The effect of corruption on growth and investments

Exploring the direct and indirect effects of corruption on growth via three different investment channels in low income countries

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Authors: Nora Aobadia Sandström & Rebecca Lägerud

Supervisor: Pontus Hansson

Department of Economics, Lund University School of Economics and Management

Abstract

This thesis investigates both the direct effect and indirect effect of corruption on growth via three different investment transmission channels. According to growth theory, different types of investment are commonly considered as important contributors to economic growth. Therefore, this study aims to examine the indirect effect of corruption on growth via following investment transmission channels: domestic investment, foreign direct investment (FDI) and human capital investment. Since poor countries are both in general more exposed to corruption and in need of investments, the direct and indirect effect of corruption on growth are tested in low and low-to-middle income countries, during a time period of 1996-2011. The direct and indirect effect of corruption is tested through conducting four different multiple regression analysis with panel data. Thereafter this thesis aims to put together these effects to determine the total effect of corruption on growth. However, the latter was not conducted since our result shows no strong significant effect of corruption on growth, neither direct or indirect. Although a weak significant negative of corruption on human capital investment is indicated. Our result is not in line with previous research, which might be explained by the properties of our country sample, the econometric method and a possible need of interaction variables. However, corruption should still be considered distortive for countries and societies and a greater understanding of the significance of transmission channels and interaction between corruption and other variables is needed.

Key words: Corruption, Economic growth, Transmission channels, Investment, FDI, Human capital, Low and low-to-middle income countries

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1. Introduction

During the last decades, a growing interest for the importance of social, economic and political institutional factors for economic growth have evolved. Following this, the effect of corruption on growth has become a popular research subject. Corruption is today considered a major obstacle for global development as it distorts countries and societies in various ways and creates political, economic, social and environmental costs (Transparency International, n.d.). The costs of corruption are approximated to 5% of global GDP yearly (OECD, 2014). The World Bank identified corruption as *"the single greatest obstacle to economic and social development. It undermines development by distorting the rule of law and weakening the institutional foundation on which economic growth depends."* In 1996, the erstwhile President of the World Bank, James D. Wolfensohn, even compared corruption to cancer (Bhargava, 2006).

Throughout the years, a lot of research on the impact of corruption on economic growth have been published. The majority of previous researches indicates that there is a significant negative relationship between corruption and economic growth. However, some argues that the direct effect of corruption on economic growth becomes insignificant once some common determinants of economic growth are controlled for. This implies that the impact of corruption is transferred indirectly via its effect on the determinants of economic growth, which functions as transmission channels. Human capital and domestic investments are both crucial determinants of economic growth and commonly considered as critical transmission channels for the effect of corruption on growth.

Poor countries are of particular interest since they are more vulnerable to corruption according to the World Bank. Corruption reduces access to health, education and judicial public service, where these services already are of low availability in poor countries. Additionally, the poorest population in the world seem to pay the highest percentage of their income in bribes (World Bank, 2018a). Since poor countries are more exposed to corruption and often are in big need of important investments for exhilarating growth, these countries are the focus of this thesis. In addition, as the world get more globalized, the inflow of FDI has increased the last decades and has been especially essential in developing countries (Agosin & Mayer, 2000).

This thesis is therefore based on the interest of examining the effect of corruption on growth and domestic investment, FDI and human capital investment as transmission channels in low and low-to-middle income countries. We aim to examine this effect in order to create a greater understanding of how right policies against corruption and relevant investment decisions can help poor countries to exhibit higher growth.

1.1 Purpose

The purpose of this study is to examine the effect of corruption on different types of investments and economic growth in low and low to middle-income countries. This thesis investigates both the direct effect of corruption on economic growth and the indirect effect of corruption on growth via three types of investments. The three types of investment examined in this thesis are domestic investment, foreign direct investment (FDI) and investment in human capital. Different types of investment are often considered important determinants of growth, where this thesis wish to capture if corruption affect different investments and thereby affect the economic growth in countries with low and low to middle income level. This is examined with panel data regression analysis, covering 46 countries during time period 1996-2011.

The main questions of this thesis follow:

- Is there any direct effect of corruption on growth in low and low to middle-income countries?
- Are there any indirect effects of corruption on growth via three types of investments?

1.2 Structure of thesis

The structure of this thesis follows: After introduction and purpose in chapter 1, chapter 2 contain of important definitions applied throughout the thesis. Chapter 3 present previous research and empirical work within corruption, growth and investments. Thereafter, chapter 4 aim to present the theoretical background to why corruption affects growth and through different mechanisms. Chapter 5 present our methodology, followed by chapter 6 which demonstrate all chosen data and expected results. Before proceeding to results, chapter 7 discuss the econometric implications of the method. Thereafter, chapter 8 present our final results followed by a discussion about the results. Finally, chapter 9 summarize and conclude the key findings of this thesis.

2. Definitions

2.1 Corruption

The widespread phenomenon of corruption is explained differently in previous research. It shows diverse perceptions of the concept, fundamentally based on the social and cultural differences among countries. However, a legitime definition of corruption is stated by the World Bank. The World Bank (1997) defines corruption as *"the abuse of public office for private gain"* which is the one we follow.

Transparency International classifies three different types of corruption: grand, petty and political corruption. Grand corruption refers to corruption that enables leaders to benefit at the expense of the public good. Petty corruption is the abuse of governmental officials in daily interactions with their citizens, often as bribes and embezzlement. Lastly, the political corruption refers to manipulation of policies in the favor of the politics for them to sustain power (Transparency International, n.d.).

2.2 Country classification

Motivated by the widespread appearance of corruption in poor countries, this thesis examines corruption's effect on growth and investments in low and low to middle income countries. The country classification is based on the classification made by the World Bank (2018b), which consists of four different income groups, where the countries belonging to low income and lower middle income are the lowest income groups. Low income countries are defined as countries who in 2017 had an annual GNI per capita below $995 and lower to middle income below $3,895 according to the World Bank (2018b). However, some countries have been excluded due to lack of data, which are discussed later. See full list of countries in Appendix 1.

2.3 Economic growth

Economic growth is the long-term growth of GDP per capita. Economic growth is mainly measured in the long run, i.e. no attention is drawn to short term fluctuations due to business cycles within countries. GDP per capita is chosen as a measure of economic growth, as only GDP does not consider the size of the country or population and is thereby not an appropriate measure to capture a country's income level.

2.4 Transmission channel

During the last decades, researchers have found that corruption is likely to affect growth indirectly, as it is transmitted via other determinants of growth. Growth can be explained by a range of different variables, where corruption in turn can affect these determinants. These different determinants through which corruption can affect growth are called transmission channels.

2.5 Domestic investment

Domestic investment is often referred to as investment in the growth literature. However, in this thesis we refer to it as domestic investment in order not to create confusion as we distinguish between domestic investment, foreign investment and investment devoted to human capital. Domestic investment refers to investment in capital goods and land improvements that increase productivity in the production sector and thereby increases production overall. Such investment can for example be investment in machinery, equipment and construction of roads, buildings and railways (World Bank Data, n.d.a). Domestic investment includes both private and public investment.

2.6 Foreign direct investment (FDI)

Foreign direct investment is defined, both by OECD and IMF, as *"a cross-border investment made by an investor that has the intention to maintain a long-term relationship with the enterprise"*. The intention by the investor is also to ensure a significant influence over the enterprise's management, production and decision making. A further requirement for investment to be considered as FDI, is for the investor to acquire at least 10% of the ordinary shares of the direct investment enterprise (OECD, 2008 & IMF, 2003).

2.7 Human capital investment

Human capital investment refers to in this thesis to investment made in education. Due to limitations in data for our chosen countries, we use educational attainment as a proxy for previous investment done in education. Limitations with this proxy are discussed later in this thesis, see chapter 6.3.7. Moreover, human capital is only measured by education and we do not consider other investment within human capital such as investment in health services.

3. Previous research

This chapter briefly summarize results of earlier research within this subject. We will first present and discuss evidence on the roles of domestic investment, FDI and human capital investment on economic growth. Following this, empirical evidence on the impact of corruption on economic growth, domestic investment, FDI and human capital investment is presented.

3.1 Economic growth and investment

Economic growth literature provides broad suggestions of what determines economic growth and empirical research offers a range of different variables that may have a robust relationship with economic growth. Thus, it helps us understand what creates growth. The focus of this part is to review traditional researchers' findings on the effect of different types of investment (domestic, foreign and human capital investment) on economic growth.

One of the earliest work in this area is the work of Barro, who found several variables that have a significant effect on economic growth in his cross-section country study. The investment ratio (i.e. domestic investment) was one of the variables proven by Barro to have a significant positive effect on economic growth (Barro, 1991). Sala-i-Martin (1997) further present cross section country results on a positive impact of investment on growth, where he differs between equipment and non-equipment investment. However, both effects are significant. Barro argues for a possible reversed causality, that higher growth will have a positive effect on the investment ratio (Barro, 1991). Levine & Renelt (1992) conducted a similar study to the one of Sala-i-Martin, where the effect of domestic investment on economic growth was also found to be significant positive.

Human capital is in addition argued for having a positive impact on economic growth according to both exogenous and endogenous economic growth models. From Romer (1990), we know that human capital is the factor that can increase efficiency in the research sector, resulting in new ideas and products, which in turn spur technological progress and economic growth. Hence countries who invest more in human capital will have a large human capital stock and should therefore experience higher growth. In addition, a greater human capital stock should increase how much of the world technology frontier a country can take part in, according to the technology diffusion model (Jones & Vollrath, 2013). Lucas (1988) further enhances the spillover effects from human capital, where the rate of return on human capital increases over time. Barro (1991) finds that a higher initial level of human capital, measured as educational attainment, is substantially positively related to growth rate. Barro (1991) did only find this relationship positive for men. However, that finding may depend on limited data for women. Additionally, even if women were educated, one can expect that they did not enter the labor market in the same extent as men, due to family obligations and norms.

