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ERASMUS SCHOOL OF ECONOMICS

The Relation Between GDP Growth in Poland and Chinese Investments in Infrastructure Coming from the Road and Belt Initiative

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Bachelor Thesis Economics and Business Economics

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Abstract

Ever since China's Belt and Road Initiative was announced in 2013 it received a lot of press coverage and attention worldwide. This study investigates the relation between Chinese investments in railways and ports in Poland coming from the Belt and Road Initiative and Poland's growth in GDP using a multiple regression analysis. Before the multiple regression analysis is conducted a literature review regarding the relevant academic literature on the relation between investments in ports and railways and GDP is made. Panel data from the period of 2010 up to and including 2016 coming from the OECD, IMF, NPB, Eurostat and the World Bank are analyzed to measure this relation. It can be concluded from the literature review that there is a positive relation between investments in infrastructure and growth in GDP. No significant supportive results were found from the multiple regression analysis for the existing literature stating there is a positive relation between GDP and investments in ports and railways.

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1. Introduction

China opening up its economy to the world is one of the best examples of the impact global markets can have on a country's economy. Where between 1953 and 1978 China's gross domestic product (hereafter referred to as GDP) had an annual average of 6%, this percentage grew up to 9.4% between 1978 and 2012 (Hirst, 2015). The process of market liberalization continued, allowing the reopening of the Shanghai stock exchange in December 1990, and ultimately the accession to the World Trade Organization. Before China joined the World Trade Organization in 2001, their foreign exchange reserves stood at US$212 billion; in 2014, when the Chinese foreign exchange reserves were at its highest point, it had already grown to almost US$4 trillion (Public Bank of China, 2018).

However, the average growth rate of real GDP has been lower in the last couple of years than it was over the past decades. In the recent period, a lot more investments were needed for GDP growth, which was significantly slower than in the past decades (Dollar, 2015). In order to achieve the government's ambitious growth targets, China relies heavily on expanding its domestic demand. As a result of China's past excessive economic growth, a deepening regional disparity has taken place between the rich West and the poor East. One way to spread wealth more evenly and to counter the deepening regional disparity is by developing inland regions and by stimulating industry to move to the western part of China.

In 2012, Xi Jinping, the President of the People's Republic of China, started to work on his signature foreign policy right after assuming office as president. In September 2013, he introduced his idea of creating a 'Silk Road economic belt' in a speech during a visit in Kazakhstan. One month later, during the Asia Pacific Economic Cooperation (APEC) summit in Indonesia, he promoted his ideas of building a 'twenty-first century maritime Silk Road' (Summers, 2016).

However, it wasn't until March 2015 when the China's Ministry of Commerce and the Ministry of Foreign Affairs jointly published a document when it became more apparent what the exact vision regarding the implementation of these ideas was. These ideas combined in the "One Belt, One Road" initiative, involves China investing billions of dollars into infrastructure in countries along the old Silk Road that links China with Europe and the ancient maritime routes. The initiative's ultimate aim is to make Eurasia, dominated by China, an economic and trading area to rival against the transatlantic one, dominated by America (The Economist, 2017).

Also known as the Belt and Road Initiative (hereafter referred to as BRI), the initiative is estimated to involve potentially 65 countries and 4.4 billion people. By enhancing the interconnectivity in a geographical area which represents 70% of global population, generates 55% of global GNP and has an estimated 75% of known energy reserves, major opportunities could be generated (Grieger, 2016).

The BRI is a way to achieve the goal of countering regional disparity in China: by developing a rail-freight network to Europe, a new route to the market of China's

poorest areas that lie along this network opens up (The Economist, 2017). But the Road and Belt Initiative is not supposed to only benefit China. The initiative is described by the Chinese government as “a bid to enhance regional connectivity and embrace a brighter future” and a win-win opportunity for countries that participate, by promoting the free flow of economic factors, highly efficient allocation of resources and deep integration of markets (Xinhua, 2015). Critics of Xi Jinping’s initiative called it a strategy to expand China’s geopolitical influence and an instrument for promoting China’s geopolitical expansion through investing in stakeholders’ economies and creating political control over them in order to create a China-centered trading network (Hong Kong Economic Journal, 2016).

