The effect of infrastructure on foreign direct investment in Africa

Abstract

This thesis is about the effect of (different types of) infrastructure on foreign direct investment (FDI) in Africa. The existing academic literature gives no clear indication on whether different types of infrastructure have different effects. Research on these effects is relevant for policymakers, who may invest in infrastructure to stimulate economic growth, as well as academic researchers, who should generally include the most representative proxy for infrastructure in their models regarding the determinants of FDI. The fixed effects and generalized method of moments estimations show mostly robust insignificant relationships between a wide variety of infrastructure variables and FDI. Although this was not unforeseen with respect to communication infrastructure and electricity supply, also transport infrastructure does not exert a significant influence, which is surprising given that FDI in Africa is mainly resource-driven. These findings imply that I have not found support for investments in infrastructure by African governments to attract FDI. Furthermore, given that academic researchers often use the number of telephone lines as a proxy for infrastructure, this thesis provides theoretical and empirical reasons to overthink this choice when studying the determinants of FDI in Africa.

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1 Introduction

There is a consensus in the academic literature that infrastructure is an important determinant of Foreign Direct Investment (FDI) in Africa. Therefore, many authors have included this factor in their models to explain the variance in FDI inflows. However, considering that there has been little research on this relationship in Africa, it is questionable whether this is necessary. Moreover, in many cases researchers have proxied infrastructure with the number of telephone lines per 1000 inhabitants, but it is doubtful whether this indicator is (still) appropriate to represent the full level of infrastructure in a country. Other indicators could be related to transport infrastructure, such as roads, rails, seaports and airports, telecommunication infrastructure, like the number of mobile subscriptions or the number of inhabitants with access to internet, or electricity. Besides, the academic literature provides policymakers with insights in the determinants of FDI, of which some can be influenced by them. If a higher level of infrastructure in a country would stimulate FDI, they could be advised to invest in infrastructure. Nonetheless, so far there is no clear indication whether different types of infrastructure in Africa have different effects and if so, which ones should be invested in more heavily. Therefore, the aim of this thesis is to provide African policymakers with more accurate insights into the effect of (investing in) infrastructure on FDI and to fill a gap in the academic literature.

An important assumption in this thesis is that FDI stimulates economic growth, which makes studying the effect of infrastructure on FDI very relevant. Many studies have shown significant positive effects of FDI on economic growth (e.g. Johnson, 2006; Prüfer and Tondl, 2008), stimulating researchers to focus on how FDI could be attracted. FDI would lead to greater technological and knowledge spillovers, employment creation, innovation and increased competitiveness (Kobrin, 2005; Alfaro, Chanda, Kalemli-Ozcan, and Sayek, 2004). Some studies found that FDI only stimulates economic growth under certain conditions. A few others even dispute the existence of a clear relationship. Therefore, assuming that there is a positive effect, as I do in this thesis, might be wrong, but is very common to do. This not only holds for researchers but also for, for example, the United Nations, which have perceived FDI as a focus point in establishing long-term economic growth in developing countries (UNCTAD, 1999). As it is hard for policymakers to stimulate economic growth or to attract FDI to their country in a direct way, the determinants of FDI have received much attention on a global scale, with the bulk of research focusing on developed countries.

Within the literature on developing countries, only a small part is about Africa, whereas the determinants are not equally important with respect to this continent, according to Asiedu (2002). The number of studies that is about the determinants for FDI in Africa is limited, but most of them include infrastructure as one of the variables. Several of them found a positive correlation, but a considerable number of others did not find a significant relationship. Hence, the results on the relationship between infrastructure and FDI are rather mixed. This also follows from studies about FDI determinants in other continents. Although it might be expected that foreign investors prefer locations with a high level of infrastructure more, there is no straight-forward evidence in the academic literature that this factor significantly impacts their location decision. What makes it even more relevant to analyse this relationship in Africa, is that the papers specifically aimed at clarifying the effect of infrastructure on FDI in (a part of) Africa are just those of Khadaroo and Seetanah (2009 and 2010). Also, to my best

knowledge, the only paper that included a wide variety of infrastructure indicators is the one from Fedderke and Bogetic (2009). However, it examines the relationship with economic growth instead of FDI. The authors found a significant positive relationship, meaning that there might not only be an indirect effect of infrastructure on growth (via FDI), but also a direct effect. Furthermore, this study is one of the few that addresses the problem of reverse causality regarding the effect of infrastructure. When studying the effect of infrastructure on FDI this endogeneity should be accounted for, because otherwise the effect cannot be estimated accurately. Hence, there is ample room for enrichment of the present literature on this topic.

Apart from filling an apparent gap in the academic literature, there is another reason why it is important to study infrastructure as one of the possible determinants of FDI in Africa. From all developing countries, African countries have attracted the smallest amount of FDI during each year in the period 1990-2015, as is indicated by figure 1. Moreover, many countries in this continent are very poor. By attracting more FDI, poverty in these countries can be reduced. Hence, if infrastructure appears to attract FDI, investing in this factor could help to eradicate poverty in Africa. There are various prestigious organisations that underscore the importance of good infrastructure in Africa. According to the World Bank, a sufficient level of infrastructure is one of the components of a favourable investment climate for foreign as well as domestic investors (Farole and Winkler, 2013). However, it has declared that 'across Sub-Saharan Africa, poor infrastructure is a major bottleneck for sustainable development' (World Bank, 2014, p. 1). Also, the results from EY's 2015 Africa attractiveness survey showed that 'poor basic infrastructure' is the fourth most prominent barrier according to foreign investors, behind unstable 'political environment', 'corruption' and 'weak security' (EY, 2015). On top of that, KPMG identifies infrastructure as a stimulator for FDI inflow in Africa (KPMG, 2016). Hence, as it seems that a higher level of infrastructure may attract FDI, it is relevant to analyse this relationship empirically.

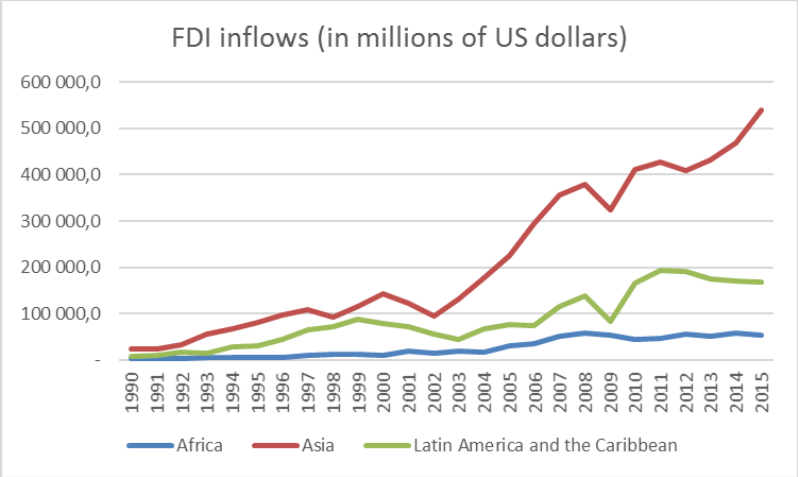

Figure 1. Source: UNCTAD, World Investment Report 2016.

In this thesis, I will deliberately analyse all countries in Africa, so not only Sub-Saharan countries, the latter being more common in the academic literature. It may be useful not to include developing countries from other continents, given that, at least according to Asiedu (2006), many African policymakers consider Africa to be structurally different from the rest of the world. Therefore, they would probably regard the results of the analysis in this thesis as

more credible. There are many determinants for FDI inflow, which will be controlled for in the empirical models, but the focus will be on the effect of infrastructure on FDI. This leads to the following research question:

"What is the effect of infrastructure on foreign direct investment in Africa?"

In order to be able to answer this question, three types of infrastructure will be analysed, namely transport infrastructure, communication infrastructure, and electricity supply. This distinction is necessary because these categories are rather different by definition, for which it is not unlikely that their relationships with FDI differ. Moreover, such a distinction makes it possible to test whether a common indicator for infrastructure, being the number of telephone lines per 1000 inhabitants, is representative.

The remainder of this thesis is as follows. Section 2 consists of the theoretical framework, in which I will elaborate on the present academic literature on the effects of different types of infrastructure on FDI. Furthermore, it includes hypotheses and discusses the endogeneity problem related to these effects. Then, section 3 describes the dataset and the variables used in the empirical models. Section 4 comprises the methodology, which includes the models and the methods used. After that, the results are presented in section 5. Lastly, section 6 concludes.

2 Theoretical framework

2.1 Infrastructure

Infrastructure is defined by the online economics dictionary of The Economist as 'the economic arteries and veins. Roads, ports, railways, airports, power lines, pipes and wires that enable people, goods, commodities, water, energy and information to move about efficiently'. Amongst others, it also says that infrastructure is increasingly considered as competitiveness-enhancing (The Economist, 2017). In this thesis, 'infrastructure' refers to both the quantity and the quality of infrastructure. For example, the number of roads (quantity) as well as the percentage of paved roads (quality) contributes to this factor. In the following, I shortly discuss the importance of a high level of infrastructure for an economy and I describe how the level of infrastructure in Africa is perceived in the academic literature.

According to Limao and Venables (2001), a relatively remote geographical location and poor transport and communications infrastructure are substantial barriers for countries to participate in global production networks. Poor infrastructure may lead to considerably high transport costs, may thus increase prices and in that way decrease competitiveness. Escribano, Guasch, and Pena (2010) noted that such an increase in logistical and transaction costs limits rural production and access to markets. They show empirical evidence that improvements in infrastructure may result in higher firm productivity and other economic performance measures, such as employment and investments. Hence, infrastructure development may influence all areas of an economy. According to Estache and Fay (2010), apart from its effect on firm productivity, infrastructure may affect the costs of investment adjustments, which decreases the amount of sunk costs, the durability of private capital and demand for as well as supply of health and education services. In addition to that, the authors conclude that there are network effects apparent in the infrastructure sector, which means that the value of the product or service is dependent on the number of users. Regarding telecommunications, an increase in the number of users would increase the value. However, this may be different for transport infrastructure types, such as roads and rail, which are generally more likely to face congestion problems. This means that infrastructure effects on, for example, economic growth may be nonlinear.

Another important feature of infrastructure is its spillover effects, which were researched by Richaud, Sekkat, and Varoudakis (1999). Their paper shows that improved infrastructure in one country may raise investment profitability in neighbouring countries. Therefore, cooperative agreements between countries on infrastructure investments may be attractive (Richaud et al, 1999). Also, these spillover effects are particularly important to landlocked countries, which can diminish their disadvantage of being landlocked by not only investing in their own infrastructure but also in the infrastructure of certain neighbouring countries (Limao and Venables, 2001). Due to these characteristics of infrastructure, its effect on economic growth has received much attention in the academic literature (see for example Ndulu (2006), Calderón and Servén (2008), and Estache and Fay (2010)). There is no need to discuss this effect extensively in this thesis, as it focuses on the effect of infrastructure on FDI.

With respect to the level of infrastructure in (Sub-Saharan) Africa, Calderón and Servén (2008) stated that it is generally low, even in comparison with other developing regions. They found

from the literature that there are two characteristics of Africa that may strengthen the effect of infrastructure on the region's economic development. These are that a large part of Africa's population is living in landlocked countries and that most of the region's economies are very remote from global market centres. Furthermore, Limao and Venables (2001) found that transport costs in Sub-Saharan Africa were relatively high and that internal and external trade flows were lower than predicted in standard gravity models. This was due to poor infrastructure and a penalty for remoteness. In addition to that, Collier and Gunning (1999) concluded that infrastructure is less available and less reliable in Africa than in other regions. Hence, it appears that the level of infrastructure in Africa is relatively low.

In addition to that, recently Bonfatti and Poelhekke (2017) studied the transport infrastructure and the direction of trade flows in developing countries, in particular in Africa. Their results showed that an increase in the number of mines, functioning as a proxy for mine-related infrastructure, biases trade flows of African countries directly connected to the coast towards overseas countries, whereas the opposite relationship is found for mining landlocked countries, which trade relatively more with neighbouring countries. This effect did not exist for oil and gas fields, which was expected as these commodities are transported through pipelines instead of over roads and rail. Also, the presence of a colonial legacy appeared to significantly influence the shape of a country's transport infrastructure network, given that colonial transport networks were primarily designed to export natural resources in an efficient way. Therefore, infrastructural networks in Africa may be different than in other continents, which might influence the effect of infrastructure on FDI in this continent.