The effect of FDI on economic growth is not as straightforward as the other investment according to existing literature. One could argue that FDI should produce externalities such as technology transfers and spillovers and increase growth, in accordance with Romer (1990) and Lucas (1988). Hence FDI could be an essential factor for deriving growth, especially in poor countries. However, Levine & Carkovic (2002) finds no independent influence on economic growth in their cross-sectional analysis. They find in cases where the right level of educational attainment, level of development and financial development in the host country are reached, FDI can spur growth. FDI can be proved to be an important vehicle for transfer of technology only when the host country has a minimum threshold of human capital. FDI contributes to growth when there is enough absorptive capability of the technology frontier in the host country, i.e. FDI’s effect on growth is dependent on the level of available human capital (Borensztein et al., 1998).

3.2 Economic growth and corruption

The relationship between corruption and economic growth has been a popular subject of research over the last decades. Today, economists seem to agree on an existing negative relationship between the two variables. However, that result has not always been conventional.

In earlier research, economists as Leff (1964) and Huntington (1968) argued for a positive effect of corruption on economic growth. The underlying mechanism was that corruption “speeds money” as corruptive activities, such as bribing, might facilitate for some as it can avoid bureaucratic delay. Bribes could further incentivize government employees to work harder and increase efficiency.

However, most more recent research does exhibit a negative relationship between corruption and economic growth. An influential and early study in this area of subject is the work of Mauro (1995), who conducts a cross country analysis and founds that corruption has a significant negative impact on economic growth. This is further confirmed by the majority of the growth research, for example by Gyimah-Brempong (2001) who investigates the effect of corruption on growth using panel data from African countries and Knack & Keefer (1995) in their cross-country study.

3.3 Corruption and domestic investment

One key result of Mauro's (1995) influential study is that corruption has a negative impact on private investment, a result supported by a broad range of literature. Mo (2001) studies the transmission channels through which corruption affects economic growth and finds that the investment channel accounts for 21% of the overall effect of corruption on economic growth. Pellegrini & Gerlagh (2004) in addition concludes that corruption has a substantial negative effect on the investment level. Both Mo (2001) and Pellegrini & Gerlagh (2004) apply cross sectional regressions. The conclusion is further supported by Sekkat & Méon (2005) and Knack & Keefer (1995).

One study separates private and public investment and shows that corruption have a positive effect on public investment, but a negative effect on private investment in African countries (Baliamoune-Lutz & Ndikumana, 2008). Another approach is that the impact of corruption on investment level also depends on the predictability, i.e. the nature of corruption in addition affects the investment ratio. Corruption in countries or sectors where corruption is predictable have a less negative impact on investment ratio than where corruption is unpredictable (Campos & Lien, 1999).

However, there are studies that does not conclude a significant negative relationship between corruption and investment. Dridi's (2013) method is based on a system of simultaneous equations to test the effect of different transmission channels. He finds that the most important transmission channels through which corruption reduces growth are human capital and political instability, where the domestic investment channel remains insignificant.

3.4 Corruption and FDI

The effect of FDI on economic growth depends on the host country's initial conditions, where corruption could be one institutional factor that impairs the benefits of FDI on growth. However, the empirical evidence of the effect of corruption on FDI is mixed. Wheeler & Mody (1992) studies how location decisions made by U.S. investors depend on different risks in the host country through panel data regressions, where the effect of corruption is found to be insignificant. Henisz (2000) further finds no significant effect of corruption on FDI, but indicates of a positive effect. There is empirical support for a negative relation between FDI and corruption, for example by Shleifer & Vishny (1993) who finds a negative impact of corruption on FDI.

3.5 Corruption and human capital investment

Corruption is considered to be a great obstacle for the UN development goal on education for all. Investment in education are in general determined by the country's education sector. If officials and bureaucrats steal public funds meant for schools, it will result in insufficient funding for the sector which has serious implications for the human capital level (Anti-Corruption Research Centre U4, n.d.).

There is empirical evidence for a negative effect of corruption on human capital investment. Mauro (1998) confirms the concern about corruption having a negative impact on human capital investment through cross country regressions. He finds evidence of a significant negative relationship between corruption and government expenditure on education. Several studies use human capital as a transmission channel for corruption, as Pellegrini & Gerlagh (2004), Hodge et al. (2011) and Dridi (2013) where all concludes a negative effect of corruption. Dridi (2013) argues for human capital being one of the most important transmission channel where corruption is most likely to reduce growth.

3.6 Summary of previous research

Both domestic investment and human capital investment are shown to have a positive effect on economic growth according in previous research. Therefore, we consider both to be important determinants of growth. The empirical evidence of the effect of FDI on growth is more ambiguous, however theory suggest a positive effect as well.

There is a lot of empirical evidence for corruption having a negative effect on economic growth today. Further, corruption has also proven to have a negative effect on domestic investment and human capital investment. Empirical evidence of the effect of corruption on FDI is more uncertain, as previous research exhibit both an insignificant relation and a negative effect of corruption on FDI.

4. Theoretical background

This chapter discuss through which mechanisms corruption affects different types of investment, i.e. how theory can explain why we expect corruption to distort investments and therefore growth. Our theory is based on the growth literature and earlier research. Each sub chapter briefly explains how our chosen transmission channel affects growth, thereafter presents how corruption affects the transmission channel.

4.1 Corruption and domestic investment

Investment are a crucial factor for economic growth as it increases the physical capital stock in a country, which directly increases economic growth according to both endogenous and neoclassical theories. Investment in physical capital stock often refers to investment in machines, equipments, infrastructure and institutions which creates a solid ground for domestic production and therefore enhances GDP growth (Jones & Vollrath, 2013).

The investment channel for the effect of corruption on economic growth is well established by earlier literature. Corruption can both affect the amount of investment made and the allocation of investment. Mainly, corruption adds uncertainty to returns, which overall reduce the incentives for investing (Hodge et al., 2011). Further, corruption in the form of bribes increases the cost of doing business, as bribes are needed to obtain permits and licenses. Increased costs due to corruption can be seen as an additional tax on investment, but where uncertainty is high (Shleifer & Vishny, 1993).

Agreements based on bribes are in general unenforceable by law (Pellegrini & Gerlagh, 2004). An inefficient judicial system which fails to enforce contracts and secure property rights for psychical capital, profits and patents most likely reduces incentives to invest (Mauro, 1995). Mauro (1995) further emphasizes that malfunctioning government institutions overall are an obstacle for investment, entrepreneurship and innovation. Mo (2001) suggest that innovators are easier subjects for corruption in comparison to established producers, which results in a reduction in private investment. People's talent will thereby be misallocated, by focusing on rent-seeking and other unproductive activities, instead of productive investment (Mo, 2001). Therefore, corruption would lead to a misallocation of investment. One can further see some types of investment being prioritized over others due to corruption. For example, corruption is more common in public investment in infrastructure than other types of investment, which then would be prioritized by corrupt regimes (Baliamoune-Lutz & Ndikumana, 2008).

4.2 Corruption and FDI

From a neoclassical point of view, FDI should directly increase economic growth as it increases the capital stock in host countries, which in turn results in higher growth rates than from only domestic investment. Endogenous growth theories emphasize an indirect effect of FDI on growth, as FDI will allow host countries to access more advanced technologies than are available within the country (Freckleton et al., 2012). According to Romer (1990), more advanced technology is a key factor stimulating economic growth by creating externalities. FDI can also be argued to increase competition in the domestic market, which in turn would lead to higher domestic efficiency (Freckleton et al., 2012). One can expect various spillover effects when multinational companies (MNC's) invests in other countries, as a higher human capital level and increased productivity in local firms as additional external effects. Employee training and new know-how by MNC's increases the human capital level in the host country, as their training with local suppliers, subcontractors and customers creates room for diffusion (Blomström & Kokko, 2003).

The ideas behind FDI as a transmission channel for corruption is similar to the mechanisms behind domestic investment as a transmission channel, which are discussed in section 4.1. Corruption can be a critical factor which investors consider when making decisions for foreign investment, among other factors such as market size, expected returns and political stability (Lambsdorff, 2005). Shleifer & Vishny (1993) argues for that foreign investors will not invest in countries where the central government is so weak that they allow governmental agencies and bureaucracies to impose bribes on private agents.

Corruption increases the cost of doing business, as it makes handling government officials to obtain licenses and permits costlier for foreign investors (Smarzynska & Wei, 2000). Increased costs result in lower profitability of investments. Bribes for foreign investors can be more extensive than for domestic investors, as domestic investors are more familiar with how bribes are minimized in a certain country than foreign investors might be. Thus, foreign investors are easier targets for collecting bribes (Hodge et al., 2011). Further, corruption adds an uncertainty as an agreement joined under corruptive manners is not enforceable as the judicial system overall is uncertain. This decreases incentive for foreign investors to invest in countries with high corruption levels (Freckleton et al., 2012). Low transparency and high corruption levels can in addition increase the credit risk and the risk of banks to withdraw their engagement, which further reduces incentives for FDI in the host countries (Lambsdorff, 1999).

4.3 Corruption and human capital investment

From neoclassical growth theory, it is commonly known among economists that human capital is one of the key components for economic growth. Additionally, endogenous growth theory supports the importance of human capital as well (Jones & Vollrath, 2013). Previous empirical research show robust evidence on school enrollment rates (Levine & Renelt, 1992) and educational attainment (Barro & Lee, 1993) impact on economic growth. Furthermore, investment in human capital is beneficial for increasing income and reducing poverty (Collin & Weil, 2018).

Corruption can distort various perspectives of human capital, and not only investment in human capital. There is for example evidence on a high level of corruption having severe consequences for dropout rates in primary school. Suggested consequences of corruption affecting the human capital are that corruption increases the cost, decreases the volume and lowers the quality of education services (Gupta et al., 2002). However, the main focus of this part is to describe how corruption can affect investment in human capital and education spending.