This means that the investments in infrastructure do not stop at China’s border. In order to connect China with Europe, investments into infrastructure in parts other than China are needed as well. One way to clear a path towards more investments in the European Union (hereafter referred to as EU) and to enter the larger market of the EU is by investing in Central and Eastern European countries (hereafter referred to as CEEC). Nearly one fourth of the countries along the Belt and Road is made up by CEEC. Prior to the sixth meeting of heads of the government of China and the CEEC in 2017, Chinese Ambassador to Hungary Duan Jielong said that: “*China’s stable and developing economy puts forward great opportunities. China wishes to share those opportunities with the world. Let us combat the instability of the world economy with the stability in the Chinese economy; combat the uncertainty of the world order with the certainty of China-EU relations and… 16+1 cooperation.”* (Xinhua, 2017). This 16+1 format consists of eleven EU Member States and five Balkan countries. China defined three potential priority areas for economic cooperation, with the most important one being infrastructure. Investments in CEECs have already exceeded US$9 billion (Yongq, 2017).

However, so far only three countries have benefited from the Chinese investments: Hungary, the Czech Republic and Poland. In 2014, Chinese investments in Poland are said to have amounted up to US$329, equaling 19.41% of total Chinese investment in CEECs (Zuokui, 2016). Poland’s economy has also grown immensely in the last couple of decades, with its GDP growth rising from 1.4% in 2002 to 4.6% in 2017 (OECD, 2017). It is even expected that it is the next major nation to join the group of advanced economies, after the last one that had joined was South Korea, 20 years ago (Sharma, 2017).

Do the Chinese investments in Poland have anything to do with this growth? And if so, how much of this growth can be assessed to investments coming from the BRI? It is interesting to research the influence of Chinese investments on Poland’s GDP, because a contribution to the growth of GDP could change Poland’s foreign policy more towards “leaning towards the east”. This possible change of direction in foreign policy could have an impact on the stability and the future of the EU.

To research this contribution of the BRI to Poland's growth in GDP, the following research question is brought forth:

What is the relation between Poland's growth in GDP and Chinese investments in infrastructure coming from the Belt and Road Initiative?

The research in this thesis will attempt to explain whether there is a relation between investments in infrastructure in Poland and its growing GDP, and if so, how much of it can be attributed to the BRI. Research conducted by using panel data for a sample of 24 Chinese provinces has already shown that transport infrastructure account for a significant part of observed variation in the growth performances of provinces (Démurger, 2001). Research that analyzed infrastructure and productivity in the Spanish regions showed that infrastructures most directly linked to the productive process present a significant and positive effect on productivity, and therefore growth performance (Mas, Maudos, Pérez & Uriel, 1996). This proves that investments in infrastructure have an influence on productivity and (therefore) the growth performance of a country.

The research conducted in this report will be an addition to prior research regarding this topic because it will focus on the influence of investments in Polish infrastructure coming from China, a foreign direct investor. Until now, most research regarding investments in infrastructure were about investments in infrastructure done by a country itself. However, this situation is different, because the BRI is the first global infrastructure project of this size with investments coming from a foreign country. If the investments prove to have a large effect, a new strategy may be necessary from the EU's perspective in order to limit the already complex present political environment.

This thesis will be structured as followed. Firstly, the theoretical framework consisting of a literature review will be discussed. Secondly, an overview of the literature review and the relation it has to the research question will be discussed. Thirdly, the data and methodology will be discussed and explained. Fourthly, the results from the literature review and the quantitative research will be presented and connected to the research question. Finally, the research will be concluded, the limitations of the research will be discussed, and suggestions for further research will be made.

2. Theoretical framework

In order to answer the research question, certain definitions need to be specified. The theoretical frameworks starts off by discussing relevant academic literature on the main aspects of this study. For this research the term 'infrastructure' will be limited to the following two means of travel: ports and railways. These modes of transport are part of the 'active means of transport' and are alongside roads the most common modes of transport. In the overview the importance and contribution of these means of transport to GDP will be explained.

2.1 Literature review

2.1.1 Infrastructure

The *Oxford English Dictionary* defines infrastructure as "the basic physical and organizational structures and facilities needed for the operation of a society or enterprise". Infrastructure is the basis of economic development and includes services and facilities that are necessary for an economy to function (O'Sullivan & Sheffrin, 2003).

The word originates from France, and originally means "the installations that form the basis for any operation or system." Infrastructure has traditionally been used to refer to permanent installations required for military purposes. However, nowadays the term almost exclusively concerns the necessary economic and organizational foundation of a highly developed economy (Buhr, 2003).