2.2 The effect of infrastructure on FDI

One of the first studies on the determinants of FDI that included a proxy for infrastructure is the one by Root and Ahmed (1979). They found that 'commerce, transport and communication', which was defined as the average percentage of a country's GDP attributable to wholesale and retail trade, transport, and communication, had a significantly positive effect on FDI. Since then there have been several studies in which the models included the factor infrastructure as a determinant for investments. For example, Wheeler and Mody (1992) investigated the international investment location decisions for US firms. They defined infrastructure quality as the quality of transport, communications, and energy infrastructure. The results showed that, particularly for developing countries, infrastructure quality was one of the determining factors for FDI from US firms. A third important study in this respect from the previous century is the one by Loree and Guisinger (1995), which also focused on FDI of US firms. They performed a factor analysis including over twenty country-specific infrastructure characteristics, which enabled them to examine the effect of more infrastructure indicators on FDI than in previous studies. Both the communications and transport infrastructure variables had a significantly positive effect on FDI.

Biswas (2002) performed another study on FDI determinants and used two proxies for infrastructure, namely the number of main telephone lines per 100 inhabitants in each country and the per capita net installed capacity of electric generating power plants. The former controlled for communication infrastructure while the latter controlled for electricity supply. The influence of both variables on FDI was significantly positive. On top of that, Ramasamy and Yeung (2010) created a composite measure of infrastructure including the electricity supply per capita, the number of telephones per 1000 inhabitants, and the road

mileage per capita. They found a significant positive effect of this measure on FDI in the services industry as well as the manufacturing industry.

There are also studies that have focused on a specific type of infrastructure. For example, Cheng and Kwan (2000) researched the determinants of FDI in China and used three different proxies, namely the total length of roads per unit of land mass (road density), the total length of high grade paved roads per unit of land mass (paved road density), and the total length of railway per unit of land mass (railway density). Of these three proxies, only the first appeared to have a significantly positive effect. Another paper that solely used transport infrastructure proxies is the one by Coughlin and Segev (2000), who also researched FDI in China. The level of infrastructure was proxied by road density and air staff density, the latter being 'the number of total staff and workers in state-owned units of airway transportation in a province, divided by its population'. The effect of both variables was insignificant in all models. A third study on the effect of transport infrastructure, again in China, was performed by Sun, Tong, and Yu (2002). Their proxy, railway density, was significantly positive in most of the models.

Moreover, there is a study that solely used a communication infrastructure; Kinoshita and Campos (2003) used the number of main telephone lines as a proxy. They considered the availability of main telephone lines necessary to facilitate communication between home and host countries. They found a significantly positive effect for only a part of their sample. Finally, in their analysis on FDI by Japanese firms, Urata and Kawai (2000) used a different proxy for infrastructure, namely the level of electricity generation per person, for which they found a significantly positive effect on FDI.

Hence, a variety of proxies have been used to examine the effect of infrastructure on FDI. Most of the studies found positive effects. However, the relationship between infrastructure and FDI may be different in Africa. The question rises to what extent the results from studies that do not (only) include African countries are applicable to these countries. As mentioned before, Asiedu (2002) argued that the determinants of FDI are not equally important with respect to this continent, which she attributes to the very different circumstances in these countries. Indeed, this possible difference may have to do with, for example, low income levels, low schooling levels, and the abundance of natural resources. It could be the case that infrastructure only significantly stimulates FDI given, for example, a certain level of education in a country, which would explain a possible absence of significantly positive effects of infrastructure on FDI in Africa. With respect to infrastructure in Africa, the previously mentioned remarks of, amongst others, Calderón and Serven (2008) and Bonfatti and Poelhekke (2017) strengthen the notion of Asiedu (2002).

Furthermore, the relationship between infrastructure and FDI in Africa may be different because the type of FDI is generally different; in Africa, FDI is mostly driven by the abundance of natural resources (Pigato, 2000; Asiedu, 2006; Anyanwu, 2012). According to Asiedu (2006), this is problematic, because it would mean that FDI is very dependent on an uncontrollable factor, so it could not be influenced easily by the governments. Besides, investments in the natural resource sectors tend not to generate positive spillovers. This implies that countries which receive resource-seeking FDI are only benefiting from this to a relatively low extent, which is unfortunate as income levels are very low in Africa (Asiedu, 2006). Other concerns have been that this type of FDI would lead to environmental degradation and a high vulnerability in case of trade shocks, the latter because of the high

volatility of the commodity prices (Dupasquier and Osakwe, 2006). Apart from the relationship between FDI being driven by the abundance of natural resources and economic development, this type of FDI may also be influenced differently by infrastructure. For example, foreign investors that invest in natural resources would want to transport those resources to the location where they are used to fabricate products, which is often a location abroad, sometimes even in another continent. This means a high-quality transport network could be more important to these kinds of investors than to investors whose investments have other purposes.

Concluding, country-specific characteristics, which would generally be different in Africa than in other continents, and the fact that FDI would mostly be driven by the abundance of natural resources advocate that the effect of infrastructure on FDI may be different in Africa. Therefore, it may be fair to assign relatively more weight to studies that focus on Africa when establishing a theoretical basis for the expected effects of different types of infrastructure on FDI.

Before discussing the academic literature on the effect of infrastructure in Africa, I distinguish different types of infrastructure, namely transport infrastructure, communication infrastructure, and electricity supply, for which the effect should be examined separately. There are several reasons for this categorization. First, as was mentioned in the introduction, the relationships of these three infrastructure types with FDI could differ because they are different from each other by definition. Also, many studies have used the number of telephone lines per 1000 inhabitants as an indicator of the total level of infrastructure, but it is questionable whether this indicator is representative. For example, foreign investors may value the presence of a high-quality rail network in a country, but this does not necessarily mean that these same investors value the presence of a telephone line network to the same extent. In this case, the number of telephone lines would not fully capture the effect of infrastructure on FDI. Furthermore, the infrastructure indicators regarding which the World Bank provides data fall into these categories. On top of that, these categories comprise the elements in the definition of infrastructure given by The Economist (section 2.1). Lastly, they are mentioned by a variety of researchers as being important to foreign investors (Morisset, 2000; Anyanwu and Erhijakpor, 2004; Dupasquier and Osakwe, 2006). Thus, it is important to distinguish between these three types of infrastructure.

2.2.1 Transport infrastructure

Examples of transport infrastructure are roads, rail, seaports, and airports. Although many papers about the determining factors of FDI in developing countries have included a telephone indicator in their models as a proxy for infrastructure, mostly due to data unavailability, there are a few researchers who have used examples of transport infrastructure to study, amongst others, the effect of infrastructure on FDI. Kandiero and Chitiga (2006) have performed a study on the effect of trade openness on FDI using a selected panel of African countries. They found a significantly positive effect of road length on FDI, from which they conclude that infrastructure is an important factor to consider if Africa is to attract more FDI. Another study was conducted by Khadaroo and Seetanah (2009), who specifically studied the effect of transport infrastructure on FDI in Africa. They found a robust significantly positive effect of paved road density. A year later they conducted a similar study using a slightly different sample, from which they drew the same conclusions (Khadaroo and Seetanah, 2010).

Concluding, the few available African studies on the effect of transport infrastructure on FDI found a significantly positive influence. The non-African studies discussed earlier show rather mixed results in the sense that no effect or a positive effect was found. In the African context, I expect foreign investors to value transport infrastructure, as a high-quality transport network may save them lots of time and costs. As mentioned before, Limao and Venables (2001) reasoned that the relatively low external trade flows in Africa could be due to the generally high transport costs. This could equally apply to inward FDI flows. A decrease in transport time and costs could especially be important for foreign investors in Africa given that FDI in general would be resource-seeking to a large extent. Although there could be factors that are much more important to foreign investors, diminishing the impact of transport infrastructure on FDI, in my empirical analysis I expect to find a positive effect. This leads to the first hypothesis:

H1: *'There is a positive effect between transport infrastructure and FDI'*.

2.2.2 Communication infrastructure

As noted before, many researchers have included a telephone indicator in their models to proxy for infrastructure. This is one of the indicators that falls into the category 'communication infrastructure'. As this type of infrastructure may also be important for foreign investors, I give an overview of the literature on the effect of communication infrastructure on FDI.

Most of the literature on the effect of communication infrastructure on FDI in Africa also used the number of telephone lines as a proxy. Several of them found a significantly positive effect on FDI. These are the studies by Anyanwu and Erhijakpor (2004), Asiedu (2006), and Khadaroo and Seetanah (2009 and 2010). However, Asiedu (2002) and Onyeiwu and Shrestha (2004) used the same indicator and did not find a significant effect. The former found a significantly positive effect for her sample of non-Sub-Saharan African countries. She attributed this difference in outcome to the fact that FDI to Sub-Saharan Africa is mainly resource-seeking and infrastructure development, particularly the availability of telephones, is not very relevant for this type of investments. The latter gave a similar explanation for their finding, which was that the huge endowment in natural resources in some countries, such as Nigeria, more than compensates for the poor infrastructure, so the effect of infrastructure was outweighed.

Then there are studies that used another communication infrastructure proxy, such as the study by Kinda (2010), who used telecommunication problems as a proxy for infrastructure problems. These constraints appeared to have a significantly negative effect on FDI in Sub-Saharan African countries which implies a significantly positive effect of (the lack of a relatively low) infrastructure on FDI. One of his conclusions was that export-oriented firms were more constrained by these problems than firms that were supplying the domestic market. Given that resource-seeking FDI is prominent in Africa and that this type of FDI is mainly made by export-oriented firms, this could imply that communication infrastructure is important for foreign investors in Africa. Another study used the number of fixed and mobile subscribers per 1000 inhabitants; Anyanwu (2012) did not find a significant effect of this variable.

From the previous follows that the empirical results are quite mixed, as the studies either found a significantly positive effect or an insignificant relationship. These studies differ from each other in several ways, such as in (i) the number of countries that were included, (ii) the

period of time analysed, (iii) the estimation method used, and, to some extent, (iv) the used proxies for communication infrastructure. Hence, there is quite some heterogeneity present between these studies. This heterogeneity might explain the mixed results from these studies.

Although many studies have included the number of telephone lines as a proxy for infrastructure as a whole, I doubt whether this variable captures the effect of infrastructure on FDI fully. Several points of criticism can be thought of. First, Asiedu (2002) noticed that a good measure of infrastructure development should consider the availability as well as the reliability of infrastructure, whereas the number of telephone lines only captures the former. Nevertheless, she chose this proxy due to data unavailability of reliability measures, e.g. how often the phone lines are out of order. Hence, the reliability component of infrastructure is not taken into account.

Second, it is questionable to what extent the number of telephone lines is related to transport infrastructure, such as the number of roads in a country. For example, it is possible that the number of roads is quite high in (parts of) the country due to the its colonial history, for which Bonfatti and Poelhekke (2017) found a significant influence on a country's transport infrastructure network, whereas this colonial history may not have affected the level of communication infrastructure. This would imply that a country's level of transport infrastructure is relatively high whereas its level of communication infrastructure is relatively low, meaning that the number of telephone lines would not capture the total effect of infrastructure on FDI accurately.

A last point of criticism is that the number of telephone lines probably becomes less important in modern times, given the inventions of the internet and mobile phones. Foreign investors are more likely to care about internet access than about access to a fixed telephone, given that people can also speak to each other via the internet, which also provides many more options apart from that. Again, this results in the number of telephone lines being an inaccurate measure. However, this argument mostly applies to datasets including recent years, given that these communication options only have been available since a relatively short period of time.

The reason why communication infrastructure would be an important factor for foreign investors, is that it facilitates communication between home and host countries (e.g. Kinoshita and Campos, 2003). For example, it may be essential for high-ranked employees within multinationals to be able to communicate orders to their employees at the foreign facility without having to travel to the country the investment was made in. As well as a high level of transport infrastructure, a high level of communication infrastructure saves time and costs. In comparison to transport infrastructure, communication infrastructure may become more and more important due to globalisation and the shortening of product cycles. Proposed changes in global supply chains have to be implemented as quickly as possible.

It makes sense to assume that the above benefits of a high level of communication infrastructure are also applicable to FDI in Africa. If I would find a significantly positive effect between communication infrastructure and FDI, then this would support the findings of Anyanwu and Erhijakpor (2004), Asiedu (2006), Khadaroo and Seetanah (2009 and 2010), and Kinda (2010). However, I doubt that this relationship is significant in this continent. In line with the reasoning of Asiedu (2002) and Onyeiwu and Shrestha (2004), I consider it probable that the influence of communication infrastructure is outweighed by the abundance of natural

resources; if foreign investors want to exploit natural resources that are available in a limited number of African countries, there will be other factors that are way more important to them, among which is, in my opinion, transport infrastructure, because this factor affects costs more directly. Therefore, I will test whether there is a positive effect between communication infrastructure and FDI or not. This leads to the second hypothesis:

H2: *'There is a positive effect between communication infrastructure and FDI'*.