The empirical evidence on corruption affecting human capital investment is mostly related to investment in education. Previous research indicates for corruption to distort the structure of public expenditure in favor of public services and order, at the expense of the social sectors, including education (Delavallade, 2006). This is supported by Tanzi & Davoodi (1997), who argue for corruption being a factor which decrease the share of recurrent expenditure for government operations, something that can result in lower quality of education and decreasing educational attainment.

Mauro (1998) argues for that corrupt governments finds it easier to collect bribes on certain government expenditure. Education uses in great extent only available mature technology, hence does not necessarily require inputs from oligopolistic suppliers where corruption normally is more present, and education itself is thereby perceived as an unattractive target for rent-seekers. Therefore, corrupt governments will not invest as much in education relatively to other government expenditures (Mauro, 1998). Gupta et al. (2002) in addition argues for a reduction of corruption may result in more productive spending of governments.

Corruption further distorts investment in human capital as it adds an extra operating cost of government and distorts tax administration which overall reduces the amount of available resources for funding public human capital investment as education and health.

Corruption also affect the composition of government expenditure, towards types of expenditure which allow bribe collecting as discussed above. Additionally, corruption can decrease share of expenditure devoted to operations and maintenance, which in turn lowers the quality of existing education and health service (Hodge et al., 2011).

5. Methodology

The aim of this thesis is to examine the direct effect of corruption on growth and the indirect effects on different types of investment. To do so, our methodology is based on regression analysis. We perform in total four regressions and thereafter summarize the total effect. This chapter presents the procedure for our empirical research and a specification of our model.

5.1 Regression analysis

Regression analysis is the most common methodology in growth research. Since all our dependent variables are assumed to be determined by several explanatory variables, we conduct OLS multiple regression analysis. OLS multiple regression analysis is used when testing the effect of several different explanatory variables on one dependent variable. The regression gives us slope coefficients for each explanatory variable, which are indicators of the marginal effect of each explanatory variable on the dependent variable. The focus of this thesis is mainly the marginal effect of corruption on growth and our three transmission channel variables.

5.2 Panel data

Our model is based on panel data which includes both cross-sectional and time-series observations. This means our dataset consists of both observations between countries and yearly observations. Panel data thereby captures both differences between countries and within countries, and increases the number of observations. Growth research can also be conducted with cross country data where both Mauro (1995), Pellegrini & Gerlagh (2004) and Mo (2001) apply cross country data instead of panel data. Panel data can result in more complex econometrics, where more advanced econometrics can be needed to deliver more robust results and ensure the credibility of the results. However, as we which to capture both differences between and within countries and have a greater number of observations, we apply panel data.

Our panel data reaches from 1996 to 2011. We have divided the period into four time periods, 1996-1999, 2000-2003, 2004-2007 and 2008-2011. This study covers 46 low and low-to-middle income countries, which in total results in 184 observations. See list of all countries in Appendix 1. Most of our time period variables are based on arithmetic means in order to minimize the effect short term cyclical deviances on the final result. We also expect some variables to not change or give a particular effect from year to year, for example the variable educational attainment. Therefore, it makes more sense to use a mean instead of each year's observation.

A panel data regression consists of both individual and time observations, according to a general model:

$$y_{i,t} = \alpha_0 + \beta_1 x_{1,i,t} + \beta_2 x_{2,i,t} + \ldots + \beta_k x_{k,i,t} + \varepsilon_{i,t} \quad (5.1)$$

where α_0 is the intercept, $\beta_1, \ldots, \beta_k$ captures the marginal effect of each variable k, for each country *i,* and time period *t* and ε is the error term.

5.3 Fixed effects regression

In our sample, it is reasonable to assume every country to have specific differences affecting the dependent variables. These differences among countries are persistent over time and cannot be explained by other variables, thus we must consider these as country-specific properties. Two common panel data models are the random effect model and the fixed effect model (Dougherty, 2016). Fixed effect estimators take country specific effects into account by adding one more dummy variable for each country which captures the individual specific effect. These extra variables imply that the OLS will be less efficient. However, the OLS results will still be consistent (Jochumzen, 2017a).

Fixed effects are convenient when assuming something within the individual variable may impact or bias outcome variables and using fixed effects will remove the effect of the time-invariant characteristics (Torres-Reyna, 2007). However, one can conduct a test to choose which model to apply. The test is called the Hausman-test, which we performed for all regressions, see appendix 3.1 for test result. The Hausman test suggested us to reject the null for three out of four regressions and thereby use fixed effects for those. Since we want to use the same methodology for each regression, we use fixed effects for all regressions.

An argument for using fixed effects regards the preconditions for using random effects. According to Dougherty (2016), one precondition for using random effects is for the observations to be drawn randomly. This precondition is not fulfilled in our data set, as our countries are drawn from the specific group low and low-to-middle income group. It would be incorrect to consider these countries to represent a random sample of all the countries worldwide. Another caution to consider is for the Hausman test is not valid for data with heteroskedasticity (Schmidheiny, 2016). As our dataset suffers from heteroskedasticity, as we confirm in section 7.1, the results from the Hausman test should not be taken too seriously. Therefore, we applied the fixed effect model for all four regressions.

The fixed effect models result in one dummy variable for each country, where this dummy variable captures all the country specific conditions that may affect the result. Therefore, the intercept in the regression will differ for each country and a general model follows:

$$y_{i,t} = \alpha_{0,i} + \beta_1 x_{1,i,t} + \beta_2 x_{2,i,t} + \ldots + \beta_k x_{k,i,t} + \varepsilon_{i,t} \quad (5.2)$$

where $\alpha_{0,i}$ then captures this country specific effect for every country i. However, we cannot know which variables are included in this country specific intercept, but this does not affect the result.

5.4 Specification of method

The model is based on four regressions. The first regression measures the direct effect of corruption on growth and the three latter measures the effect of corruption on three types of investments. The aim of the transmission channel regressions is to examine the indirect effect of corruption on the chosen transmission channels. Thereafter, we use the results of these regressions to form a model which captures both the direct and indirect effect of corruption on growth, where the indirect effect is captured by three investment transmission channels: domestic investment, FDI and investment in human capital. Thus, our method is based on five equations.

5.4.1 Regressions

We refer to our four regressions as regression (1), (2), (3) and (4). Regression (1) is the growth regression which measures the direct effect of corruption on growth. The dependent variable is GDP per capita growth, followed by corruption as an explanatory variable and a set of relevant control variables. The transmission channel variables, domestic investment, FDI and human capital investment, are all included as explanatory variables in regression (1) in order to proceed on our last equation.

Regression (2) is the first transmission channel regression, where the effect of corruption on domestic investment is measured. The dependent variable is domestic investment, followed by corruption as the explanatory variable and other control variables.

Regression (3) is the second transmission channel regression and measures the effect of corruption on FDI. The dependent variable is FDI, with corruption and other control variables as explanatory variables.

Regression (4) is the last transmission channel regression which measures the effect of corruption on human capital investment. The dependent variable is our proxy for human capital investment, followed by corruption and other control variables as explanatory variables. Specifications of all regressions are in Appendix 2.

5.4.2 Model for total effect of corruption

The final procedure is to use the marginal effects of corruption from the regressions to determine the total effect of corruption on growth, both the direct and indirect effect via our three transmission channels. This step is mainly based by the method of Mo (2001). The total effect of corruption on growth can be calculated accordingly:

$$\frac{dGr}{dCorr} = \frac{\partial Gr}{\partial Corr} + \sum_{i=1}^{3}\left(\frac{\partial Gr}{\partial Z_i} \times \frac{\partial Z_i}{\partial Corr}\right) \qquad (5.3)$$

where Z_i stands for each investment transmission channel: domestic investment, FDI and human capital investment. $\frac{dGr}{dCorr}$ captures the total, both direct and indirect when considering three transmission channels, effect of corruption on economic growth. $\frac{\partial Gr}{\partial Corr}$ is the direct effect of corruption on growth, i.e. the marginal effect of corruption on growth from regression (1). $\frac{\partial Gr}{\partial Z_i}$ is the marginal effect of each transmission channel variable on growth. These values are taken from regression (1), where we have the marginal effect of domestic investment, FDI and human capital investment on growth. $\frac{\partial Z_i}{\partial Corr}$ is the marginal effect of corruption on each transmission channel variable, i.e. the effect of corruption on domestic investment, FDI and human capital investment. These marginal effects are retrieved from regression (2), (3) respectively (4). The term $\frac{\partial Gr}{\partial Z_i} \times \frac{\partial Z_i}{\partial Corr}$ therefore captures the indirect effect of corruption on growth from each transmission channel regression. The indirect effects added from the three transmission channels together with the direct effect $\frac{\partial Gr}{\partial Corr}$ together results in a value of corruption's total effect on growth.

6. Data

This chapter presents all our data, including both variables and countries. Our methodology is based on four regressions in order to explain the effect of corruption on economic growth and three types of investment. It is therefore important to choose relevant control variables to capture the unbiased effect of corruption on the dependent variables. If we were to omit fundamental explanatory variables, the results would probably suffer from endogeneity in a greater extent. We investigated which explanatory variables are showed to be robust in earlier research and include them as control variables for each regression. Our four regressions ((1), (2), (3) and (4)) consists of different sets of control variables. How many and which variables we included in each regression are thereby presented and motivated in this chapter.

However, we did suffer from some data collection issues, as data for developing countries in general is limited. Hence, we start this chapter with discussing these issues and the difficulties with measuring corruption.

6.1 Limitations in data set

We followed the World Bank's classification for low and low-to-middle income countries when determining which countries to include. Countries within these boundaries are in total 81 countries, where we have excluded 35 countries. Exclusion is based upon limited data availability. Since our panel set is divided into four time periods and based on averages, we decided to exclude every country where more than one average value per time period is missing. Thus, we have kept countries where one value per time period is missing. This results in our data not being a balanced panel data set, as it requires the number of time periods to be equal for all countries. Values missing in our data set are infrastructure for Mauritania for time period 1996-1999 and inflation rate for Nicaragua and Tajikistan for time period 1996-1999.

