion

This paper has tried to explore the different causes as to why divergences in economic growth between countries occur. Several different theories have been developed in order to give an explanation. The Solow model explained growth through capital accumulation. Due to the diminishing marginal productivity of capital, poor countries should have higher growth than rich countries, thereby predicting a convergence in growth rates between rich and poor countries (Solow, 1956). The Romer model incorporated technological change into the model and hypothesized that growth in the long run would stem from the production of new technology. According to this model, rich countries would experience a higher growth in TFP. By employing a growth accounting exercise, a framework for empirical analysis was derived, expressed in equation (9). According to this formulation, economic growth could only originate from growth in the capital-output ratio, human capital or TFP.

From the discussion in section 3, it emerged that institutions are thought to have an important function in economic development and growth. A lowering of corruption is thought to have an important role as it can affect the institutional quality within a country. The "greasing the wheel" hypothesis states that corruption has a positive effect on growth by speeding up troublesome bureaucratic processes. In opposition stands the "sanding the wheel" hypothesis which states that corruption makes the investment and innovation climate more uncertain, reducing economic growth.

By using a cross-country panel dataset consisting of 170 countries over a time period of 17 years, from 2002 to 2019, this paper has tried to explore what effect corruption and institutional quality have on economic growth. The paper has also tried to discover whether the effect differs between rich and poor countries, and if the "greasing the wheel" hypothesis is true for the Southeast Asian countries and "sanding the wheel" is true for the Sub-Saharan countries. Further, the convergence hypothesis from the Solow model and Romer's prediction of faster technological growth for rich countries have been tested. To explore this, two estimation models were constructed, one for growth in real GDP per capita, based on equation (9), and one for growth in TFP. To control for unobserved heterogeneity, fixed effects estimation was applied. The control of corruption (cce) index from the WGI dataset was used as a proxy for corruption, in order to capture the effects of corruption on growth in real GDP per capita and growth in

TFP. To test the convergence hypothesis, the lagged logarithm of real GDP per capita was added in the model for growth in real GDP per capita. To capture the hypothesis of faster technological growth in rich countries, the lagged logarithm of TFP was added in the TFP growth model. The inclusion of lagged dependent variables could lead to the problem of *inconsistent* estimates when applying fixed effects estimation. However, the same regressions were also performed without the lagged dependent variables, and yielded virtually the same results. The inclusion of the lagged variables is therefore not perceived as a major issue.

The results suggest that corruption has a negative/detrimental effect on growth in real GDP per capita and TFP in general. This effect is larger for low income and highly corrupt countries, according to the results in this study. The effect becomes smaller for middle income countries, as well as for countries with cce scores ranging in the middle of the cce ranking. For the high income and least corrupt countries, the results show that corruption does not have a significant impact. For the 15 richest and 15 least corrupt countries, the evidence even points towards a small positive effect of corruption on both growth in real GDP per capita and TFP. Continent-wise, the effect of corruption seems to be larger in Africa than other continents. This is true for both growth in GDP per capita and growth in TFP. Further, the results give some support for a “greasing the wheel” effect in Southeast Asia for growth in TFP, albeit the estimate is only significant at the 10% level. The interaction terms with the WGI indicators also exhibits positive coefficients. This indicates that improved institutional quality mitigates the effect of corruption. As for the convergence hypothesis *a la* Solow and Romer’s prediction of higher technological growth for rich countries, the results, in line with the literature, lend support to the convergence hypothesis, but largely rejects the Romer prediction.

To summarize, the results suggest that corruption in general has a detrimental effect on growth. This effect is seen to be larger for poor and corrupt countries. For the Southeast Asian countries, the evidence in this paper points towards a “greasing the wheel” effect for growth in TFP. The study gives support to the convergence hypothesis. It did not find evidence of the note that rich countries should experience higher growth in technology/TFP. In fact, evidence was found to the contrary. The results are robust as the coefficients retain their signs, albeit the absolute values change for different specifications of the models.

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