2.2.3 Electricity supply

There are relatively few studies that have included an electricity variable as a proxy for infrastructure in their empirical research, of which, to the best of my knowledge, none are about FDI in Africa. As mentioned before, Urata and Kawai (2000) found a significantly positive effect of their proxy for electricity supply on FDI for Japanese outward FDI. They noted that electricity supply is particularly important to small and medium-sized enterprises, as they do not, contrary to large firms, have the resources available to build their own power generating facilities. A good electricity supply may be important to foreign investors for various reasons. For example, a production facility requires a good electricity supply, given that machines cannot be operational otherwise. A good electricity supply requires sufficient access to electricity as well as reliable access. The latter implies that it may not be profitable to invest in a new production facility in a country if occasionally there is no electricity available.

In Africa, sufficient electricity supply and certainly a reliable supply may vary heavily among countries. In the light of the above reasons, a good electricity supply could therefore be a determining factor for FDI. This means that there might be a significantly positive effect between electricity supply and FDI. However, given that FDI is mostly resource-driven and that the exploitation of natural resources requires large investments, Africa probably attracts investments from foreign firms that possess the resources to build their own power generating facilities. Thus, it is doubtful whether this factor will significantly impact the location decision of foreign investors. Therefore, I will test whether there is a positive effect between communication infrastructure and FDI or not. This results in the third hypothesis:

H3: *'There is a positive effect between electricity supply and FDI'*.

2.2.4 Moderating factors of the effect between infrastructure and FDI

It is possible that certain factors influence the effect of infrastructure on FDI. In this thesis, I examine two of these factors, namely natural resources abundance and trade openness. The idea behind the first factor is that transport infrastructure may become more important to foreign investors if the amount of natural resources in the host country is large. This is because if these investors would make resource-driven investments and export the exploited resources, they would benefit from a high-quality transport infrastructure network. Given that FDI in Africa would mostly be resource-driven, I hypothesized before that there exists a positive effect between transport infrastructure and FDI (H1). As a follow-up, it is interesting to research whether transport infrastructure becomes more important when a country's natural resource endowment is high, and vice versa, which would mean that a possible positive effect regarding H1 is indeed linked to resource-driven FDI. So, if an influence would be found for this moderating effect, this would give information about the possible relationship between transport infrastructure and FDI. This leads to the fourth hypothesis:

H4: *'Abundance of natural resources positively moderates the effect between transport infrastructure and FDI'*.

The second factor, trade openness, embodies the extent to which governmental policies stimulate trade and to which a country is involved in trade with other countries. I assume that a higher level of trade openness renders the infrastructure more important to foreign investors, because the more they trade in a country, the more likely they are to use the infrastructure network and benefit from a high-quality network. I expect that this assumption specifically holds with respect to transport infrastructure; when trade openness is low, investment costs will generally be high, given that the government is not very motivated to facilitate trade. Foreign firms will therefore be less willing to import and export and will subsequently value the costs of trading less than when trade openness is high. Hence, I expect each foreign investor to require a certain level of trade openness to be present before transport infrastructure becomes relevant for the location decision of their investments. The higher the level of trade openness is above that required level, the greater the effect of transport infrastructure on FDI will be. Because of that, transport costs will be more important for foreign investors when trade openness is high. This results in the last hypothesis:

H5: *'Trade openness positively moderates the effect between transport infrastructure and FDI'*.

3 Data

In this section, the variables that were used in the empirical research are described. First, I discuss the database and the sample. Second, the dependent variable is mentioned. Third, the explanatory variables follow, which are proxies for the three types of infrastructure. Fourth, I mention the control variables.

3.1 Databases and sample

The data are mostly provided by the World Bank in its World Development Indicators database. There are a few variables for which the African Development Bank provides data, which will be mentioned if applicable. The sample covers unbalanced panel data from 54 African countries[1] from the period 1970-2015. As noted before, I have not limited this sample to Sub-Saharan African countries, as is common in the academic literature, in order to maintain a sufficient degree of variance, given that the North-African countries are generally considered as economically more developed. For each year, one score for each variable is attributed to each country. It should be clear that I did not remove any countries from the dataset. However, with respect to Somalia as well as South Sudan there is a very low number of observations, namely three, which are from 2013 onwards. Regarding the latter, this makes sense as it is only an independent country since 2011. Also, the dataset is unbalanced because I do not have data on all variables for the given time period, which implies that the sample is narrowed down dependent on the variables that are included in the model. This will mean that the sample in my analysis only covers data from 17 years from 1996 to 2015, not including 1997, 1999 and 2001.

With respect to several variables the natural logarithms are taken. These are the variables which are not denoted as percentages or indexes in order to have less skewed distributions. This diminishes the effect of outliers. The interpretation of the coefficients of log-transformed percentage or index variables would be difficult, so these variables are left in levels. Some variables are log-transformed with '+1', given that they have initial values that are equal to 1 or lower. Not adding one unit to their values would lead to negative or missing observations when log-transforming them. This is not uncommon in the literature (Asiedu, 2006; Bonfatti and Poelhekke, 2017). However, this method is not ideal, given that I had to modify the data in this way. The abbreviation 'ln' will indicate which variables were log-transformed.

3.2 Dependent variable

The dependent variable is the ratio of FDI over GDP. FDI is defined as the net inflows of foreign direct investments in every given year. This means that its value is positive if the amount of inflowing FDI is larger than the amount of outflowing FDI. A significant degree of influence on the management of the enterprise, which is a prerequisite for FDI, is expressed by the World Bank as the ownership of 10 percent or more of the ordinary shares of voting stock (World Bank, 2017). The data are given in current US dollars. The ratio of FDI over GDP as the

[1] These countries are the following: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo-Kinshasa, Congo-Brazzaville, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe.

dependent variable in models that estimate the influence of FDI determinants is widely used in the academic literature (Onyeiwu and Shrestha, 2004; Asiedu, 2006; Khadaroo and Seetanah, 2009; Anyanwu, 2012). It is important to interpret the amount of FDI in relative terms, because this simplifies comparing FDI flows to different countries. One of the reasons for studying FDI flows is that FDI may enhance the economy of the destination country. So, for example, if the FDI flows to two countries are equal but the sizes of their economies, measured as the GDP levels, differ, the FDI in the country with the lower level of GDP will have a greater impact, ceteris paribus. Given that present FDI location decisions may be based on previous investments, the one-year lag of the dependent variable is added as a control variable (*FDI/GDP (-1)*). Several studies have shown a significantly positive relationship between lagged FDI and aggregate FDI (Cheng and Kwan, 2000; Noorbakhsh, Paloni and Youssef, 2001).

3.3 Infrastructure variables

The three types of infrastructure are discussed below in three separate headings. Regarding transport and communication infrastructure there are also subheadings. Although not all variables will be used in the empirical analysis, they give an impression of the available data with respect to infrastructure.

3.3.1 Transport infrastructure

3.3.1.1 Air transport

The first out of four types of transport infrastructure is air transport. This type captures traffic of persons and goods by planes. The variables that can be used as indicators for this type are *air carriers*, *air freight*, and *air passengers*. *Air carriers* (ln) is the number of registered carrier departures worldwide, which is measured as the sum of domestic take-offs and take-offs abroad of air carriers registered in the country. This variable is a good proxy for air transport infrastructure, because an increase in this variable implies an increase in the amount of air transport between the country and other countries. This also applies to the other two variables, of which one is related to goods and the other to persons. *Air freight* (ln) is the volume of freight, express, and diplomatic bags carried on each flight stage, which is measured in metric tons times kilometres travelled. *Air passengers* (ln) is the number of both domestic and international aircraft passengers of air carriers registered in the country. Although these three variables are very related to each other, they measure slightly different components of air transport infrastructure. Other possible appropriate proxies, such as air staff density (used by Coughlin and Segev, 2000), are not included in my dataset due to data unavailability.

3.3.1.2 Rail transport

The second type is rail transport, which captures transport of persons and goods by trains. The variables in this case are *rail length* and *rail goods*. *Rail length* (ln) measures the length of railway route available for train service. I assume here that an increase in this variable leads to an increase in rail transport. However, it should be noted that this variable does not provide information on the quality or reliability of the rail nor the extent to which the rail network connects large parts of the country. Regarding the latter, it could indeed be the case that the number of kilometres of rail is high, but that the network is concentrated in a specific part of the country. The second variable is *rail goods* (ln), which captures the volume of goods transported by rail, again measured in metric tons times kilometres travelled. Apart from providing information on the quantity component of rail transport, it may indirectly indicate

how fast and reliable rail transport in a certain country is, because a relatively fast and reliable rail network will generally attract more demand for goods to be transported by this mode.

3.3.1.3 Waterway transport

With respect to the third type, waterway transport, data on two proxies was provided by the World Bank. The first variable is *container port traffic* (ln), which measures the flow of containers from land to sea transport modes, and vice versa, in twenty-foot equivalent units (TEUs). It is thus an indicator of how many goods are transported by ships. I assume that the more goods are transported via waterways, the higher the overall level of waterway transport is, ceteris paribus. The second variable is *liner shipping connectivity*, which is an index computed by the United Nations Conference on Trade and Development (UNCTAD). It measures how well countries are connected to global shipping networks. Five components of the maritime sector were used by UNCTAD to create this index, namely the number of ships, their container-carrying capacity, the maximum vessel size, the number of services, and the number of companies that deploy container ships in a country's ports. Hence, it gives an overall impression of the waterway connectivity of a country and thus of the attractiveness for firms to transport their goods via waterways. As landlocked countries are not (directly) connected to global shipping networks, this variable provides no information regarding these countries.

3.3.1.4 Road transport

The fourth type of transport infrastructure is road transport, which is proxied by *road length* and *road paved*. The data on these variables are provided by the African Development Bank. *Road length* (ln) captures the total road network in kilometres. Regarding this variable, the same criticism as regarding *rail length* is applicable. Again, I assume that more or longer roads lead to a higher level of transport infrastructure. Road paved is the number of kilometres of road that is paved as a share of the total road length. The African Development Bank defines 'paved' as surfaced with crushed stone, with concrete, or with cobblestones. This variable gives information on the quality of the roads, given that vehicles may drive faster over paved roads, which are more reliable and safe. However, Kinoshita and Campos (2003) and Mollick et al (2006) have argued that this variable can be misleading. They give the example that in a certain country there would only be one road, which is paved, resulting in a score of 100 percent. Such a high percentage would indicate a high level of transport infrastructure, but as there is only one road, this is not the case. Still, it could be useful to include this variable in an analysis, but no strong conclusions should be drawn from the results regarding this variable.

3.3.2 Communication infrastructure

3.3.2.1 Telephone

There are three proxies for communication infrastructure available that are related to telephones: *telephone lines*, *telephone fixed*, and *telephone mobile*. The data on the first one is provided by the African Development Bank and the data on the other two by the World Bank. *Telephone lines* (ln) represents the number of main telephone lines per 1000 inhabitants. These are telephone lines that connect the subscriber's terminal equipment to the public switched network and that have a dedicated port in the telephone exchange equipment. The higher the score on this variable, the more connected people in a country are or at least can be. As noted before, this is a common proxy for the total level of infrastructure.

However, with communication via mobile phones and internet taking a more and more prominent position in the operations of firms, it is doubtful whether this proxy is still so important to foreign investors as it might have been in the past. The second indicator, *telephone fixed* (ln), is the number of fixed telephone subscriptions per 100 inhabitants. This variable is very related to *telephone lines*, because the presence of a telephone main line is a prerequisite for a fixed subscription. Again, the higher the score for this variable, the more connected people may be. The third proxy is *telephone mobile* (ln), which is the number of mobile cellular subscriptions per 100 inhabitants. It is a communication variable that may be an appropriate proxy for the extent to which a country's communication infrastructure is modern.

3.3.2.2 Internet

The last communication infrastructure indicator is *internet users* (ln), which measures the number of internet users per 100 inhabitants. Just like telephone mobile subscriptions, this variable is probably becoming more important relative to the other two telephone variables. The more people use internet in a country, probably the more internet access points there are. In case of market-seeking FDI, the target group of domestic consumers can be reached easier when the people in such a group generally have internet access.

3.3.3 Electricity supply

There are two indicators for electricity supply available, which are *electricity access* and *electric power consumption*. The former represents the percentage of the population with access to electricity. A more indirect proxy for electricity supply is *electric power consumption (ln)*. It measures the electricity production of power plants in kWh per capita. The more electricity per capita is consumed, probably the more people have access to electricity.