Moreover, as long as we could compute an average for each time period we have kept the country, even if the average is based on less than four yearly observations. Thereby we did not lose too many country observations. Further, no values for corruption and political instability indexes were available for year 1997, 1999 and 2001 for any country. The arithmetic means for corruption and political instability the two first periods (1996-1999 and 2000-2003) are therefore based on two yearly observations instead of four observations.

Since our methodology is mainly based on the methodology of previous growth literature, we included what we consider established control variables explaining growth and our investment variables. The consequences of omitted variables should not therefore be too severe. We did however omit interest rate explaining the investment ratio, as it is not available for our time period and choice of countries.

6.2 Measuring corruption

Measuring corruption is hard as corruption occurs undocumented and is a subjective matter. Several institutions and organizations provides measures which are often perception based. Perception based measures of corruption does not measure the actual corruption, only the perception of corruption in different countries. Further, since the definition of corruption is broad and corruption can take various forms, the attempt to create one single measure which would capture all variations is not an easy task. Perception based measures are conditioned on the approach and the definition of corruption adopted by international agencies and experts. The available measures are therefore likely to reflect a Western definition and idea of corruption (Andersson & Heywood, 2009). Further, another claimed issue with perception based corruption measures is that they seem to be colored by recent economic performance. The measure will then reflect an overall dissatisfaction of the government and economic performance instead of measuring the corruption (Kurtz & Schrank, 2007). Another potential problem with indexes are that the distance between each index level does not necessarily capture the difference in corruption, which a linear model assumes.

Popular corruption measures in earlier research are Corruption Perceptions Index (CPI) issued by Transparency International, Worldwide Governance Indicators' (WGI) measure Control of Corruption issued by the World Bank and International Country Risk Guide (IRCG) issued by the PRS Group. IRCG is based on assessments made by country experts to capture the level of corruption. Both WGI and CPI are based on surveys answered by both business people and experts. IRCG is most frequently used in earlier research, however, we do not have access to the IRCG-data. We decided to use WGI:s corruption index, Control of Corruption, as it seemed more complete than CPI. Rock & Bonnett (2004) further claims that the WGI-measure gives the most robust result in comparison to the other measures.

Control of Corruption aim to display the perceptions of how public power is used for private gain and consists of petty and grand corruption (WorldBank, n.d). Their data is based on surveys collected from survey institutes, non-governmental and international institutions and corporations. The measure is constructed as a weighted average of 23 different assessments and surveys concerning corruption. Some examples on indicators the measure evaluates are the existence of grand and petty corruption throughout different governmental levels, corruption's effect on interest and attractiveness of business climate, frequency of deviant transactions and expected costs of bribery (MCC, 2019).

Corruption is the only variable that is included in all our regressions, as the main aim of this thesis is to examine the direct and indirect effect of corruption on growth and three different investment channels. The WGI index reaches from -2.5 to 2.5 where -2.5 captures the highest level of corruption, where a negative impact of corruption therefore is equivalent to a positive sign of the beta coefficient. We expect corruption to have a negative effect on growth, domestic investment, FDI and human capital investment.

6.3 Control variables included in regression (1)

This subchapter presents all our control variables for our first regression and a brief motivation for including them and from which source they are retrieved. Regression (1) is the growth regression with GDP per capita growth rate as dependent variable. GDP per capita growth is based on data from Penn World Table (Feenstra et al., 2015), where we use *Expenditure-side real GDP at chained PPPs in million 2011 USD* and population data. This data is used to calculate the annual GDP per capita growth in each four-year period, according to:

$$Gr_{GDP per\ capita} = \frac{GDP\ per\ capita_{T+4}}{GDP\ per\ capita_{T}}^{1/4} - 1 \qquad (6.1)$$

6.3.1 Log initial GDP per capita

The variable initial GDP per capita has a significant effect on economic growth according to the economic growth theory of conditional convergence (Barro, 1991). The theory of conditional convergence states that the further away a country is from its steady state, the higher growth will the country experience (Jones & Vollrath, 2013). Therefore, we expect a negative effect of the variable on growth. The data is collected from Penn World Table (Feenstra et al., 2015), *Expenditure-side real GDP at chained PPPs in million 2011 USD* and subsequently calculated to per capita each initial year for every time period. The values are logged in order to interpret the variables as percent instead of absolute terms.

6.3.2 Infrastructure

Both neoclassical and endogenous growth theory emphasizes the importance of infrastructure for growth. Infrastructure is a broad concept and includes everything from internet access to functioning railway system and roads. Recent empirical work argues for well-equipped countries with modern infrastructure facilities, such as telephone and internet, will create a business-friendly environment (Mottaleb, 2007). Thus, we expect a high infrastructure to contribute to economic growth. We have chosen *"Mobile cellular subscriptions per 100 people"* from World Bank Data (n.d.c) as measure on infrastructure.

6.3.3 Trade openness

Trade openness is often perceived as facilitating production across international boundaries, resulting in increased production and growth (Burange et al., 2019). The importance of trade openness for growth can be supported by the technology diffusion model, where trade openness is a prerequisite for technology to be spread internationally. This model is applicable in developing countries who do not develop technology on their own (Jones & Vollrath, 2013). Previous research also indicates that there is a robust correlation between openness and growth (Sala-i-Martin, 1997). Hence, we expect trade openness to have a positive effect on growth. Data is collected from Penn World Table (Feenstra et al., 2015), where we define trade openness as the sum of *Share of merchandise export at current PPPs* and *Share of merchandise import at current PPPs,* i.e. export + import over GDP.

6.3.4 Political instability

Political instability is included by many researchers in growth regressions as well, for example by Pellegrini & Gerlagh (2004) and Levine & Renelt (1992). Political instability is a subjective phenomenon, where finding an appropriate measure can be challenging. We use the standardized measure "*Political instability and Absence of Violence"* index provided by WGI, i.e. the same providers as for the corruption measure we use. Since political instability can shadow and misallocate the resources and efforts for activities that enhance economic growth, we predict a negative relationship between political instability and economic growth.

6.3.5 Population growth

Population growth is frequently used as an explanatory variable for growth throughout most of the growth research, where Mauro (1995), Mo (2001) and Levine & Renelt (1992) include the variable in their regression.

According to neoclassical growth theory, a higher population growth is associated with a negative impact on economic growth. The argument, discussed by the Solow model, is that a higher amount of people shares the same amount of limited resources, resulting in a stagnated or even decreased growth. However, endogenous growth theory suggests the opposite. More people will result in more innovations, which contributes to growth (Jones & Vollrath, 2013). We assume the variable to be negative in our regression due to the limitations and constraints for innovation in developing countries. Data is collected from Penn World Table (Feenstra et al., 2015) as *Population in millions*, where we calculate annual growth rate according to function (6.1).

6.3.6 Investment ratio to GDP

Investment ratio is our variable for domestic investment. Investment ratio to GDP is believed to affect growth positively as discussed in chapter 4.1. We thereby predict a positive effect of investments on growth. Data is retrieved from Penn World Table (Feenstra et al., 2015), as the *Share of gross capital formation at current PPPs*. This variable is one of the key variables, as it occurs as a transmission channel variable.

6.3.7 Human capital investment

Human capital is considered an important source of growth, as discussed earlier in chapter 4, and we therefore expect a positive effect on growth. As a proxy for human capital investment, we use *Educational attainment for population above 25* retrieved from Lee and Barro's (2018) database. The data is in its original dataset divided into five year periods. This does not correspond with our time periods of four years. Our value for time period 1999-1996 thereby originates from the value of 1995, time period 2000-2003 originates from 2000's value, time period 2004-2007 originates from 2005's value and time period 2008-2011 originates from 2011's value. Since educational attainment is a variable not considered to change substantially from one year to another, we do not consider this division to be severe for our result.

We are aware of that investment in human capital is not limited to investment in education and the level of education does not need to be directly correlated with the investment made in education. Even if we assume that education level correlates with investment in education, there is probably a substantial time lapse not taken into consideration. Preferably, we would use data on education public spending. Unfortunately, the data on education public spending is limited in our sample, hence we decided to use educational attainment as a proxy for investment in human capital. Educational attainment is further used as a proxy for human capital investment by Pellegrini & Gerlagh (2004). However, this requires that any implications of our result regarding human capital investment should be interpreted with awareness of this. Human capital investment is further one of our transmission channels.

6.3.8 FDI inflow

The discussion regarding foreign direct investment, FDI, and its effect empirically on economic growth is ambiguous, as discussed earlier. However, theory suggests that FDI should have a positive impact on economic growth. Data on FDI inflow is retrieved from World Bank Data (n.d.b), as *Net inflow of FDI as % of GDP*. FDI is also one of our transmission channels.

6.3.9 Government expenditure

One of the most influential theory of the relation between government expenditure and growth was introduced by Barro (1990) called the BARS-curve. The curve is an inverted U-shaped curve which indicates that government spending is beneficial to a certain level, afterwards the impact on growth will be negative (Barro, 1990). The variable is throughout research recurrent as control variable for growth. However, a large government sector is most frequently expected to influence growth negative, when excluding spending on education and defense (Barro, 1990). The data is retrieved from Penn World Table, as *Share of government consumption at current PPP* (Feenstra et al., 2015).

6.4 Control variables included in regression (2)

Regression (2) is a transmission channel regression, where the aim is to examine the effect of corruption on domestic investment. The dependent variable here is investment ratio to GDP.

6.4.1 Log initial GDP per capita

Initial GDP per capita is included as control variable in regression (2) as well. The initial GDP per capita i.e. the income level, should affect the amount of private and public investment made, as a richer country probably invests more. We expect this variable to have a positive effect on investment.

6.4.2 Infrastructure

One of the basic determinants of the amount of investment is the difference between expected returns and costs associated with the investment. If the expected returns are higher than costs, investment will take place. The costs associated with doing business and starting companies depend on the infrastructure in the country (Jones & Vollrath, 2013). Investment ratio to depend on how business-friendly the country is, where infrastructure can determine the business environment. We thereby expect a positive effect of infrastructure on domestic investment.