Infrastructure consists of means of connectivity like road, rail and ports, which are physical links and nodes of networks. They depend on each other in order to provide their overall function of delivering needed commodities and services to society. Fulmer (2009) describes these networks as the analogous arteries and veins that attach society to the essential services and commodities that are required to uphold or improve standards of living. The World Bank (1994) describes infrastructure as representing the "wheels" of economic activity, "if not the engine".

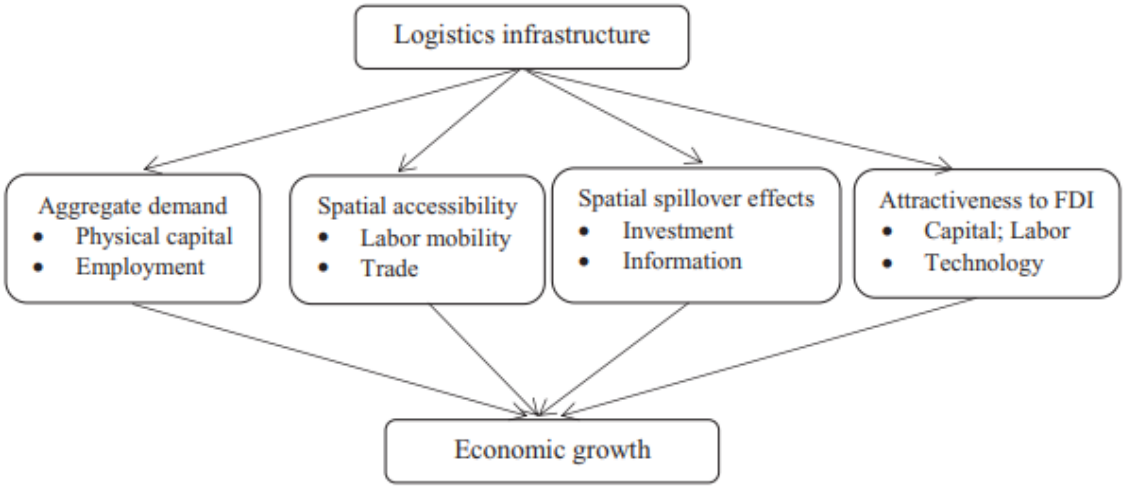
Changes in the relative prices of accessibility of various locations are the most fundamental outcomes of investments in transport infrastructure. Banister and Berechman (2003) state that price changes imply changes in the relative advantage of spatially located activities and the economic opportunities for both consumption and production sectors. These economic opportunities can only lead to economic growth if these investments evoke changes in transport-economic behavior, which implies that in order for investments in infrastructure to be beneficial, agents like firms, households and markets need to react to the changes in the transport network.

The importance of infrastructure to economic development has justified a large role for public policy in its provision and financing. However, the economic impact of infrastructure and how it varies with the business cycle remains subject to debate. Where some view this form of spending as “bridges to nowhere”, others view it as a form of boosting economic activity in the long and in the short run (Leduc & Wilson, 2013).

2.1.1.1 Economic contribution of infrastructure

Many studies proved a positive relationship between infrastructure investments and GDP. Investments in the maintenance of roads, airports, railways and other types of infrastructure are an important component of GDP and positively contribute to GDP in multiple ways (Perkins, Fedderke & Luiz, 2005). Construction of transport infrastructure promotes economic growth by providing employment opportunities, which increase aggregate demand alongside an increases in the demand for intermediate inputs provided by related sectors (Pradhan & Bagchi, 2013). Next to increased aggregate demand, a well-built transport network allows for the optimal allocation of limited resources which increases productivity (Shi, Bang & Li, 2016). Well-built transport networks lower transport costs which enables trade and the allocation of input factors to high-yielding sectors. Transport and other costs of conducting international business are important factors in determining whether a country is able to participate fully in the world economy (Limao and Venables, 2001). Well-functioning neighboring transport networks sometimes also have positive spillover effects on local economic growth and are more likely to increase FDI which offer capital inputs for the economy (Liu, Chen & Zhou 2007).

Figure 1. Economic contribution of logistics infrastructure



Adapted from “Logistics as a driving force for development under the Belt and Road Initiative – the Chinese model for developing countries,” by Li, Jin, Qi, Shi and Ng, 2018, *Transport Reviews,* 38:4, pages 457-478.