3.4 Control variables

3.4.1 Market size, market potential and market advancement

There are certain variables related to characteristics of the host market that are generally accepted as being determinants of FDI. These variables are proxies for the market size, the market advancement and the market potential. Tsai (1994) stated that the market-size hypothesis implies that a sufficiently large market is necessary for an efficient utilization of resources and exploitation of economies of scale. The growth-hypothesis is that an economy that is growing at a high pace provides better opportunities to make profits than one that is not (Lim, 1983), thus this hypothesis has to do with market potential. In this thesis, the market size is proxied by a country's GDP and the market potential by the variable *GDP growth*. The former is already included in the dependent variable and is therefore not included as a separate control variable. According to Jaumotte (2004), who also used this proxy, the expected growth of the economy is an important determinant as FDI is typically a long-run and thus a forward-looking decision. As a third market characteristic, the extent to which the market is advanced is captured by the variable *real GDP per capita* (ln), which denotes the income of the inhabitants controlled for price fluctuations. It represents the per capita GDP converted to international dollars using purchasing power parity rates, i.e. an international dollar has the same purchasing power over GDP as the US dollar has in the United States. This variable could positively affect FDI, because higher levels of real GDP per capita may result in more savings and therefore more capital investments (Greene and Villanueva, 1991). Also, if

consumers have more money available, they may be more inclined to spend it on high-quality products. Chakrabarti (2001) argues that per capita GDP and absolute GDP measure sufficiently different aspects of the market, for which he chose to include both variables in his model. Hence, the market characteristics are controlled for via three variables.

3.4.2 Macroeconomic stability

Another factor that should be controlled for is the macroeconomic stability in a country. This factor is controlled for by the variable *inflation*, being the annual GDP deflator, which shows the rate of price change in a whole economy. According to Buckley, Clegg, Cross, Liu, Voss, and Zheng (2007), a volatile and unpredictable inflation rate creates uncertainty and makes long-term corporate planning difficult. Also, a high inflation rate results in a domestic currency devaluation, which diminishes the returns of foreign investors. Therefore, a high inflation rate worsens the business climate (Fisher, 1993). Greene and Villanuova (1991) found a significantly negative relationship between the inflation rate and private investment in developing countries. Again, this variable is widely used in the literature on FDI determinants in Africa (e.g. Asiedu, 2002; Anyanwu, 2012). I applied winsorizing on the inflation variable to the 0.005 and 0.995 percentiles to remove some very extreme values.

3.4.3 Trade policy

The extent to which a country's government is willing to stimulate trade by means of its trade policies is proxied by the sum of imports and exports as a share of GDP. This variable is called *trade openness*. Morisset (2000) found a significantly positive relationship between this indicator and FDI in Africa, for which the reason would be that it represents a less restrictive trade policy and a higher level of competitiveness. Furthermore, Kandiero and Chitiga (2006) specifically researched the relationship between trade openness and FDI, which also in this paper on Africa appeared to be significantly positive. Open markets would lead to a more efficient allocation of resources than less open markets. On top of that, Mottaleb and Kalirajan (2010) argued that a high degree of trade openness can compensate for having a small domestic market in attracting market-seeking FDI, as it enables foreign investors to reap the benefits of economies of scale nonetheless.

3.4.4 Natural resource endowment

As is indicated by several researchers, FDI in Africa is mostly driven by the abundance of natural resources (Pigato, 2000; Asiedu, 2006; Anyanwu, 2012). Therefore, omitting a control variable for this factor would probably give biased results (Asiedu, 2002). In this thesis, the variable is called *natural resources.* This represents the amount of fuel exports as a share of merchandise exports. These fuels comprise mineral fuels, lubricants and related materials. The fact that this variable shows fuel exports as a share of merchandise exports means that it measures the relative importance of fuels to a country's exports. Hence, if a country has an abundance of natural resources in absolute terms while its exports in general are high, the country's value would not be high, relatively. It thus shows the dependency of a country on natural resources rather than the extent to which an abundance of natural resources is present. Because the latter is what I aim to control for, this control variable is not ideal, but still gives some indication of natural resource endowments. The effect of this indicator on FDI is expected to be positive, given that, especially in Africa, natural resources generally attract FDI.

3.4.5 Human capital

Unsurprisingly, a larger high-skilled workforce attracts investments from foreigners that aim to produce high-quality products. Noorbakhsh et al (2001) found a significantly positive effect of this human capital on FDI. Their findings were supported by Nunnenkamp (2002). The human capital levels in African countries are in general relatively low, due to the fact that relatively many children do not go to school or enjoy fewer years of education. A proxy such as the enrolment ratio of people receiving tertiary education would not capture the effect of human capital on FDI in Africa properly, because the differences between the countries would be relatively small. Other proxies, such as the primary enrolment ratio and the secondary enrolment ratio, are more appropriate. I will use the gross primary enrolment ratio in my main analysis, given that the secondary enrolment ratio causes multicollinearity problems. The variable is called *human capital*. The gross primary enrolment ratio represents the total enrolment in primary education, regardless of age, expressed as a percentage of the population of official primary education age. This means that this percentage can reach levels above 100%. This proxy is not ideal, because measuring the net enrolment ratio would give data that are more comparable. With this I mean that measuring the number of children of a certain age group enrolled in primary education instead of the total enrolment in primary education would probably give a clearer picture of the differences in human capital between countries. A higher share of children of that age group in the gross primary enrolment ratio implies that there is relatively more potential to reach generally higher levels of education than in the situation that this share is low, because the older people get, the less likely they are to receive years of education after finishing their primary school or in the future in general. Because a sufficient level of human capital may be important to foreign investors to hire educated workers, I expect to find a positive coefficient of this proxy for human capital.

3.4.6 Institutional quality

The presence of good institutions would have a positive impact on FDI, because it decreases uncertainties and increases expected rates of return (Bénassy-Quéré, Coupet, and Mayer, 2007). Poor institutional quality implies higher costs, for example in the case of corruption (Wei, 2000). Other examples are that much bureaucracy is time-inefficient and results in extra costs, and that a high quality of legal enforcement measures increases certainty regarding safety and the property of goods. Institutional quality may also be related to whether the political system is a democracy, although the academic literature is divided on the effects of this factor on FDI (see for example Jensen, 2003; Asiedu and Lien, 2011). Morrissey (2012) concluded that good governance attracts FDI. *Political institutional quality* is included as a control variable in my analysis, which is related to the country average of twelve proxies for political institutional quality for every year, which Kunčič collected data on from different sources, such as the Freedom House, from 1990 to 2010 (Kunčič, 2014, p. 143, table 1). Contrary to the relative value of political institutional quality in his dataset, these absolute values are suitable for a within-country analysis, like the one in this thesis (Kunčič, 2014, pp. 149-150). Because in my sample this indicator is highly correlated with the other two indicators in the paper of Kunčič, namely legal institutional quality and economic institutional quality, it is less relevant which one of them is included in the analysis.

3.4.7 Financial development

Another factor that should be controlled for is the development of the financial system in a country. There is much literature on the impact that financial development has on the effect of FDI on economic growth (Hermes and Lensink, 2003; Alfaro et al, 2004). However, it is less common as a determinant of FDI. Noorbakhsh et al (2001) included a proxy for the depth of the financial sector, namely the share of domestic credit to the private sector in GDP. They also believed that this variable could be an indirect proxy for macroeconomic stability, as successful inflation stabilizations would be associated with an increased private sector's share of domestic credit. However, they found barely any significant effects on FDI. Anyanwu (2012) found a negative effect in his study on African countries. He concludes that a high level of credit to the private sector indicates that there is an abundance of domestic capital, which decreases the need of foreign capital in the form of FDI. There are data on two proxies for financial development available, namely the share of domestic credit to the private sector in GDP and the share of domestic credit provided by the financial sector in GDP. However, as will be explained later on, I do not include either of these proxies in my models because in this respect even the least problematic variable, being the share of domestic credit provided by the financial sector in GDP, leads to multicollinearity issues.

3.5 Descriptive statistics

In this section, the descriptive statistics of the variables that are included in the general model are shown. These are the dependent variable, the control variables, a transport infrastructure variable (*rail goods*), a communication infrastructure variable (*internet users*), and an electricity supply variable (*electricity access*). These variables are considered appropriate proxies for the effect of the respective type of infrastructure they belong to.

First, the summary statistics of the (partly transformed) data are shown in table 1. There are a few remarks to be made regarding these statistics. The first one is that the number of observations of *rail goods* is relatively low, which substantially decreases the number of observations included in the model. *Political institutional quality* has a relatively low number of observations as well. Therefore, this variable will not be included in the base model. Its addition to the base model will function as a robustness check, of which the results will be presented in the appendix. Regarding the variable *human capital,* it should be noted that it has values above 100 percent, as was explained before.

Second, the correlation matrix (table 2) indicates that possible problems may arise due to high correlations between certain variables, which can result in multicollinearity. In this thesis, I consider correlation scores of 0.7 or above as problematic. From the correlation matrix can be derived that there are two of such scores, which are the correlation between *financial development* and *rail goods*, and the one between *real GDP per capita* and *electricity access*. This implies that the respective control variables should not be included in models in which these infrastructure variables are included, because otherwise the effect of the infrastructure variables would not be measured accurately. Given the high correlations, the infrastructure variables control to a great extent for the effect that the control variable is supposed to have on the dependent variables, so it is not troubling to omit the control variables. However, it is important that the models are as consistent as possible in terms of the control variables that are included. Therefore, because I consider *financial development* to be of relatively minor importance, I remove this variable also from the other models. This does not apply to *real GDP*

per capita, which is a more common control variable in the academic literature. Thus, it is more incriminating to remove this control variable.

Table 1: summary statistics

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Number of observations	Mean	Standard deviation	Minimum	Maximum
FDI/GDP	2,019	3.292	8.526	-82.89	161.8
FDI/GDP (-1)	1,954	3.265	8.596	-82.89	161.8
GDP growth	1,989	3.940	7.679	-51.03	150.0
Ln real GDP per capita	1,302	7.682	1.020	5.480	10.79
Inflation	1,942	12.43	21.77	-18.22	181.5
Trade openness	1,889	71.88	44.51	6.320	531.7
Natural resources	1,137	17.64	30.27	0	99.66
Human capital	1,665	85.60	29.47	11.73	207.2
Financial development	1,914	32.83	57.78	-79.09	2,066
Political institutional quality	933	0.391	0.152	0.0425	0.831
Ln rail goods	601	6.869	1.782	0.693	11.81
Ln internet users	1,024	1.239	1.127	0	4.080
Electricity access	1,229	36.88	30.27	0.0155	100

Table 2: correlation matrix

1	2	3	4	5	6	7
FDI/GDP	FDI/GDP (-1)	GDP growth	Ln real GDP per capita	Inflation	Trade openness	Natural resources

8	9	10	11	12	13
Human capital	Financial development	Institutional quality	Ln rail goods	Ln internet users	Electricity access

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.00												
2	0.49	1.00											
	(0.00)												
3	0.21	0.25	1.00										
	(0.00)	(0.00)											
4	0.04	0.06	0.08	1.00									
	(0.13)	(0.02)	(0.00)										
5	-0.02	-0.01	-0.07	-0.09	1.00								
	(0.43)	(0.64)	(0.00)	(0.00)									
6	0.50	0.48	0.27	0.38	-0.04	1.00							
	(0.00)	(0.00)	(0.00)	(0.00)	(0.13)								
7	-0.02	-0.04	-0.03	0.38	0.06	0.01	1.00						
	(0.42)	(0.18)	(0.33)	(0.00)	(0.04)	(0.80)							
8	0.16	0.16	0.10	0.41	-0.04	0.29	0.13	1.00					
	(0.00)	(0.00)	(0.00)	(0.00)	(0.12)	(0.00)	(0.00)						
9	-0.16	0.02	-0.02	0.20	-0.04	0.07	-0.02	0.10	1.00				
	(0.00)	(0.33)	(0.28)	(0.00)	(0.06)	(0.00)	(0.58)	(0.00)					
10	-0.05	-0.08	0.01	0.26	-0.13	0.01	-0.33	0.33	-0.01	1.00			
	(0.11)	(0.01)	(0.66)	(0.00)	(0.00)	(0.72)	(0.00)	(0.00)	(0.69)				
11	-0.01	-0.01	0.00	0.55	-0.17	-0.05	-0.04	0.10	0.70	0.20	1.00		
	(0.73)	(0.84)	(0.93)	(0.00)	(0.00)	(0.20)	(0.37)	(0.02)	(0.00)	(0.00)			
12	0.04	0.04	-0.06	0.57	-0.13	0.14	0.09	0.39	0.25	0.37	0.40	1.00	
	(0.24)	(0.23)	(0.06)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)		
13	0.03	0.04	0.04	0.81	-0.07	0.27	0.35	0.29	0.44	0.19	0.56	0.56	1.00
	(0.23)	(0.15)	(0.12)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

4 Methodology

In this chapter, the methodology is discussed, which means I present the econometric model and the methods that I have used to examine the relationship between the infrastructure variables and FDI. In this respect, I also address the endogeneity problem.