6.4.3 Trade openness

Trade openness is included as explanatory variable in regression (2) as well. An open trade regime widens the available market for companies wanting to expand, and one can thereby expect a greater market increases the investment made in a country. We therefore assume trade openness to have a positive effect on investment ratio.

6.4.4 Inflation rate

The stability of the economic environment affects the amount of investment, where inflation rate can be an indicator of how stable a country's economy is (Jones & Vollrath, 2013). High inflation rates are often a sign of an unstable and uncertain economic environment. A higher inflation has been shown empirically to decrease the amount of investment, as the risk increases (Suhendra & Anwar, 2014). Thus, we predict inflation to have a negative effect on domestic investment. Inflation rate is derived from World Bank Data (n.d.d), as *Inflation in consumer prices, annual %.*

6.5 Control variables included in regression (3)

Regression (3) is a transmission channel regression which measures the effect of corruption on FDI. The control variables explaining FDI are presented below. The dependent variable here is FDI net inflow in % of GDP.

6.5.1 Log initial GDP per capita

Previous work on the determinants of FDI in developing countries indicates that the effect of initial GDP on FDI is significant positive, as higher income level implies more consumption and capacity for investing (Mottaleb, 2007). Wells and Wint (2000) further also finds that initial GDP per capita has a significant positive effect on FDI. Therefore, a positive effect of initial GDP per capita on FDI is expected.

6.5.2 Infrastructure

Infrastructure can determine the amount of foreign investment, where empirical work indicates that countries with modern infrastructure facilities a more business-friendly environment (Mottaleb, 2007). Ozturk (2007) also emphasizes the importance of infrastructure quality for the possibility of receiving FDI. Therefore, we expect a higher level of infrastructure to have a positive effect on FDI.

6.5.3 Trade openness

The importance of trade openness for growth is illuminated by the technology diffusion model, in particular for developing countries (Jones & Vollrath, 2013). The higher level of openness will alleviate the process of receiving FDI. Trade regime and attitude have been shown to be an influential source of FDI according to Freckleton et al. (2012) and Asiedu (2002). We thereby assume a positive effect of trade openness on FDI.

6.5.4 Log population

The size of the host economy is an implication of the market size, which is a determinant of FDI according to both Kobrin (1976) and Habib & Zurawicki (2002) as large markets imply greater scale opportunities. A positive effect of population size is expected. The values are logged in order to interpret the variables as percent instead of absolute terms.

6.5.5 Industrial value added

Another significant and positive effect is found between the industrial value and FDI (Mottaleb, 2007). Industrial value added aims to add valuable information about the countries market and market potential, hence showing the share of industries to GDP. Therefore, we predict a positive sign. This variable is retrieved from the World Bank Data (n.d.e), *"Industry (including construction), value added as % of GDP"*.

6.6 Control variables included in regression (4)

Regression (4) is the last transmission channel regression, where the effect of corruption on human capital investment is examined. The dependent variable is our proxy for human capital investment, educational attainment for population above 25 years old.

6.6.1 Log initial GDP per capita

Initial GDP per capita can be used as a measurement of welfare. More frequently does a higher welfare level of a country indicate more resources spent on education. The proposed sign of this explanatory variable is positive.

6.6.2 Infrastructure

Infrastructure is often perceived as a measure on the level of development in the country. Further, it is common for more developed countries to invest more in education relatively to less developed countries. The higher level of infrastructure would thereby imply a higher spending on education, therefore a positive sign is expected.

6.6.3 Political instability

The consequences of political instability often are misallocation of resources and reductions in saving and investments, as discussed in 6.3. Therefore, higher political stability would probably result in a negative effect on investment in human capital. One can further assume that unstable governments do not prioritize long term investments, as human capital investment.

6.6.4 Log population

Log population aims to take account for the importance of scale economies in the provision of public goods, and can thereby help to explain the investment in education (Ansell, 2008). Moreover, Ansell (2008) uses log population as a control variable in his study when investigating the key determinants that may affect educational expenditure. This variable is expected to be positive.

6.6.5 Population under 14 years old

The highest share of government expenditure on education goes to primary and secondary education. Therefore, it is expected for the size of the age group below 14 years have a positive effect on education expenditure (Akanbi & Schoeman, 2007). The younger population a country has, the greater is the need for education spending. Mauro (1998) validates this when including the share of the population aged between 5 and 20 when explaining education spending. Data is collected from the World Bank Data (n.d.f), as *Population between the ages 0 to 14 as percentage of the total population.*

6.7 Expected results

All expected results of the four regressions are displayed in table 6.1 below. Note that, due to the scale of the corruption measure, we expect a positive sign of corruption in all regression as it is equivalent to a negative effect of corruption.

Table 6.1: Expected results

(1), (2), (3) and (4) refers to each regression, with Growth, Investment ratio, FDI respectively Human capital investment as dependent variables.

	(1) **Growth** (Gr)	(2) **Investment ratio** (Inv)	(3) **FDI** (FDI)	(4) **Human capital investment** (Hum)
Corruption (Corr)	+	+	+	+
Initial GDP per capita (LogY_0)	-	+	+	+
Infrastructure (Infr)	+	+	+	+
Trade openness (Open)	+	+	+	
Political instability (Pol)	-			-
Log population (LogPop)			+	+
Population growth (Pop)	-			
Investment ratio (Inv)	+			
Human capital (Hum)	+			
FDI inflow (FDI)	+			
Government size (Gov)	-			
Inflation rate (Infl)		-		
Industrial value (Indu)			+	
Population under 14 (Pop14)				+

7. Econometric discussion

Before proceeding to our result, an econometric discussion is needed. In order to present our results, we need to ensure that all results can be interpreted fully. Therefore, we below discuss possible issues and present the tests conducted to ensure the credibility of our results.

7.1 Heteroskedasticity

Heteroskedasticity occurs when the variance among the error terms are non-constant, resulting in the standard error terms being invalid (Dougherty, 2016). Heteroskedasticity causes OLS standard errors to be biased in finite samples. Thus, the consequences of heteroskedasticity are quite severe, since the OLS estimator becomes inefficient. Heteroskedasticity is common in panel data studies and likely to exist as it is reasonable to assume that different countries have different standard error properties. To test if our data suffer from heteroskedasticity, we conduct a Wald-test for each regression. As expected, all test results stated that our data suffered from heteroskedasticity, see result in Appendix 3.2.

One way to handle heteroskedasticity is to apply robust standard errors. With robust standard errors, the OLS will still be consistent even if the error terms are heteroskedastic. Thereby, inference estimates and robust standard errors will approximately be correct when the sample is big (Jochumzen, 2017b). We therefore applied Huber-White standard errors in all regressions to fix the heteroskedasticity.

7.2 Endogeneity

Endogeneity occurs when at least one independent variable is affected by the dependent variable resulting in a reversed causality. Endogeneity can also occur when the dependent variable and the explanatory variables influence each other at the same time (Pinzón, 2016). Reversed causality is a common problem when working with growth regressions, as it is often difficult to determine the direction of the effects of the variables (Svensson, 2005).

Unfortunately, there is no simple test for endogeneity. There are several different econometric methods, as including instrumental variables or simultaneous equations and apply 2- or 3-least square methods to solve for endogeneity (Pinzón, 2016). However, these models require advanced econometrics that we consider fall outside the scope of a Bachelor thesis.

Pellegrini & Gerlagh (2004) discusses endogeneity in their study about transmission channels, a study which has in part inspired the method in this thesis. They argue for that low corruption levels are mainly explained by the institutional quality, more than by income level. Since institutions are overall time persistent and an important determinant of growth, additionally as corruption is highly correlated with institutional quality, suggest that corruption thereby also is persistent over time. Corruption being time persistent implies that corruption is an exogenous variable. Pellegrini & Gerlagh (2004) further receives the same results from handling endogeneity as when not considering it.

Both testing for and handling endogeneity are complex procedures and something we do not proceed on. However, we must keep the possibility of endogeneity with us in mind when interpreting the result.

7.3 Multicollinearity

Multicollinearity occurs when two or more explanatory variables are highly correlated. The most severe case of multicollinearity occurs when there is a perfect linear relationship among variables in a regression. Multicollinearity generates a problem when it comes to the estimation of the coefficients and their standard errors. However, when a model is suffering from multicollinearity, OLS estimators are still unbiased and BLUE (Best Linear Unbiased Estimators) (Williams, 2015). The consequence of multicollinearity is that the regression will presumably show a good general fit, based on a high R^2, but with insignificant individual explanatory variables (Dougherty, 2016). To test for multicollinearity, one can conduct the VIF-test. Our VIF-test results, see Appendix 3.3, does not suggest that the multicollinearity between our variables is too high.

Additionally, one can detect multicollinearity by looking for values over 0.8 in the correlation matrix (Williams, 2015), see our correlation matrix in Appendix 3.4. Our matrix show no big values i.e. all values are under 0.8. Therefore, we do not consider multicollinearity to be a severe problem.

7.4 Autocorrelation

Another common problem in regressions using time series data is autocorrelation. If a model suffers from autocorrelation, it implies that the residual observations in different series are correlated with each other and the OLS estimator will be inefficient. Consequences of autocorrelation is highly similar to the consequences of heteroskedasticity (Dougherty, 2016).

Detection of autocorrelation can be achieved by proceeding the Wooldridge test, which we conducted. The null hypothesis in the Wooldridge test imply no first-degree autocorrelation. Our test results indicate that we cannot reject the null hypothesis in two out of four regressions, thus our data does not suffer from first degree autocorrelation in regression (1) and (3). See appendix 3.5 for test results.

One way to handle the consequences of autocorrelation, which are in general the same as the consequences of heteroskedasticity, is to run the regression with robust standard errors (Jochumzen, 2017c). This action is therefore taken both to fix the heteroskedasticity and autocorrelation.