2.1.1.2 Productivity growth

A well-built transportation network positively contributes to productivity growth. Growth can be facilitated through lower transport costs which facilitate agglomeration effects, trade and structural change which can lead to higher productivity (Berg, Deichmann, Liu & Selod, 2015). Transportation networks improve social inclusion which improves economic opportunities for the poor, and by promoting sustainability, health and environmental externalities can be reduced.

Productivity is a major determinant to the future standard of living and therefore of major concern to economists and others. It has a substantial influence on living standards: people can expect their real wages and living standard to double once a generation if the efficiency by which resources can be used rises at 2.5% per year. If you take productivity growth at 0.5%, children can expect living standards that are only 15% higher than those of their parents (Munnell, 1990).

When in the 1970's productivity growth in the United States was declining, economists blamed it mainly on gas prices resulting from the 1974 oil shock. Nobody discovered a "silver bullet" to the question where this decline came from, and most of the conclusions attributed the slowdown to a vague variety of factors. It was not until Aschauer (1989) published a study in which he argued that much of the decline in productivity in the United States was the result of declining rates of public capital investment in infrastructure that economists started to pay attention to the relation between investments in infrastructure and economic growth. In his study, Aschauer used a production function which indicated that the contribution of basic infrastructures to economic development are very large: there was a strong relationship between the stock of capital and the output per unit of private capital, and there was a statistically significant relationship between the stock of capital and the level of multifactor productivity. His original time series estimates (1989) and the reestimates from Munnell (1990) suggest the impact of aggregate public capital on private sector output and productivity to be very large.

Aschauer's critics argue that the idea of correlation between infrastructure investments and economic growth is spurious. Sturm, Kuper and De Haan (1998) researched studies that followed Aschauer's, and showed that the literature contained a wide range of estimates regarding the relation between public capital and economic growth, which made them useless from a policy perspective. However, the most recent update of this survey by Romp and De Haan (2007), created consensus that public capital stimulates economic growth (albeit less substantially than suggested in earlier studies).

Démurger (2001) found a nonlinear and concave relationship for the impact of transport endowment on economic growth. This suggests that the positive effect of transport equipment is decreased with its development, and despite the fact that investing in network expansion of transport-poor regions can be very useful for economic growth, transport-rich regions are benefitted more by upgrading or

improving the quality of existing facilities. This corresponds to research by Fan and Chan-Kang (2004), who assessed the impact of public infrastructure on growth and poverty reduction in China. They found that, in terms of poverty reduction, investments in low quality roads raised far more rural and urban poor people above the poverty line per yuan invested than high quality roads. Multiple studies confirm this finding that investments in infrastructure reduce rural poverty not only through productivity growth but also through higher wages and increased nonagricultural employment opportunities in the private sector (Fan, Hazell & Thorat, 2000; Chakrabarti, 2018).

Research by Canning & Fay (1993) related to the aforementioned work by Aschauer. By using physical measures of transportation networks of 104 countries, they estimated returns in the form of higher aggregate output and related these to construction costs. They found that rates of return vary greatly across countries based on their economic status and distinguished four groups. One group contained countries with the highest rates of return with some exceeding 200% per year, which were newly industrializing economies. This group was followed by less developed and predominantly agricultural countries with returns of less than 50% a year. The third group existed of long established members of the developed world, which exhibited rates of around 5-25% per year. The fourth group existed of countries that had reached maturity more recently (at that time e.g. Japan and Italy), which showed returns of around 40-50% per year. The estimates for the rate of return varied widely across the countries. An explanation for this could be the high marginal product of infrastructure for countries with high levels of income and relatively few roads and railways. This group consisted mainly of rapidly developing countries.

Canning & Fay (1993) found that, despite taking precautions to avoid the endogeneity problem, doubling a country's road stock lead to 1% growth in real GDP, proving that transportation networks have strong effects on economic growth rates. Short run effects of changes in infrastructure on output appeared to be very small in time series analysis. However, high rates of return could be seen in the cross-section analysis which indicated that returns to infrastructure may occur slowly, but are ultimately very large. The authors concluded that infrastructure cannot be considered a factor of production, because an insufficient amount of evidence was found from the time series analysis that increases in infrastructure lead to immediate increases in output. Infrastructure should rather be considered as a condition for high rates of economic growth, mainly by promoting total factor productivity growth through facilitating technological progress in an economy.