4.1 Model

The base model only consists of the dependent variable and the control variables. The infrastructure variables will separately be added to this base model, after which the general model will follow. The most important papers in which this estimation methodology was applied as well are the paper of Wiklund and Shepherd (2003) and the paper of Rothaermel (2001). The base model is as follows:

(1) $$FDI/GDP_{it} = \alpha + \beta_1 * FDI/GDP_{it}(-1) + \beta_2 * GDPgrowth_{it} + \beta_3 * Real\ GDP\ per\ capita_{it} + \beta_4 * Inflation_{it} + \beta_5 * \text{Trade openness}_{it} + \beta_6 * Natural\ resources_{it} + \beta_7 * Human\ capital_{it} + \eta_i + \eta_t + \varepsilon$$

Where the subscript i denotes the country and the subscript t the year of observation. The country- and time-specific effects are accounted for by η_i and η_t, respectively. The error term is denoted by ε.

In the results section, I will present four different results tables. The first table will contain the estimation of a general model, which will consist of the base model and three infrastructure variables, each of which represents one type of infrastructure, as was mentioned before. They will separately be added to the base model in different models, so that the effects of the infrastructure variables can be examined more accurately. As a proxy for total transport infrastructure, I have chosen *rail goods*, because I consider rail transport together with road transport as the most essential type of transport, especially for resource-driven FDI. Waterway transport is also important, but including only a proxy of this type would eliminate all observations from landlocked countries. I consider a rail transport proxy to give more information about the overall advancement of the level of infrastructure in a country, because rail transport is a more expensive and cost-efficient way of transport than road transport. Also, I consider *rail goods* to be more appropriate than *rail length* because this variable has a quantity component (the more rail there is, the more goods can be transported) as well as a quality component (if the quality is low, this will probably decrease the number of goods transported), although it is influenced by the supply of and the demand for goods.

The proxy for communication infrastructure will be *internet users*. The reason for not choosing *telephone lines* or *telephone fixed* is that they are highly correlated with *real GDP per capita* and the electricity variables. Given that *telephone mobile* and *internet users* share a high correlation and are both not highly correlated with other variables in the general model, and given that there is no considerable difference in the number of observations included in the general model when replacing the one with the other, the choice for *internet users* was rather arbitrary in this respect.

Electricity access will function as a proxy for electricity supply, because I consider this variable to represent this type of infrastructure to a greater extent than *electric power consumption*. This is because if *electricity access* is high, it means that electricity is supplied to relatively many people, whereas *electric power consumption* can be high if there are only few people using electricity but to a great extent. I assume here that a high score on the former is

more likely to imply a countrywide supply of electricity, although I am aware that this might not be true for all countries.

Then, the second, third and fourth table show a closer look at the effects of transport infrastructure, communication infrastructure, and electricity supply, respectively. In these tables, models including multiple variables of the same infrastructure type are shown. In this way, the first three hypotheses can be researched. When choosing the infrastructure variables for these models I have selected combinations that are not highly correlated with each other and that do not cause large problems in terms of (many) high correlations with control variables or a decrease in the number of observations to below 70. The latter is because I do not consider results from models with observations below the arbitrary number of 70 to be representative. Also, I have tried to create diverse models in terms of the types of infrastructure that are represented.

Furthermore, the second table regarding transport infrastructure will contain a full model including several interaction terms, which enables me to research the fourth and fifth hypothesis. Joint F-tests will indicate whether the interaction effects are significant.

4.2 Estimation techniques

4.2.1 Fixed effects

I have preferred the fixed effects (FE) estimation over other common panel estimation methods, such as pooled OLS (POLS) and random effects (RE), for several reasons. There is undoubtedly an unobserved effect in the models; there are inherent time-constant differences between countries. Neglecting this effect would result in biased and inconsistent coefficients. Therefore, POLS is unsuitable. Besides, the underlying assumption of RE is that the unobserved effect is uncorrelated with each explanatory variable in all time periods, which is likely to be violated. Moreover, when the unit of observation is a large geographical unit, which applies to my dataset, it is advised to use FE instead of RE (Wooldridge 2013, p. 478). On top of that, the Hausman test, which I applied on the model without the explanatory variables (the base model) but including year dummies, shows that there is a significant difference between the FE and RE estimates (chi-square score of 118.07). Hence, I conclude that I should prefer FE. There could be a problem if there is little within-variation, but I argue that this is not the case in my dataset. Besides, the models will include year dummies to control for the impact of unobserved time-specific effects. Also, I will make use of robust standard errors to account for possible heteroskedasticity. The inclusion of the one-year lag of the dependent variable results in the panel being dynamic. This means the strict exogeneity assumption is violated, because the lagged dependent variable is necessarily correlated with the idiosyncratic error term. This implies that the fixed effects estimator is inconsistent. This problem is tackled in the next section.

4.2.2 Accounting for endogeneity

Apart from endogeneity resulting from the lag of the dependent variable, it is very likely that the infrastructure variables and the dependent variable are also endogenously related. Whereas I expect to find positive effects of infrastructure on FDI, FDI may also influence infrastructure. This is because this type of investments may actually be partly targeted on improving the infrastructure in the host country. For example, a foreign investor that invests in an African country to extract natural resources may be willing to improve the transport

infrastructure to ensure that the raw materials can be exported more easily. This example applies to certain Chinese multinationals that are active in Africa (Kaplinsky and Morris, 2008).

An appropriate method to deal with this endogeneity problem in panel data analysis is the generalized method of moments (GMM) estimation, which is recommended for cross-country panel data analyses by Arellano and Bond (1991). The instruments would be lags of the explanatory variables. Data on exogenous regressors that could function as instruments, such as a lag of governmental investments in infrastructure, were unavailable. In this thesis, a one-year lag for each infrastructure variable would suffice, as there is no reason to assume that the two-year lag would significantly affect the location decision of foreign investors.

The inconsistency of the fixed effects estimator is particularly problematic for panel datasets with many units of observation and few time periods (Nickell, 1981). Because in my dataset the number of units of observation is not large but also not small (in the base model the number of countries included is 42; Bruno (2005) considers 10 to 20 units to be small) and because only seventeen time periods are included, Nickell bias is likely to be present in my dataset. Also, Bruno noted that a weakness of GMM estimators is that they can be biased when the number of units of observation is small. Therefore, also in the light of the panel being unbalanced, I should correct for this by using the bias approximations by Bruno (2005), who extends the results by Kiviet (1995) and Bun and Kiviet (2002) to unbalanced panels. Because my dataset is unbalanced, meaning that the countries have a different number of observations, this technique is appropriate. I will use bootstrapped standard errors. Concluding, I will use the *xtlsdvc*-estimator proposed by Bruno with the initial estimator being the GMM-estimator by Arellano and Bond to correct for Nickell bias.

5 Results

This chapter is divided into several parts. First, in section 5.1, the general model is estimated. Then, in section 5.2, I have a closer look at the effect of transport infrastructure on FDI by including multiple transport infrastructure variables in one model. The same applies to section 5.3 and 5.4 regarding communication infrastructure and electricity supply, respectively. In section 5.5, GMM estimations are presented in order to take into account endogeneity.

5.1 General model

The results regarding the general model are given in table 3. The transport infrastructure variable *rail goods* does not have a significant effect on the dependent variable in any of the models, although I expected to find a significantly positive effect between these variables (H1). Albeit the number of observations, and subsequently the number of countries included, is considerably decreased by adding *rail goods* to the model, which makes it less representative, the R-squared is quite high in comparison with the models that include another infrastructure variable (3 and 4)[2], so apparently *rail goods* results in a remarkably higher share of the total variation in the dependent variable that is explained. The communication infrastructure variable *internet users* does not have a significant effect in the single model (3) nor in the general model (5). I hypothesized before that communication infrastructure would have a positive effect (H2), but this hypothesis is not supported by models 3 and 5. However, this finding is not completely robust, because the robustness check shows that *internet users* has a significantly positive effect in the full model (5) when *political institutional quality* is included as an extra control variable (table 1 in the appendix). Electricity supply, proxied by *electricity access*, appears not to significantly influence the dependent variable, so the third hypothesis is not supported.

With respect to H4, the F-test for joint significance[3] shows that the interaction effect (the unique effect of *rail goods* combined with the interaction term) is insignificant in model 6. However, the interaction effect regarding H5 in model 7 appears to be significant. The results regarding these hypotheses are looked into in more detail in the next section.

With regard to the control variables in models 1 to 5,[4] it should be noted that *real GDP per capita* is not included in the models that include *electricity access*, due to the high correlation between the two variables. Moreover, the first lag of the dependent variable has a significantly positive effect in all models. Also, *GDP growth* appears to have a significantly positive impact on the dependent variable in most of the models, as was expected. On top of that, *trade openness* and *human capital* significantly stimulate the dependent variable in the models that do not include *rail goods*, despite of the low correlations between these variables. This probably has to do with the substantial loss of observations that is accompanied with the inclusion of *rail goods*.

[2] Because the given R-squared is not the adjusted R-squared, which gives a 'penalty' for adding variables, the R-squared of model 2 should not be compared to that of model 1, which includes one variable less.
[3] This test calculates the joint significance of the unique effect of the infrastructure variable and the effect of the interaction term.
[4] The effects of the control variables in models 6 and 7 are not interpreted, as the inclusion of interaction effects causes unreliable estimates of the former effects.

Table 3: FE estimation of the general model

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP	(6) FDI/GDP	(7) FDI/GDP
FDI/GDP (-1)	0.392**	0.574***	0.370*	0.395**	0.607***	0.603***	0.588***
	(0.189)	(0.152)	(0.199)	(0.192)	(0.119)	(0.120)	(0.125)
GDP growth	0.050*	0.098*	0.065	0.049*	0.128**	0.134**	0.162***
	(0.025)	(0.054)	(0.052)	(0.025)	(0.060)	(0.060)	(0.057)
Ln real GDP per capita	1.805	2.549	2.785				
	(1.854)	(1.777)	(2.256)				
Inflation	0.007	-0.029	-0.009	0.007	-0.016	-0.015	-0.032**
	(0.021)	(0.022)	(0.012)	(0.021)	(0.015)	(0.016)	(0.015)
Trade openness	0.045***	0.036	0.074***	0.044***	0.081	0.082	-0.154
	(0.013)	(0.031)	(0.021)	(0.013)	(0.052)	(0.052)	(0.141)
Natural resources	0.020	0.032	0.011	0.022	0.015	-0.092	0.012
	(0.024)	(0.036)	(0.024)	(0.025)	(0.020)	(0.133)	(0.021)
Human capital	0.020*	0.007	0.028**	0.019*	0.025	0.028	0.039
	(0.012)	(0.011)	(0.012)	(0.011)	(0.020)	(0.021)	(0.026)
Ln rail goods		0.531			1.380	1.088	-0.629
		(0.602)			(0.861)	(0.890)	(1.577)
Ln internet users			-0.456		-0.231	-0.228	-0.225
			(0.476)		(0.470)	(0.458)	(0.438)
Electricity access				-0.006	-0.067	-0.080	-0.127
				(0.030)	(0.076)	(0.082)	(0.088)
NRxRailgoods						0.015	
						(0.018)	
TOxRailgoods							0.035
							(0.022)
Constant	-17.449	-26.204	-27.131	-3.743*	-13.946*	-11.553	1.734
	(14.665)	(16.467)	(18.082)	(1.902)	(7.767)	(8.281)	(12.463)
Observations	645	275	557	643	220	220	220

R-squared	0.359	0.552	0.344	0.356	0.627	0.628	0.641
Number of countries	43	26	43	43	26	26	26
Year dummies	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: summary statistics of additional transport infrastructure variables

VARIABLES	(1) Number of observations	(2) Mean	(3) Standard deviation	(4) Minimum	(5) Maximum
Ln air freight	1,774	2.332	1.579	0	7.118
Ln road length	567	9.691	1.383	5.768	12.80
Liner shipping connectivity	456	11.82	10.99	0	68.28

Table 5: correlation matrix of additional transport infrastructure variables

1	2	3	4	5	6	7
FDI/GDP	FDI/GDP (-1)	GDP growth	Ln real GDP per capita	Inflation	Trade openness	Natural resources
8	9	10	11	12	13	
Human capital	Institutional quality	Ln rail goods	Ln air freight	Ln road length	Liner shipping connectivity	