7.5 Non-stationarity

Non-stationarity is a common problem when working with panel data and may cause deceptive results. The consequence of non-stationarity is that the regression results will show a relationship, and receive high R^2, between variables that may not in fact be related (Dougherty, 2016). To detect if data is stationary, one can conduct the Im-Pesaran-Shin (IPS) test for unit roots for all variables, where the null hypothesis implies that the data has unit roots i.e. is non-stationary (Doan et al., 2003). Our test results showed all variables except domestic investment, trade openness, human capital and initial GDP per capita to be stationary. Furthermore, for the variables inflation and infrastructure, the IPS-test was not feasible since both variables are missing data for one time period.

To handle non-stationarity, a lagged variable can be included in the regression for the non-stationary variables. We tried to include a lagged variable for domestic investment, trade openness, human capital and initial GDP per capita without further success. These four variables were still non-stationary, hence we proceeded without any action against non-stationarity taken as lagged variables results in less observations.

7.6 Normally distributed residuals

If the residuals do not follow a normal distribution, inference cannot proceed. To test for normal distributed residuals, we have conducted the Jarque-Bera-test (Stata, n.d.). Our results from the Jarque-Bera-test are presented in appendix 3.7. As shown, the test indicates that we must reject the null for regression (1) and regression (3) and thereby do these regressions not exhibit normally distributed residuals. According to the central limit theorem, a large amount of observations will result in the residuals being normally distributed however. As our sample contains of 184 observations, that two of our regressions does not have normally distributed residuals is not considered a problem.

8. Result & Analysis

In this chapter, we present our results from our empirical research. Following, a discussion of the result is presented which analyses both the effect of corruption and of the additional control variables. The chapter starts with presenting the findings from all four regressions in order to detect the total effect of corruption. Regression (1) measures the direct effect of corruption on growth. Regression (2) measures the effect of corruption on domestic investment, regression (3) measures the effect of corruption on FDI and regression (4) measures the effect of corruption on human capital investment. The main focus in each regression is the marginal effect of corruption.

8.1 Result of regressions

Table 8.1: Result from the four regressions

*Coefficient result from regressions: (1), (2), (3) and (4). Values in [ ] are the White Huber adjusted standard errors, and values in ( ) are p-values. *, ** and *** corresponds to a significance level of 10%, 5% respectively 1%.*

	(1) Gr	(2) Inv	(3) FDI	(4) Hum
C	**40.50** [14.66] (0.008***)	**-43.06** [15.06] (0.006***)	**-6.176** [13.26] (0.644)	**2.917** [1.899] (0.131)
Corr	**-0.259** [1.693] (0.879)	**1.390** [1.929] (0.475)	**1.109** [1.073] (0.307)	**0.366** [0.226] (0.112)
Log*Y0*	**-6.823** [2.080] (0.002**)	**7.534** [1.943] (0.000***)	**-1.096** [1.928] (0.573)	**0.166** [0.167] (0.327)
Infr	**0.037** [0.015] (0.019**)	**0.012** [0.015] (0.448)	**0.010** [0.011] (0.405)	**0.006** [0.002] (0.006***)
Open	**0.028** [0.038] (0.459)	**0.127** [0.033] (0.000***)	**-0.005** [0.051] (0.928)	
Pol	**0.892** [0.790] (0.265)			**-0.198** [0.108] (0.073*)
LogPop			**7.191** [2.821] (0.014**)	**1.867** [0.360] (0.000***)
Pop	**-0.699** [0.740] (0.350)			
Inv	**0.201** [0.081] (0.017**)			
Hum	**2.039** [0.697] (0.005***)			
FDI	**0.0580** [0.084] (0.495)			
Gov	**0.026** [0.135] (0.848)			
Infl		**-0.020** [0.005] (0.000***)		
Indu			**-0.063** [0.056] (0.259)	
Pop14				**-0.117** [0.024] (0.000***)
Adjusted R^2	0.329	0.363	0.062	0.762
Nr of obs.	183	181	183	183

Note on results: Intercepts, C, represent an average value of the individual intercepts due to fixed effect model.

8.2 Total effect of corruption

As follows from the results, we fail to detect any strong significant direct effect of corruption on economic growth. Further, this result is recurrent in all transmission channel regressions. We cannot conclude any strong significant direct or indirect effect of corruption on growth. However, we find a weak significant negative effect of corruption on human capital investment.

Our result indicates a weak significant effect of corruption on educational attainment, which is our proxy for human capital investment. The negative relation between corruption and human capital investment is found at a p-value of 11.2%, see table 8.1 column 4. However, as we use educational attainment as proxy for human capital investment, our result indicates corruption having a weak negative effect on educational attainment. The use of educational attainment as proxy is a source of error, and hence something we need to consider. We cannot determine any effect between human capital investment and corruption, as we de facto do not measure human capital investment. However, as we assume human capital investment and educational attainment to be strongly correlated, corruption should have a similar effect on human capital investment as on educational attainment. Therefore, one could predict that corruption has a negative effect on human capital investment. This indication of a significant negative effect of corruption on human capital investment is consistent with a range of earlier research, such as Mauro (1998), Pellegrini & Gerlagh (2004), Hodge et al. (2011) and Dridi (2003).

However, the marginal effect of corruption on growth, i.e. the direct effect of corruption on growth, is indeed insignificant and we can therefore not determine any direct effect according to table 8.1 column 1. Our result is not consistent with Mauro (1995) who presented a negative effect of corruption on growth, nor with earlier research such as Huntington (1968) who found a positive effect of corruption.

An insignificant indirect effect is further found in two of our transmission channel regression, with domestic investment and FDI as dependent variables. In both cases, corruption has an insignificant negative effect, see table 8.1, column 2 and 3. The insignificant effect of corruption on domestic investments is inconsistent with for example Mauro (1995), Pellegrini & Gerlagh (2004), Sekkat & Méon (2005) who all find a significant negative effect of corruption on domestic investment. However, the result is in line with the work of Dridi (2013) who failed to detect any significant effect of corruption on domestic investment. The insignificant effect of corruption on FDI is supported by Wheeler & Mody (1992), who did not find any significant relation between the two variables. In general, the effect of corruption on FDI is not as established by earlier research as the other investment variables. Our result, however, is not consistent with Shleifer & Vishny (1993) who detected a negative effect. We can thereby not conclude any indirect effect of corruption on growth via domestic investment or FDI as transmission channels.

The final procedure in our methodology was to determine the total effect of corruption on growth, with help from our four regressions. This step is illustrated in equation (5.3), where the total effect ($\frac{dGr}{dCorr}$) captures both the direct effect of corruption on growth via regression (1), and the indirect effect of corruption on our three investment transmission channels, regression (2), (3) and (4). We unfortunately did not receive any strong significant values for $\frac{\partial Gr}{\partial Corr}$, nor $\frac{\partial Z_i}{\partial Corr}$ for any investment channel. We did receive significant values for the effect of the transmission channels domestic investment and human capital investment on growth, which should be inserted in $\frac{\partial Gr}{\partial Z_i}$. However, since $\frac{\partial Gr}{\partial Z_i}$ thereafter should be multiplied with $\frac{\partial Z_i}{\partial Corr}$ respectively, the whole function takes the value zero. We therefore consider proceeding and displaying this step as pointless. We can instead conclude that we cannot show any strong direct or indirect effect of corruption on economic growth.

8.3 Effect of control variables

The effect of the control variables in the four regressions are here discussed, where the majority of the significant variables are consistent with previous research.

As interpreted from table 8.1, we can establish that the growth regression, regression (1), obtain several significant control variables. Initial GDP per capita, investment ratio, human capital and infrastructure are all significant. All significant variables have a positive effect on economic growth except initial GDP per capita. Initial GDP per capita has a significant negative effect on economic growth, supporting the theory of conditional convergence. The positive effect of investment ratio to GDP of growth is supported by, among others, Barro (1991), Sala-i-Martin (1997) and Levine & Renelt (1992). The positive effect of human capital in growth is further consistent with both exogenous and endogenous growth theories. All significant signs confirmed our expectations as presented in table 6.1. However, in regression (1), population growth, trade openness, FDI inflow, political instability and government size have no significant effect on economic growth. The insignificance of the effect of FDI on growth has been shown by Levine & Carkovic (2002) in addition, as it is hard to determine the independent effect of FDI on growth.

In regression (2), results from table 8.1 indicate that initial GDP per capita, openness to trade and inflation have a significant effect on domestic investment. Initial GDP per capita and openness to trade have a significant positive effect on domestic investment, whereas inflation rate has a significant negative effect as expected. The fact that initial GDP per capita has a significant positive effect on domestic investment, imply that the negative effect on initial GDP per capita on growth which was shown in regression (1) due to the conditional convergence theory can be subdued by the positive effect of initial GDP per capita on domestic investment as domestic investment was shown to have a significant effect on growth. The total effect of initial GDP per capita on growth must therefore consider these properties. However, since it is not the key focus of this thesis, we do not proceed on that. All significant results in regression (2) are consistent with our expectations.

The results from regression (3) implies only one significant effect on FDI, which is the effect of logged population as a measure of country size. Our result shows that logged population has a significant positive effect on economic growth, supporting previous results on large markets creating greater scale opportunities. However, all other control variables show an insignificant effect on FDI. Further, this regression suffers from quite low adjusted R^2. This result is not too shocking, as the determinants of FDI in general is ambiguous in earlier research.

Lastly, the results from regression (4) is presented in the last column in table 8.1. The result indicate that the control variables infrastructure and logged population have a significant positive effect on human capital investment, consistent with previous result and our earlier presented expectations in chapter 6.6. Political instability shows a significant negative effect on human capital investment, also confirming previous research. However, population under 14 have a significant negative effect on human capital investment. This is not consistent with previous research and our expectations. Furthermore, the only insignificant control variable in regression (4) is initial GDP per capita.