	1	2	3	4	5	6	7	8	9	10	11	12	13
11	-0.16	-0.17	-0.05	0.18	-0.00	-0.15	0.07	0.06	0.14	0.61	1.00		
	(0.00)	(0.00)	(0.04)	(0.00)	(0.85)	(0.00)	(0.03)	(0.04)	(0.00)	(0.00)			
12	-0.15	-0.14	-0.10	-0.09	0.13	-0.40	0.26	0.00	0.06	0.43	0.25	1.00	
	(0.00)	(0.00)	(0.03)	(0.04)	(0.00)	(0.00)	(0.00)	(0.98)	(0.20)	(0.00)	(0.00)		
13	-0.16	-0.15	-0.05	0.28	-0.05	-0.18	0.03	0.07	0.25	0.43	0.50	0.41	1.00
	(0.00)	(0.00)	(0.29)	(0.00)	(0.29)	(0.00)	(0.65)	(0.23)	(0.00)	(0.00)	(0.00)	(0.00)	

Table 6: FE estimation of the transport infrastructure models

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP	(6) FDI/GDP	(7) FDI/GDP
FDI/GDP (-1)	0.574***	0.373*	0.270	0.303	0.499***	0.495***	0.516***
	(0.152)	(0.213)	(0.162)	(0.228)	(0.131)	(0.125)	(0.088)
GDP growth	0.098*	0.078***	0.058	-0.044	0.125	0.244	0.022
	(0.054)	(0.025)	(0.036)	(0.128)	(0.134)	(0.233)	(0.126)
Ln real GDP per capita	2.549	2.475	-0.454	14.552*	2.705	4.342	-11.267
	(1.777)	(2.287)	(2.094)	(8.437)	(7.814)	(8.594)	(9.291)
Inflation	-0.029	0.006	-0.021	0.003	0.017	0.010	-0.065
	(0.022)	(0.024)	(0.020)	(0.025)	(0.066)	(0.064)	(0.079)
Trade openness	0.036	0.050***	0.024	0.187**	0.235**	0.242**	-0.398*
	(0.031)	(0.014)	(0.018)	(0.078)	(0.103)	(0.102)	(0.191)
Natural resources	0.032	0.022	0.059	-0.014	-0.011	-0.390	0.014
	(0.036)	(0.024)	(0.040)	(0.036)	(0.017)	(0.392)	(0.036)
Human capital	0.007	0.020	0.030	0.111*	0.129	0.158	0.369
	(0.011)	(0.014)	(0.018)	(0.057)	(0.154)	(0.139)	(0.212)
Ln rail goods	0.531				2.132	0.636	4.035
	(0.602)				(3.729)	(5.673)	(4.525)
Ln air freight		-0.218			0.921	2.489	4.534***
		(0.235)			(0.719)	(1.560)	(1.052)
Ln road length			1.674				

			(1.037)				
Liner shipping connectivity				-0.051	-0.063	-0.080	0.482
				(0.049)	(0.060)	(0.067)	(0.299)
NRxRailgoods						0.063	
						(0.058)	
NRxAirfreight						-0.036	
						(0.024)	
NRxLSC						0.000	
						(0.001)	
TOxRailgoods							0.115***
							(0.025)
TOxAirfreight							-0.078**
							(0.030)
TOxLSC							-0.007
							(0.004)
Constant	-26.204	-22.634	-16.938	-139.210*	-68.772	-78.586	-9.581
	(16.467)	(18.333)	(20.612)	(74.281)	(87.398)	(92.777)	(121.051)
Observations	275	530	237	230	98	98	98
R-squared	0.552	0.367	0.460	0.356	0.758	0.772	0.822
Number of countries	26	39	36	28	14	14	14
Year dummies	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Transport infrastructure

In table 4 and table 5 respectively, the summary statistics and the correlation table regarding three additional transport infrastructure variables are presented. Regarding *liner shipping connectivity* only data is available from 2004 onwards. Table 6 shows the results regarding the four transport infrastructure variables, of which three are included in a full model (5). *Road length* is not included in this model, as the number of observations would become too low to provide meaningful information.[5] However, because I expect the road infrastructure to be of high importance to foreign investors, *road length* is included in a single model (3); its effect is insignificant. It is remarkable that the robustness check shows a significantly positive effect (table 2 in the appendix). *Rail goods* does not have a significant influence in the full model (the single model was already shown in table 3). The same goes for *air freight* and *liner shipping connectivity*. Hence, none of the infrastructure variables in the full model is significant, so there is barely any support for the first hypothesis. The significance and sign of the coefficients of certain control variables change through the different models, but as their signs do not significantly change, this is not problematic.[6]

With regard to the interaction effects with natural resources in model 6 (H4), none of them are significant. However, the robustness check results in three significant interaction effects, of which *rail goods* and *liner shipping connectivity* are positive and *air freight* is negative. As the coefficient of the interaction term between *rail goods* and *natural resources* is positive, it implies that there is a positive interaction effect. This means that an increasing level of natural resources results in a greater effect of *rail goods*, being a proxy for rail transport, on *FDI/GDP.*[7] The same goes for the proxy for waterway transport (*liner shipping connectivity*). This was also my expectation (H4). The negative coefficient of the interaction term with *air freight* is surprising. Hence, the fourth hypothesis is only partly supported and the findings are not robust.

The results of the interaction effects regarding trade openness are given in model 7 (H5). Two out of three interaction effects appear to be jointly significant (p-value for *rail goods* as well as for *air freight* is below 0.01). Considering the interaction term between *trade openness* and *rail goods* there is a positive coefficient, indicating that the interaction effect is positive. For the interaction term between *trade openness* and *air freight* however, a negative effect is found. This contradicts my expectation that the interaction effects of the different proxies for transport infrastructure would be positive. However, this significant interaction term is not robust, whereas the one with *rail goods* is. So, the only robust finding regarding H5 is that an increase in *trade openness* results in a greater effect of *rail goods* on *FDI/GDP*. Hence, I found some evidence to support the fifth hypothesis.

5.3 Communication infrastructure

In table 7 and table 8 respectively, the summary statistics and the correlation table regarding two additional communication infrastructure variables are presented. There are two

[5] Including *road length* would result in only 29 observations to be used.

[6] Note that the coefficients of the control variables in models 6 and 7 should not be interpreted.

[7] I do not look extensively into the sizes of the interaction effects. However, as an example, the size of this effect is calculated as follows. Meaningful values are used to calculate the effect, i.e. the 25% and 75% percentiles of *natural resources*. The marginal effect of *rail goods* on *FDI/GDP* for the 25% percentile is an increase of (0.64+0.05*0.07) 0.64 percentage point and for the 75% percentile (0.64+0.05*18.42) 1.56 percentage point.

correlations regarding which the scores are high, namely the correlation between *real GDP per capita* and *telephone lines*, and between *internet users* and *telephone mobile*. Due to the former, *real GDP per capita* will not be included in the models that include *telephone lines.* The latter implies that also these two communication infrastructure variables should not be included in the same models.

The results on the effects of the communication infrastructure variables are shown in table 9. None of the communication infrastructure variables exerts a significant influence, whereas a positive effect was expected (H2). The effect of *internet users* in the general model in table 3 was also insignificant. These results are robust (table 3 in the appendix). The effects of the control variables are very consistent, with those of *FDI/GDP (-1)* and *trade openness* being positive in all models and *human capital* being positive in almost all models. Hence, the second hypothesis is not supported, because an insignificant effect is found for all communication infrastructure variables.

5.4 Electricity supply

In table 10 and table 11 respectively, the summary statistics and the correlation table regarding one additional electricity supply variable are presented. *Real GDP per capita* should be left out in the model including *electric power consumption*, due to the high correlation score. Table 12 shows the results on electricity supply. No significant effects of this type of infrastructure on *FDI/GDP* are found. These findings are robust (table 4 in the appendix). The control variables with a significant coefficient all have the expected sign. Concluding, the third hypothesis is not supported, as there is no evidence for a positive influence.

Table 7: summary statistics of additional communication infrastructure variables

VARIABLES	(1) Number of observations	(2) Mean	(3) Standard deviation	(4) Minimum	(5) Maximum
Ln telephone lines	1,821	2.348	1.241	0.0136	5.742
Ln telephone mobile	1,535	1.664	1.800	0	5.201

Table 8: correlation matrix of additional transport infrastructure variables

1	2	3	4	5	6	7
FDI/GDP	FDI/GDP (-1)	GDP growth	Ln real GDP per capita	Inflation	Trade openness	Natural resources
8	9	10	11	12		
Human capital	Institutional quality	Ln internet users	Ln telephone lines	Ln telephone mobile		

	1	2	3	4	5	6	7	8	9	10	11	12
11	0.04	0.04	0.05	0.78	-0.14	0.25	0.07	0.43	0.44	0.56	1.00	
	(0.08)	(0.07)	(0.05)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)		
12	0.13	0.14	0.05	0.48	-0.20	0.18	0.06	0.41	0.28	0.86	0.39	1.00
	(0.00)	(0.00)	(0.09)	(0.00)	(0.00)	(0.00)	(0.10)	(0.00)	(0.00)	(0.00)	(0.00)	

Table 9: FE estimation of the communication infrastructure models

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP
FDI/GDP (-1)	0.370*	0.428**	0.376*	0.390**	0.397**
	(0.199)	(0.186)	(0.201)	(0.191)	(0.194)
GDP growth	0.065	0.027	0.064	0.048*	0.043
	(0.052)	(0.025)	(0.053)	(0.025)	(0.026)

Ln real GDP per capita	2.785			2.003	
	(2.256)			(1.971)	
Inflation	-0.009	0.007	-0.011	0.008	0.008
	(0.012)	(0.016)	(0.012)	(0.021)	(0.020)
Trade openness	0.074***	0.032**	0.074***	0.046***	0.043***
	(0.021)	(0.012)	(0.020)	(0.015)	(0.013)
Natural resources	0.011	0.015	0.011	0.021	0.020
	(0.024)	(0.012)	(0.024)	(0.024)	(0.024)
Human capital	0.028**	0.014	0.031**	0.020	0.019*
	(0.012)	(0.010)	(0.013)	(0.012)	(0.010)
Ln telephone lines		-0.398	-0.217		-0.098
		(0.561)	(0.614)		(0.567)
Ln internet users	-0.456		-0.247		
	(0.476)		(0.402)		
Ln telephone mobile				-0.315	-0.213
				(0.407)	(0.369)
Constant	-27.131	-2.489	-6.039**	-18.974	-2.834
	(18.082)	(1.915)	(2.603)	(15.626)	(1.719)
Observations	557	770	553	644	668
R-squared	0.344	0.392	0.346	0.360	0.363
Number of countries	43	46	43	43	43
Year dummies	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: summary statistics of additional communication infrastructure variables

VARIABLES	(1) Number of observations	(2) Mean	(3) Standard deviation	(4) Minimum	(5) Maximum
Ln electric power consumption	1,195	5.435	1.353	2.377	8.492

Table 11: correlation matrix of additional communication infrastructure variables

1	2	3	4	5	6	7
FDI/GDP	FDI/GDP (-1)	GDP growth	Ln real GDP per capita	Inflation	Trade openness	Natural resources
8	9	10	11			
Human capital	Institutional quality	Electricity access	Ln electric power consumption			

	1	2	3	4	5	6	7	8	9	10	11
10	0.03	0.04	0.04	0.81	-0.07	0.27	0.35	0.29	0.19	1.00	
	(0.23)	(0.15)	(0.12)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)		
11	-0.01	-0.01	-0.02	0.79	-0.15	0.25	0.01	0.52	0.44	0.70	1.00
	(0.72)	(0.72)	(0.53)	(0.00)	(0.00)	(0.00)	(0.89)	(0.00)	(0.00)	(0.00)	

Table 12: FE estimation of the electricity supply models

VARIABLES	(1) FDI/GDP	(2) FDI/GDP
FDI/GDP (-1)	0.395**	0.639***
	(0.192)	(0.128)
GDP growth	0.049*	0.039*
	(0.025)	(0.022)
Inflation	0.007	0.005
	(0.021)	(0.021)
Trade openness	0.044***	0.016*
	(0.013)	(0.009)
Natural resources	0.022	0.014
	(0.025)	(0.013)
Human capital	0.019*	0.007
	(0.011)	(0.010)
ln electric power consumption		0.405
		(0.506)
Electricity access	-0.006	
	(0.030)	
Constant	-3.743*	-2.617
	(1.902)	(2.890)
Observations	643	590
R-squared	0.356	0.538
Number of countries	43	27
Year dummies	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.5 Endogeneity

5.5.1 General model

To take into account the probable reverse causality in the relationship between infrastructure and FDI, GMM estimations serve as robustness checks for the results found in the previous sections. The results of the GMM estimation of the general model are shown in table 13. Compared to the results in table 3, there are no coefficients of the infrastructure variables that have now become significant in the models 1-5. The significances and signs of the control variables have stayed more or less the same. Whereas the first lag of *FDI/GDP* has a significantly positive effect in all models, the lag thereof (so the second lag of *FDI/GDP*) is mostly insignificant, which would mean that the effect of the lag of *FDI/GDP* in the main results is not robust. The interaction effects in models 6 and 7 are both jointly insignificant, whereas the one in model 7 in table 3 was significant. Hence, the results regarding the general model are robust, except for the significance of the interaction effect regarding H5.