8.4 Discussion

As displayed above, our results of the direct and indirect effect of corruption did not follow our expectations. We did find a weak negative significant effect of corruption on human capital investment. However, none of the other regressions show a significant effect of corruption.

As recently discussed in 8.2, our results indicate that corruption has a negative effect on human capital investment. Further, we have shown that human capital investment in turn have a positive significant effect on growth. Therefore, the indication suggest that human capital investment does work as a transmission channel for the effect of corruption on growth, i.e. that corruption has a negative indirect effect on growth. This implies that the costs of corruption within the education sector could be severe for transition countries. Hence it should be of interest for countries to proceed alienating corruption, as corruption seem to affect human capital investment negatively, which in turn slows down growth. However, we suggest for the areas of future empirical research to use data, if available, for educational investment. This is in order to determinate the relation that our result indicates.

However, the remaining results indicates that there is no strong sole effect of corruption on growth in low and low-to-middle income countries as we fail to detect any direct effect of corruption on growth and no strong indirect effect via domestic investment and FDI. Furthermore, there are several possible explanations behind the deviance from earlier research.

Firstly, one could expect a different result with a more inclusive country sample, as a lot of earlier research conduct their study with a more diverse country sample. For example, the influential work of Mauro (1995) and Pellegrini & Gerlagh (2004) included both rich and poor countries and showed a negative relation between corruption and growth. Our result therefore indicates that there might be circumstances in our chosen countries which further prevents growth. Our country sample consists of poor countries which in general exhibit a less stable political and economic environment than other countries. Less developed and poor countries may have other underlying essential issues that prevent growth, and thereby fail corruption alone to show any significant effect on growth. Moreover, eliminating corruption is not enough for these countries in order to increase growth, and we thereby do not capture any independent effect of corruption in poor countries. The possible relation between corruption and growth showed in earlier research may only exist when including countries with spread income levels.

Further, one way to control for these institutional, economic and political circumstances that prevent growth which are perceived in low and low-to-middle income countries is to include interaction variables in the methodology. Including interaction terms implies that the effect of corruption on growth can depend on other explanatory variables as well. Our result indicates that there probably is an interaction between growth, corruption and other factors within countries. If this interaction is controlled for, one would presumably create a more profound understanding on the effect of corruption in low and low-to-middle income countries. This approach is applied by earlier researchers as well, for example by Freckleton et al. (2012) who finds that FDI has a direct effect on growth when controlling for corruption. Including interaction terms is therefore something we suggest for future research to fully investigate how corruption affects growth in poor countries.

Secondly, all countries in our sample have a relatively high corruption level. It may therefore be the case that there is some kind of threshold. Therefore, a small difference in corruption does not affect growth as the level of corruption is still high. It might require that the level of corruption decreases a lot before any effect on growth can be indicated. In addition, the countries in our sample have quite similar levels of corruption. It further implies that brief differences in corruption may not give cause for any distinct result on the effect of corruption.

Thirdly, one could further argue for that our time span may be too short and a longer time period could result in more persistent results. This is more importantly to determinate the weak relation between corruption and human capital investment. In general, the effect of different variables on human capital take a long time to establish, and the effect of corruption on human capital investment could possibly be shown stronger if one were to investigate a longer time period. Most previous research use a longer time span, however, due to low data accessibility we had to settle for a period of 16 years. Well-established research within the subject, such as Mauro (1995), Pellegrini & Gerlagh (2004), Mo (2001), use data from earlier time periods than us, as they used corruption measures that were available further back in time. The Control of Corruption measure is only available from 1996, which shortened our time period. The data for educational attainment, the proxy for human capital investment, was only available until 2011 where we therefore could not include more recent data.

Finally, in order to compare our results with earlier research, it is necessary to discuss how our method differ from other methods in previous research. One difference in method is that some research applies cross country data instead of panel data, as discussed earlier in 5.2. Our method can be divided into our four different regressions, one growth regression and three transmission channel regressions, and equation (5.3) for capturing the total effect of corruption on growth. The growth regression (1) includes all established variables and we thereby do not consider this regression to be a source of error. However, the methodology for the transmission channels differs among researchers.

Pellegrini & Gerlagh (2004) and Mo (2001) are both focusing on the importance of transmission channels. Pellegrini & Gerlagh (2004) formed their transmission channel regressions, where the dependent variable is each transmission channel, with only initial GDP per capita and corruption as explanatory variables. Mo (2001) formed the growth regression and each transmission channel regression with the same explanatory variables. The explanatory variables explaining both growth and different transmission channels in the study are corruption, initial GDP per capita, Gastil index for political rights, Gastil index squared and population growth. The Gastil index aims to capture other institutional characteristics in each country according to Mo (2001). Both these methods differ from our method, as we included different explanatory variables for the growth regression and each transmission channel regression. We included the considered relevant explanatory variables in each transmission channel regression to explain domestic investment, FDI and human capital investment. These differences in method can likely explain why the results differ.

However, our results from our control variables in the regressions are mostly consistent with the conventional growth theory and previous research. It is mainly the effects of corruption that differ from our expectations, as it stays insignificant, which is unfortunate as it is the main focus of this thesis. This implies though that our method overall is well formed, as it returns reasonable additional results, and we therefore do not consider the model to be wrongly conducted.

9. Conclusion

This final section aims to emphasize the main findings and answer our purpose with this study. This thesis examines the relation between corruption, growth and investment. Our main questions followed: *is there any direct effect of corruption in low and low-to-middle income countries* and *are there any indirect effects of corruption on growth via three types of investment?* The three different types of investment explored are domestic investment, FDI and human capital investment as transmission channels for corruption.

This is done through panel data regressions, where we aimed to capture both the direct and the indirect effect of corruption and thereafter present a total effect of corruption on growth. This study is, to the knowledge of the authors, the first study that focuses exclusively on corruption's effect on different investment in developing countries.

The results of our empirical research indicate that there is no significant direct effect of corruption on economic growth. Neither can we establish any significant indirect effect of corruption on domestic investment and FDI. However, our result indicates that there is a weak negative significant effect of corruption on human capital investment and that corrupt countries spend less on education. Even though the relation is weak significant, it is reasonable to assume that human capital investment is an important transmission channel regression. Further, effects on human capital investment in general takes long time. It is therefore possible that a stronger relation would be found if one were to examine a longer time period. However, our result indicate that it is central for transition countries to combat corruption in order to invest more in human capital and increase their human capital level and growth.

We cannot show a strong relation between corruption and growth in low and low-to-middle income countries, but there may still exist an independent relationship if the country sample is wider across income groups. Our country sample may suffer from a range of other institutional and country specific issues that can prevent growth. Moreover, our results indicate that only eliminating corruption may not be enough to increase growth in countries which have a range of other growth preventing problems. It is therefore likely that the sole effect of corruption on growth cannot be captured. For future research, it is important to examine possible interactions between growth and corruption to understand how corruption affects poor countries. It is necessary in order to implement the right policies for both combating corruption and increasing growth in low and low-to-middle income countries and hence something we suggest for future research.

In addition, as our countries exhibit quite high levels of corruption, it is likely that there is some kind of threshold where a small change in corruption level does not affect growth in our country sample. Exploring data from low and low to middle income countries is further frequently associated with a lack of data and defective data, often resulting in deterioration of the significance.

Even if we cannot show a strong relation between corruption and growth, we still consider that corruption is severe for countries and societies. There are more consequences of corruption than economic, as it distorts countries through social, political and environmental implications. In addition to more research on the interactions between corruption and growth, we believe more research on transmission channels is needed. This study exclusively investigates three investment transmission channels, where there are various other channels through which corruption can affect growth. Therefore, more research is needed regarding both which transmission channels that can be subject for corruption and how important they are. Further research of transmissions channels would also give a better understanding for the numerous consequences of corruption by being able to specify the mechanisms via corruption affects growth. It is crucial to understand how corruption affects growth in order to establish relevant policies for fighting corruption worldwide.

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Appendix 1: Total list of all countries

Country classifications are derived from the World Bank (2018, 2).

Low income	**Low to middle income**
Burundi	Bangladesh
Benin	Bolivia
Burkina Faso	Cote D'Ivoire
Central African Republic	Cameroon
D.R. of Congo	Congo
Gambia	Egypt
Haiti	Ghana
Mali	Honduras
Malawi	Indonesia
Niger	India
Nepal	Kenya
Rwanda	Kyrgyzstan
Senegal	Cambodia
Togo	Lao
Tajikistan	Sri Lanka
Tanzania	Lesotho
Uganda	Morocco
Yemen	Republic of Moldova
	Mauritania
	Nicaragua
	Pakistan
	Philippines
	Sudan
	El Salvador
	Tunisia
	Ukraine
	Vietnam
	Zambia

Appendix 2: Specification of regressions

Regression (1): Corruption on growth

$$Gr_{it} = \alpha_{0,i} + \beta_1 Corr_{it} + \beta_2 LogY_{0,it} + \beta_3 Infr_{it} + \beta_4 Open_{it} + \beta_5 Pol_{it} + \beta_6 Pop_{it} + \beta_7 Inv + \beta_8 Hum_{it} + \beta_9 FDI_{it} + \beta_{10} Gov_{it} + \varepsilon_{it}$$

where i=(1,46) and t=(1,4) and $\beta_1, \ldots, \beta_{10}$captures the marginal effect of each variable on dependent variable GDP per capita growth.

Regression (2): Corruption on domestic investments

$$Inv_{it} = \alpha_{0,i} + \beta_1 Corr_{it} + \beta_2 LogY_{0,it} + \beta_3 Infr_{it} + \beta_4 Open_{it} + \beta_5 Infl_{it} + \varepsilon_{it}$$

where i=(1,46) and t=(1,4) and $\beta_1, \ldots, \beta_5$captures the marginal effect of each explanatory variable on Investment ratio.