5.5.2 Transport infrastructure

The GMM estimation of the transport infrastructure models can be found in table 14. In comparison with table 6 one model is missing; the correction by Bruno (2005) to the GMM estimation does not allow the variable *road length* to be included, probably because of too few observations. Whereas the FE estimation did not show significant effects for the transport infrastructure variables in the models without interaction terms, there is one significant effect in the GMM estimation; *liner shipping connectivity* has a significantly negative effect. This implies that the higher a country's score in the liner shipping connectivity index is, the lower the share of FDI over GDP. There are no remarkable changes in the coefficients of the control variables. Hence, the results regarding the first hypothesis are quite robust; the main difference in results is that *liner shipping connectivity* has become significantly negative in the full model (4).

Contrary to the findings from model 6 in table 6, the F-tests for joint significance of the interaction effects in model 5 indicate that the interaction effect between *natural resources* and *air freight* is significant (and negative), whereas the other two are (still) not. In model 6 in table 14, none of the interaction effects are jointly significant, whereas in model 7 in table 6 there were two significant interaction effects. Hence, the results with respect to H4 and H5 are only partly robust.

Table 13: GMM estimation of the general model

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP	(6) FDI/GDP	(7) FDI/GDP
FDI/GDP (-1)	0.428***	0.627***	0.433***	0.431***	0.780***	0.775***	0.748***
	(0.067)	(0.197)	(0.045)	(0.027)	(0.212)	(0.215)	(0.186)
FDI/GDP (-2)	0.091	0.038	0.056***	0.091	-0.142	-0.136	-0.119
	(0.181)	(0.041)	(0.021)	(0.087)	(0.157)	(0.157)	(0.154)
GDP growth	0.050	0.094	0.069	0.048	0.122	0.124	0.151
	(0.054)	(0.076)	(0.100)	(0.051)	(0.267)	(0.266)	(0.272)
Ln real GDP per capita	1.674	2.282	2.341				
	(4.074)	(11.969)	(1.777)				
Inflation	0.007	-0.032	-0.009	0.007	-0.020	-0.019	-0.034**
	(0.022)	(0.064)	(0.017)	(0.016)	(0.017)	(0.018)	(0.016)
Trade openness	0.037	0.031	0.066***	0.036***	0.086	0.085	-0.122
	(0.024)	(0.038)	(0.014)	(0.012)	(0.076)	(0.076)	(0.262)
Natural resources	0.014	0.031	0.006	0.015	0.008	-0.047	0.005
	(0.060)	(0.065)	(0.040)	(0.135)	(0.102)	(0.262)	(0.095)
Human capital	0.020	0.009	0.027	0.019	0.024	0.025	0.035
	(0.028)	(0.082)	(0.039)	(0.028)	(0.081)	(0.084)	(0.091)
Ln rail goods		0.338			1.182	1.023	-0.591
		(1.729)			(2.885)	(2.976)	(2.167)
Ln internet users			-0.314		-0.142	-0.145	-0.147
			(0.619)		(1.347)	(1.680)	(1.491)
Electricity access				-0.005	-0.068	-0.076	-0.123
				(0.088)	(0.300)	(0.285)	(0.276)
NRxRailgoods						0.008	
						(0.030)	
TOxRailgoods							0.031
							(0.035)
Observations	642	274	554	640	219	219	219

Number of countries	43	26	43	43	26	26	26
Year dummies	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14: GMM estimation of the transport infrastructure model

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP	(6) FDI/GDP
FDI/GDP (-1)	0.627***	0.415***	0.432***	0.900***	0.887***	0.827***
	(0.197)	(0.096)	(0.141)	(0.163)	(0.163)	(0.147)
FDI/GDP (-2)	0.038	0.105	-0.013	-0.405***	-0.376***	-0.312**
	(0.041)	(0.153)	(0.130)	(0.110)	(0.122)	(0.154)
GDP growth	0.094	0.084	-0.025	0.222*	0.314***	0.118
	(0.076)	(0.081)	(0.222)	(0.118)	(0.094)	(0.157)
Ln real GDP per capita	2.282	1.902	12.225	6.381	4.696	-10.199
	(11.969)	(5.938)	(12.976)	(12.104)	(9.681)	(13.499)
Inflation	-0.032	0.005	0.002	0.017	0.008	-0.060
	(0.064)	(0.020)	(0.034)	(0.121)	(0.100)	(0.124)
Trade openness	0.031	0.040	0.173***	0.200***	0.206***	-0.238
	(0.038)	(0.038)	(0.058)	(0.060)	(0.048)	(0.649)
Natural resources	0.031	0.014	-0.018	-0.013	-0.208	0.004
	(0.065)	(0.134)	(0.096)	(0.049)	(0.668)	(0.045)
Human capital	0.009	0.019	0.105	0.083	0.108	0.384***
	(0.082)	(0.041)	(0.128)	(0.152)	(0.240)	(0.108)
Ln rail goods	0.338			2.088	1.988	6.137
	(1.729)			(4.773)	(4.005)	(5.081)
Ln air freight		-0.201		0.797	2.274***	3.318
		(0.384)		(0.871)	(0.741)	(2.215)
Liner shipping connectivity			-0.042	-0.057*	-0.055	0.547

			(0.045)	(0.032)	(0.056)	(0.515)
NRxRailgoods					0.038	
					(0.093)	
NRxAirfreight					-0.034**	
					(0.015)	
NRxLSC					-0.000	
					(0.001)	
TOxRailgoods						0.088
						(0.092)
TOxAirfreight						-0.054
						(0.044)
TOxLSC						-0.008
						(0.006)
Observations	274	529	230	98	98	98
Number of countries	26	39	28	14	14	14
Year dummies	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.5.3 Communication infrastructure

The results on the effects of the communication infrastructure variables are shown in table 15. The coefficients are still all insignificant. Regarding the control variables can be noted that there are no surprising changes in signs of variables with significant coefficients. I conclude that the results regarding the second hypothesis are very robust.

5.5.4 Electricity supply

Table 16 shows that the coefficients of the electricity supply variables are still insignificant. Regarding the control variables I recognize that there are again no surprising changes in signs of variables with significant coefficients. I conclude that the results are robust; the proxies for electricity supply do not exert a significant influence on *FDI/GDP*, so the results do not support the third hypothesis.

Table 15: GMM estimation of the communication infrastructure model

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP
FDI/GDP (-1)	0.433***	0.437***	0.435***	0.428***	0.428***
	(0.045)	(0.068)	(0.082)	(0.073)	(0.054)
FDI/GDP (-2)	0.056***	0.124	0.073	0.090	0.105
	(0.021)	(0.101)	(0.078)	(0.183)	(0.134)
GDP growth	0.069	0.026	0.065	0.049	0.042
	(0.100)	(0.068)	(0.047)	(0.060)	(0.055)
Ln real GDP per capita	2.341			1.837	
	(1.777)			(3.078)	
Inflation	-0.009	0.007	-0.011	0.008	0.008
	(0.017)	(0.017)	(0.024)	(0.023)	(0.033)
Trade openness	0.066***	0.027	0.065***	0.038*	0.035
	(0.014)	(0.027)	(0.023)	(0.020)	(0.023)
Natural resources	0.006	0.011	0.004	0.014	0.013
	(0.040)	(0.012)	(0.025)	(0.071)	(0.042)
Human capital	0.027	0.013	0.031	0.019	0.019
	(0.039)	(0.016)	(0.032)	(0.028)	(0.018)
Ln telephone lines		-0.250	-0.150		0.007
		(1.734)	(1.038)		(0.753)
Ln internet users	-0.314		-0.151		
	(0.619)		(0.964)		
Ln telephone mobile				-0.288	-0.196
				(0.916)	(0.834)
Observations	554	766	550	641	665
Number of countries	43	46	43	43	43
Year dummies	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 16: GMM estimation of the electricity supply model

VARIABLES	(1) FDI/GDP	(2) FDI/GDP
FDI/GDP (-1)	0.431***	0.646***
	(0.027)	(0.065)
FDI/GDP (-2)	0.091	0.096*
	(0.087)	(0.050)
GDP growth	0.048	0.033
	(0.051)	(0.040)
Inflation	0.007	0.006
	(0.016)	(0.018)
Trade openness	0.036***	0.010
	(0.012)	(0.015)
Natural resources	0.015	0.009
	(0.135)	(0.028)
Human capital	0.019	0.011
	(0.028)	(0.015)
ln electric power consumption		0.312
		(1.678)
Electricity access	-0.005	
	(0.088)	
Observations	640	575
Number of countries	43	27
Year dummies	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6 Conclusion

In this thesis, I have researched the effect of infrastructure on FDI in Africa. A good infrastructure could decrease costs for foreign investors and thus attract FDI, but it has been unclear whether its influence is significant. In order to conduct this research, I have used a categorization of infrastructure, resulting in three different types: transport, communication and electricity. The level of infrastructure comprises its quality as well as its quantity. I have observed from the present academic literature that the few studies that have examined this effect in Africa do not provide a clear indication whether different types of infrastructure have different effects on FDI. If this would be true, policymakers could be advised to invest in the important types, based on the assumption that FDI leads to economic growth. In this way, poverty in this continent can be reduced. Also, whereas most researchers include a proxy for infrastructure in their estimations on the determinants of FDI, there is no consensus in the literature on which indicator represents the total level of infrastructure best. Many studies include the number of telephone lines, but this might not be an appropriate proxy. As the level of infrastructure in Africa is generally found to be relatively low and as FDI in Africa is mainly resource-driven, the effect of infrastructure on FDI could be different compared to other continents. Therefore, it is important that this effect is researched solely for African countries.

I have applied panel data regressions using FE and GMM techniques, the latter functioning as a means to take into account the probable endogeneity in the relationship between infrastructure and FDI. With respect to the first hypothesis the results indicate that I have found very little evidence for a positive effect between transport infrastructure and FDI. Only the FE estimation including the proxy for institutional quality (the robustness check) showed a positive effect of (a proxy for) road transport. Almost all coefficients were insignificant and robust. The second hypothesis is not supported, as I did not find any significant effects of communication infrastructure variables in the FE estimation as well as the GMM estimation in any of the models. However, this is not very surprising given the findings of Asiedu (2002) and Onyeiwu and Shrestha (2004) mentioned in paragraph 2.2.2. The influence of communication infrastructure on FDI may be outweighed by other factors, such as the level of natural resources. Then, the results regarding the effect between electricity supply and FDI do not support the third hypothesis, because I did not find any significant effects of its proxies. However, also these results are not very surprising, given the doubts raised in paragraph 2.2.3; Africa may mostly attract investments from foreign firms that possess the resources to build their own power generating facilities. The last two hypotheses had to do with interaction effects. The fourth hypothesis, being that there would be a positively moderating effect of natural resources on the effect between transport infrastructure and FDI, is barely supported, because the F-tests showed (unstable) insignificant effects. Lastly, regarding the fifth hypothesis I found a quite robust positively moderating effect of trade openness on the effect between rail transport infrastructure and FDI. However, this effect disappeared in the GMM estimation. Thus, the fifth hypothesis is only partly supported. I conclude that I did not find support for the first three hypotheses and that I have found some evidence to support the fourth and the fifth hypothesis.

The research question in this thesis was “what is the effect of infrastructure on foreign direct investment in Africa?” The results indicate that infrastructure barely influences the amount of FDI that African countries attract. With respect to communication infrastructure and electricity supply, this is not very surprising, given the doubts that were mentioned in the

theoretical framework; these factors could be of no significant importance to foreign investors, given that FDI in Africa is mainly resource-driven. However, although these investors in many cases want to export the natural resources, and thus would benefit from a high-quality transport network, I did also not find much evidence for the importance of transport infrastructure, even when researching the probable moderating effect of natural resources on the effect of infrastructure on FDI for this type of investors. I conclude that I have not found much support for the existence of an effect of infrastructure on FDI in Africa.

This conclusion has two important implications, one for African policymakers and another for academic researchers. Given that African policymakers may aim to attract as much FDI as possible to stimulate economic growth, I have not found much support for investments in infrastructure to achieve this goal. Based on the results in this thesis, I would suggest that they focus on other determinants of FDI which can be influenced by government policy. The implication for academic researchers is that the number of telephone lines may not be a good proxy for the level of infrastructure in a country when studying (one of) the determinants of FDI, as I did not find a significant effect of this variable in any of the models, although this variable is often used by academic researchers. Because the number of observations of several transport infrastructure variables is relatively low, it is understandable that researchers nonetheless include this proxy in their models on the determinants of FDI. However, they should take into account that the importance of this variable may have diminished in recent years due to the (increasing) availability of internet and mobile phones.

Like in many other papers in which the relationship between infrastructure and FDI in Africa is researched, I found hardly any evidence for the existence of such a relationship in this thesis. Meanwhile, Fedderke and Bogetic (2009) have found a significant positive effect of different types of infrastructure on economic growth in their study on South Africa, as was mentioned in the introduction. Hence, whereas an indirect effect of infrastructure (via FDI) on economic growth may be absent in Africa, a direct effect may exist. The reason for this could be that, although local firms may benefit from improved infrastructure – i.e. more efficient operations and lower transport costs – leading to lower production costs, a higher level of competitiveness compared to other countries than before and eventually economic growth, the importance of infrastructure for foreign investors is outweighed by other factors. Previously I have mentioned the level of natural resources being one of those factors, but also the other control variables in the empirical models could be regarded as more important. The profitability of local firms may be different from that of foreign investments, given that foreign investors may invest in a particular sector for which certain specific factors are relevant, whereas infrastructure may be more of a general factor influencing profitability which only occasionally is one of the most relevant factors in an investment location decision. Therefore, improved infrastructure may in general contribute to economic growth, but may often not be regarded as one of the most relevant factors for foreign investors.

There are several limitations present in my study. First, the errors in the regressions may suffer from autocorrelation, which means that there is a correlation between the errors in two or more consecutive time periods. It is probable that autocorrelation is present in the GMM estimations, because the instruments to tackle the endogeneity problem are the lags of the explanatory variables of the FE estimations and the values of the infrastructure variables are highly dependent on the value in the previous year. In many cases, the level of (a certain type

of) infrastructure is approximately similar to the level in the previous year. This means the errors are likely to be correlated. Moreover, the inclusion of a lagged dependent variable in a model depletes the sample size by one year and also comes with a high probability of (first-order) autocorrelation, the latter because the value of the dependent variable in a year depends on its value in the previous year. This problem of autocorrelation can be overcome by adding more lags of the dependent variable to the model. However, due to the low number of observations in most of the models, this might not have been ideal. Autocorrelation causes the GMM-estimator to be inefficient, as it is not the best linear unbiased estimator (the estimator with the lowest possible variance). This means that the t-values will be too high and so the null-hypothesis is rejected when it is true (Verbeek, 2012, pp. 95-96).

Also, I did not take into account the Sargan J-test for overidentifying restrictions, which checks whether the instruments are uncorrelated with the error term and thus whether the instruments are good; if there is a correlation between an instrument and the error term, that instrument is endogenous, which means there are more restrictions than the number of endogenous variables. If the null-hypothesis is rejected, the model is misspecified, which could imply that the coefficients are biased (Verbeek, 2012, pp. 403-404).

Another limitation is that the fixed effects estimations, as well as the method of Bruno (2005) to correct for Nickell bias that provides bootstrapped standard errors, are based on the assumption that the errors are normally distributed. Although several variables have been transformed into natural logs, resulting in more normal distributions, I did not do so for all. As probably not all variables are normally distributed, some p-values might not have been measured accurately. Although the assumption of normality is not one of the critical assumptions, non-normality decreases the efficiency of the estimations.

Moreover, the data on road length I retrieved from the African Development Bank website is rather limited, only including 567 observations of all 54 countries during the period 1990-2010. This is unfortunate, because I consider sufficient road transport infrastructure to be a basic requirement to transport people and goods within a country in an efficient way. Due to the fact that the number of observations in my models was very much decreased by including a proxy for road transport infrastructure, I could not include these proxies in my full models in order to examine their precise effects on FDI. Khadaroo and Seetanah (2009) constructed a database from, for example, the International Road Federation (IRF) and various countries' Central Statistical Office. With regard to the former, the data is not provided for free, while retrieving data from national statistical offices may be quite time-consuming. However, a more extensive database on road transport infrastructure would enrich analyses such as the ones conducted in this thesis.

A recommendation for further research is to examine whether the effect of infrastructure on FDI has changed over time. More specifically, it would be interesting to know whether certain types of infrastructure have become more (or less) important to foreign investors. An example of this is that it could be the case that the extent to which the people in a country have internet access was not important until the year 2000 or 2005, but that it has gradually become a means for foreign investors that seek to sell products to the local market to get in touch with consumers in this market and advertise in a more efficient way. If certain types of infrastructure have become more important during recent years and if a significant effect of

these types of infrastructure on FDI is found, policymakers should focus on improving especially these types of infrastructure. An analysis regarding this recommendation could be performed by including interaction terms between time dummies and the variable of interest in a model. If the coefficients of these interaction terms become higher (in absolute terms) over time, it means the effect on FDI has become greater. The estimation methods used in this thesis could be applied in such an analysis.

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Appendix

Robustness check

Table 1: FE estimation of the general model

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP	(6) FDI/GDP	(7) FDI/GDP
FDI/GDP (-1)	0.414***	0.194	0.395***	0.415***	0.119	0.098	0.115
	(0.091)	(0.123)	(0.088)	(0.093)	(0.134)	(0.143)	(0.134)
GDP growth	0.045	0.023	0.081**	0.041	0.062	0.065*	0.073*
	(0.029)	(0.026)	(0.034)	(0.029)	(0.039)	(0.038)	(0.041)
Ln real GDP per capita	-0.801	1.656	-1.871				
	(1.254)	(1.367)	(1.983)				
Inflation	0.016	-0.004	-0.010	0.017	-0.018*	-0.017*	-0.021**
	(0.017)	(0.007)	(0.008)	(0.017)	(0.009)	(0.009)	(0.009)
Trade openness	0.022**	0.001	0.027**	0.022**	-0.030	-0.027	-0.085
	(0.010)	(0.022)	(0.012)	(0.010)	(0.024)	(0.026)	(0.056)
Natural resources	-0.016	0.009	-0.020	-0.018	0.022	-0.051	0.021
	(0.019)	(0.013)	(0.020)	(0.019)	(0.014)	(0.111)	(0.015)
Human capital	0.014	-0.000	0.023*	0.015	0.013	0.014	0.016
	(0.012)	(0.007)	(0.013)	(0.012)	(0.012)	(0.013)	(0.014)
Political institutional quality	-2.048	1.350	-3.006	-2.233	-2.167	-1.600	-1.607
	(2.101)	(1.746)	(2.269)	(2.203)	(1.978)	(2.039)	(2.036)
Ln rail goods		0.001			0.389	0.238	-0.086
		(0.296)			(0.534)	(0.527)	(0.583)
Ln internet users			-0.049		0.646***	0.649***	0.657***
			(0.276)		(0.211)	(0.219)	(0.206)
Electricity access				-0.018	-0.041	-0.047	-0.054
				(0.031)	(0.036)	(0.040)	(0.045)

NRxRailgoods						0.011	
						(0.016)	
TOxRailgoods							0.008
							(0.007)
Constant	4.881	-12.648	12.558	-0.480	1.087	1.837	4.300
	(9.216)	(9.482)	(14.540)	(1.213)	(2.882)	(2.722)	(3.994)
Observations	469	203	395	467	157	157	157
R-squared	0.383	0.235	0.392	0.382	0.264	0.266	0.268
Number of countries	36	22	36	36	22	22	22
Year dummies	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2: FE estimation of the transport infrastructure models

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP	(6) FDI/GDP	(7) FDI/GDP
FDI/GDP (-1)	0.194	0.422***	0.442***	0.478***	0.274	0.103	0.466
	(0.123)	(0.088)	(0.075)	(0.130)	(0.298)	(0.279)	(0.359)
GDP growth	0.023	0.055	0.056	0.040	-0.230	-0.137	-0.156
	(0.026)	(0.033)	(0.033)	(0.039)	(0.152)	(0.168)	(0.173)
Ln real GDP per capita	1.656	-1.274	1.052	14.899*	29.937	34.803	26.010
	(1.367)	(1.533)	(1.569)	(7.978)	(22.258)	(20.172)	(20.365)
Inflation	-0.004	0.015	-0.004	-0.026**	0.067	0.132	0.023
	(0.007)	(0.020)	(0.015)	(0.012)	(0.054)	(0.083)	(0.053)
Trade openness	0.001	0.020**	0.034***	0.030	0.122	0.214**	-0.409*
	(0.022)	(0.008)	(0.011)	(0.028)	(0.069)	(0.092)	(0.225)
Natural resources	0.009	-0.013	-0.003	-0.034**	-0.036	-0.610*	-0.037
	(0.013)	(0.017)	(0.019)	(0.014)	(0.025)	(0.316)	(0.030)
Human capital	-0.000	0.012	0.032*	0.114*	0.092	0.162	0.206
	(0.007)	(0.013)	(0.017)	(0.058)	(0.224)	(0.197)	(0.191)

Political institutional quality	1.350	-1.373	-3.951	-10.544	41.322	50.583*	40.945
	(1.746)	(2.270)	(2.671)	(9.016)	(25.604)	(23.600)	(23.640)
Ln rail goods	0.001				5.665	3.746	2.481
	(0.296)				(4.151)	(5.375)	(4.503)
Ln air freight		0.022			-1.170	1.463	2.141
		(0.107)			(0.827)	(1.177)	(1.905)
Ln road length			2.266**				
			(0.992)				
Liner shipping connectivity				-0.045	-0.014	-0.076	0.501
				(0.041)	(0.076)	(0.077)	(0.290)
NRxRailgoods						0.104*	
						(0.051)	
NRxAirfreight						-0.054**	
						(0.024)	
NRxLSC						0.001*	
						(0.000)	
TOxRailgoods							0.099**
							(0.043)
TOxAirfreight							-0.066
							(0.046)
TOxLSC							-0.007*
							(0.003)
Constant	-12.648	8.383	-32.618**	-125.870*	-315.235	-365.207*	-284.903
	(9.482)	(11.556)	(14.962)	(64.203)	(183.413)	(167.826)	(184.327)
Observations	203	380	221	129	58	58	58
R-squared	0.235	0.392	0.614	0.510	0.260	0.386	0.367
Number of countries	22	33	31	22	12	12	12
Year dummies	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: FE estimation of the communication infrastructure models

VARIABLES	(1) FDI/GDP	(2) FDI/GDP	(3) FDI/GDP	(4) FDI/GDP	(5) FDI/GDP
FDI/GDP (-1)	0.395***	0.415***	0.396***	0.414***	0.414***
	(0.088)	(0.093)	(0.091)	(0.091)	(0.093)
GDP growth	0.081**	0.045	0.072**	0.044	0.044
	(0.034)	(0.029)	(0.031)	(0.028)	(0.028)
Ln real GDP per capita	-1.871			-0.753	
	(1.983)			(1.440)	
Inflation	-0.010	0.016	-0.010	0.016	0.016
	(0.008)	(0.017)	(0.008)	(0.017)	(0.017)
Trade openness	0.027**	0.023**	0.029**	0.022**	0.023**
	(0.012)	(0.011)	(0.012)	(0.010)	(0.011)
Natural resources	-0.020	-0.016	-0.023	-0.016	-0.016
	(0.020)	(0.020)	(0.023)	(0.018)	(0.021)
Human capital	0.023*	0.015	0.022	0.014	0.014
	(0.013)	(0.013)	(0.014)	(0.012)	(0.013)
Political institutional quality	-3.006	-2.041	-3.565	-2.090	-2.070
	(2.269)	(2.137)	(2.217)	(2.110)	(2.167)
Ln telephone lines		0.268	-0.082		0.287
		(0.602)	(0.758)		(0.628)
Ln internet users	-0.049		-0.200		
	(0.276)		(0.302)		
Ln telephone mobile				-0.039	-0.109
				(0.272)	(0.245)
Constant	12.558	-1.722	-0.820	4.535	-1.729
	(14.540)	(2.091)	(3.055)	(10.554)	(2.101)
Observations	395	467	393	468	466
R-squared	0.392	0.379	0.385	0.382	0.378

Number of countries	36	36	36	36	36
Year dummies	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: FE estimation of the electricity supply models

VARIABLES	(1) FDI/GDP	(2) FDI/GDP
FDI/GDP (-1)	0.415***	0.384***
	(0.093)	(0.115)
GDP growth	0.041	0.055
	(0.029)	(0.037)
Inflation	0.017	0.018
	(0.017)	(0.023)
Trade openness	0.022**	0.004
	(0.010)	(0.019)
Natural resources	-0.018	-0.018
	(0.019)	(0.019)
Human capital	0.015	0.010
	(0.012)	(0.017)
Political institutional quality	-2.233	-0.788
	(2.203)	(4.143)
Electricity access	-0.018	
	(0.031)	
ln electric power consumption		-0.297
		(0.615)
Constant	-0.480	1.481
	(1.213)	(3.703)

Observations	467	314
R-squared	0.382	0.271
Number of countries	36	23
Year dummies	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1