Regression (3): Corruption on FDI

$$FDI_{it} = \alpha_{0,i} + \beta_1 Corr_{it} + \beta_2 LogY_{0,it} + \beta_3 Infr_{it} + \beta_4 Open_{it} + \beta_5 LogPop_{it} + \beta_6 Indu + \varepsilon_{it}$$

where i=(1,46) and t=(1,4) and $\beta_1, \ldots, \beta_6$captures the marginal effect of each explanatory variable on FDI.

Regression (4): Corruption on human capital

$$Hum_{it} = \alpha_{0,i} + \beta_1 Corr_{it} + \beta_2 LogY_{0,it} + \beta_3 Infr_{it} + \beta_4 Pol_{it} + \beta_5 LogPop_{it} + \beta_6 Pop14_{it} + \varepsilon_{it}$$

where i=(1,46) and t=(1,4) and $\beta_1, \ldots, \beta_6$captures the marginal effect of each explanatory variable on human capital investment.

Appendix 3: Results from econometric tests

3.1 Hausman test for fixed effect model

Table 3.1.1: Hausman test for regression (1)

	(b) Coefficient with fixed effects	(B) Coefficient with random effects	(b-B) Difference
Initial GDP per capita	-6.82307	-1.57731	-5.24576
Population growth	-.6989855	-.1113493	-.5876362
Political Instability	.8919281	-.6298106	1.521739
Domestic investment	.2009729	.1631005	.0378724
Trade openness	.0284215	.0314659	-.0030444
Corruption	-.2585348	.315822	-.5743568
FDI	.0580117	.0355652	.0224464
Infrastructure	.0365244	.0413654	-.004841
Government expenditure	.0259162	.0410337	-.0151175
Human capital	2.039187	.2295939	1.809593
Test: Ho: difference in coefficients not systematic (random effects model appropriate) Chi2(10)=19.09 Prob>chi2=0,0391			

Table 3.1.2: Hausman test for regression (2)

	(b) Coefficient with fixed effects	(B) Coefficient with random effects	(b-B) Difference
Initial GDP per capita	7.534223	3.121071	4.413152
Inflation rate	-.0203459	-.0179699	-.002376
Trade openness	.1271504	.0542251	.0729253
Corruption	1.390552	1.982039	-.5914872
Infrastructure	.0116874	.0402568	-.0285694
Test: Ho: difference in coefficients not systematic (random effects model appropriate) Chi2(5)=17.66 Prob>chi2=0,0034			

Table 3.1.3: Hausman test for regression (3)

	(b) Coefficient with fixed effects	**(B) Coefficient with random effects**	**(b-B) Difference**
Initial GDP per capita	-1.095766	-.0929612	-1.002805

Log population	7.191062	-.6407588	7.831821
Industry VA	-.063391	.0329692	-.0963602
Corruption	1.109251	.27933	.8299214
Trade openness	-.0046435	.0217052	-.0263487
Infrastructure	.0094936	.018978	-.0094844
Test: Ho: difference in coefficients not systematic (random effects model appropriate) Chi2(6)=9.68 **Prob>chi2=0,1387**			

Table 3.1.4: Hausman test for regression (4)

	(b) Coefficient with fixed effects	**(B) Coefficient with random effects**	**(b-B) Difference**
Initial GDP per capita	.165566	.3348917	-.1693257
Log population	1.866823	.3814796	1.485343
Political instability	-.1982012	-.1825393	-.0156619
Corruption	.3656853	.2857557	.0799296
Infrastructure	.0061226	.0081814	-.0020588
Population under 14	-.1166841	-.1312747	.0145905
Test: Ho: difference in coefficients not systematic (random effects model appropriate) Chi2(6)=44.32 **Prob>chi2=0,0000**			

3.2 Wald test for heteroskedasticity

Table 3.2.1: Wald test for regression (1)

H0: sigma(i)^2=sigma^2 for all i
Chi2(46)=8008.65 **Prob>chi2=0.0000**

Table 3.2.2: Wald test for regression (2)

H0: sigma(i)^2=sigma^2 for all i
Chi2(46)=29292,54 **Prob>chi2=0.0000**

Table 3.2.3: Wald test for regression (3)

H0: sigma(i)^2=sigma^2 for all i
Chi2(46)=1.7e+06 **Prob>chi2=0.0000**

Table 3.2.4: Wald test for regression (4)

H0: sigma(i)^2=sigma^2 for all i
Chi2(46)=4.0e+05 **Prob>chi2=0.0000**

3.3 VIF-test for multicollinearity

Table 3.3.1: VIF-test for regression (1)

Variable	**VIF**	**1/VIF**
Human capital	2.55	0.391918
Initial GDP per capita	2.52	0.396817
Population growth	2.08	0.481051
Infrastructure	1.58	0.632590
Corruption	1.55	0.646498
Political instability	1.53	0.653469
Domestic investment	1.39	0.717671
FDI	1.36	0.737844
Trade openness	1.34	0.748510
Government expenditure	1.30	0.768325
Mean VIF	1.72	
Thumb rule: VIF-values under 10 are tolerated		

Table 3.3.2: VIF-test for regression (2)

Variable	**VIF**	**1/VIF**
Infrastructure	1.47	0.680435
Initial GDP per capita	1.43	0.698879

Corruption	1.13	0.885851
Trade openness	1.12	0.893639
Inflation rate	1.1	0.910004
Mean VIF	1.25	
Thumb rule: VIF-values under 10 are tolerated		

Table 3.3.3: VIF-test for regression (3)

Variable	**VIF**	**1/VIF**
Infrastructure	1.49	0.673333
Initial GDP per capita	1.77	0.565942
Corruption	1.18	0.847582
Trade openness	2.08	0.481311
Industry VA	1.92	0.521147
Log population	1.43	0.698239
Mean VIF	1.64	
Thumb rule: VIF-values under 10 are tolerated		

Table 3.3.4: VIF-test for regression (4)

Variable	**VIF**	**1/VIF**
Infrastructure	1.39	0.721340
Initial GDP per capita	2.42	0.413397
Corruption	1.46	0.687276
Population under 14	2.05	0.486658
Political instability	1.66	0.601725
Log population	1.30	0.769331
Mean VIF	1.71	
Thumb rule: VIF-values under 10 are tolerated		

3.4 Correlation matrix for multicollinearity

	Gr	Pop	Y0	Hum	Inv	Open	Corr	FDI	Pol	Infr	Gov	Infl	Indu	Pop14	LogPop
Gr	1														
Pop	-0.1097	1													
Y0	0.1077	-0.5865	1												
Hum	0.1767	-0.6301	0.5645	1											
Inv	0.2468	-0.1220	0.2790	-0.0315	1										
Open	0.2541	-0.2477	0.2354	0.2083	0.0689	1									
Corr	0.0078	-0.0984	0.2411	-0.0099	0.2563	0.0957	1								
FDI	0.1907	-0.0570	0.0911	0.2350	0.2026	0.3514	0.0421	1							
Pol	-0.0264	-0.1145	0.1908	0.0797	0.2409	0.2232	0.5224	0.2355	1						
Infr	0.3606	-0.2563	0.5116	0.3968	0.2761	0.2976	0.0547	0.2109	0.0742	1					
Gov	0.1403	-0.0998	-0.1204	0.2363	-0.1605	0.1507	0.0648	0.1445	0.0686	-0.0005	1				
Infl	-0.1240	0.0224	-0.1870	-0.0054	-0.1324	-0.1230	-0.2615	-0.0523	-0.2700	-0.0849	-0.0258	1			
Indu	0.2532	-0.1728	0.3734	0.2522	0.2388	0.5308	-0.1091	0.1771	-0.0717	0.1642	0.1094	-0.0036	1		
Pop14	-0.1592	0.8343	-0.7049	-0.7083	-0.1730	-0.1749	-0.1027	-0.0888	-0.0942	-0.4276	-0.1408	0.0508	-0.2413	1	
LogPop	0.1538	-0.0946	0.2190	0.0353	0.2367	-0.3398	-0.0837	-0.2943	-0.3597	0.0445	-0.2240	0.0939	0.1455	-0.2348	1

3.5 Wooldridge test for autocorrelation

Table 3.5.1: Wooldridge test for regression (1)

H0: no first-order autocorrelation

F(1,45)=3.715 **Prob>F=0.0602**

Table 3.5.2: Wooldridge test for regression (2)

H0: no first-order autocorrelation
F(1,45)=10.535 **Prob>F=0.0022**

Table 3.5.3: Wooldridge test for regression (3)

H0: no first-order autocorrelation
F(1,45)=1.912 **Prob>F=0.1735**

Table 3.5.4: Wooldridge test for regression (4)

H0: no first-order autocorrelation
F(1,45)=11.327 **Prob>F=0.0016**

3.6 Im-Pesaran-Shin (IPS) test for non-stationarity

Note: H0=all panels contain unit roots, Ha=some panels are stationary

Variable	**Statistic**	**P-value**
GDP per capita growth	-81.7816	0.0000
Initial GDP per capita	12.8411	1.0000
Infrastructure*	-	-
Human capital	1.5611	0.9407
Government expenditure	-8.5327	0.0000
FDI	-3.2976	0.0005
Corruption	-1.8322	0.0335
Inflation*	-	-
Domestic investment	10.2794	1.0000
Log population	-20.8048	0.0000

Political instability	-3.7089	0.0001
Population growth	-2.6e+02	0.0000
Population under 14	-12.0789	0.0000
Trade openness	4.2321	1.0000
Industry VA	-9.2310	0.0000

**=IPS-test not applicable as one time period variable is missing*

3.7 Jarque Bera test for normal distributed residuals

Table 3.7.1: JB-test for regression (1)

H0: *normally distributed residuals*
Chi2=12 **P-value=0.0025**

Table 3.7.2: JB-test for regression (2)

H0: *normally distributed residuals*
Chi2=2.274 **P-value=0.3209**

Table 3.7.3: JB-test for regression (3)

H0: *normally distributed residuals*
Chi2=14.49 **P-value=0.00071**

Table 3.7.4: JB-test for regression (4)

H0: *normally distributed residuals*
Chi2=1.507 **P-value=0.4707**