Multiple studies examined the contribution of public capital stock to output, and in particular the impact of investments in transport (Aschauer, 1989; Munnell, 1990; Canning & Fay, 1993). The empirical content of many of these papers has been criticized by Holtz-Eakin (1992), who argued that the positive effects result from failing to account for the endogeneity of public capital stock and demonstrated that there is no relationship between aggregate public-sector capital and private sector productivity. He reestimated models using various means of accounting for differences

in characteristics of states and his results suggested that public capital was not a significant determinant of gross state product (GSP). Evans and Karras (1994) used similar methods and arrived to the same conclusion.

McGuire (1992) found the same as Holtz-Eakin regarding the effect of infrastructure on GSP, but found a statistically significant effect of highways on GSP when infrastructure was separated into highways, sewer and water. This suggests that separating the different types of infrastructure leads to different results.

2.1.1.2.1 Demand for infrastructure and private investment

Since the global financial crisis, infrastructure investment has declined as a share of GDP in 11 of the G20 economies. In 2017, the Global Infrastructure Hub, backed by the G20 and funded by governments including Australia, Britain, China, Korea and Singapore, stressed the importance of continuous investments in infrastructure to support global economic growth and to fill gaps in infrastructure in both developed and developing countries (Jessop 2017). It states that nearly a fifth of investments needed by 2040, an amount of US$94 trillion, risks being unfunded if countries do not scale up their infrastructure investments. In June 2016, McKinsey published a study that estimated US$3.3 trillion per year from 2016 to 2030 needs to be invested in the world's existing infrastructure each year in order to support current growth rates (Woetzel, Garemo, Mischke, Hjerpo & Palter, 2016).

Leaders across the world have embraced the funding of infrastructure investment by private capital. The Trump administration promised new major improvements regarding infrastructure, and pledged to invest US$1.7 trillion in roads and bridges amongst other things, funded through tax-incentivized private capital (Oliphant & Shepardson, 2018); Merkel promised an increase in infrastructure investment like roads and railways without adding to the national debt (Chambers, 2016).

Since 2006, the world has seen a transformation in the ownership of the world's economic infrastructure: more than US$200 billion has been raised by private specialist funds, and at least the same amount has been allocated by other direct investors like pension funds (Woetzel, Garemo, Mischke, Hjerpe & Palter, 2016). In the United Kingdom in 2015, 56% of water assets, most ports and all of the major airports are owned by specialist infrastructure investors (PricewaterhouseCoopers, 2015). The post-crisis need for major corporates and governments to reduce debt to manageable levels combined with the need for high-quality infrastructure are key factors that have led to this ownership transformation.

2.1.1.3 Ports and railways

The BRI was launched with the aim to revive the old Silk Road, which for centuries linked China with trading cities in the world. In this research, the number of transport modalities that will be used will be limited to ports and railways. Ports and railways are the most relevant modalities to research because they have been invested in the most and have contributed most to the recent growth in bilateral trade volumes between

Poland and China, especially the rail link between Łódź, in the centre of Poland, and Chengdu in Sichuan province (Knight Frank, 2018).

2.1.2 Ports

Ports play a fundamental factor in stimulating economic development. They are important gateways for international and domestic trade and crucial linkages in global supply-chains. In analyzing the impact of different modes of transport, ports deserve special attention considered almost 80% of total world trade is carried by sea (United Nations Conference on Trade and Development, 2009).

Economic impacts of ports on local economies have always extensively been researched and is a traditional topic in the field of port policy and management (Shan, Yu & Lee, 2014). The mostly used methodologies are input-output (IO) analysis, economic base (EB) study and the income-expenditure approach.

Ports have traditionally been seen as accelerators of economic development. Access to water has a significant impact on a country's ability to conduct trade and be a part of the world economy: ports facilitate maritime trade and consequently economic development. In the period from 1965-90, more than half of the non-primary export performers were island countries, and none of the countries was landlocked (World Bank, 1998). This suggests that countries with access to the sea export more compared to countries with no or less access to the sea, or are at least more prone to do so. The ocean provides low costs and a massive mean of transport. The Ancient Maya used extensive sea trade networks that contributed largely to the success of their civilizations, just like other strong empires that became richer by trade, like Rome and Athens.

In the period between 1500 and 1800, the first major continuous divergence in income per capita across different regions in the world took place and made certain areas substantially richer than others (also known as the "First Great Divergence"). A wide range of theories have been proposed to explain why this happened, with institutions, culture, resources and "accidents of history" being a couple of them (Allen, 2011). Acemoglu, Johnson and Robinson (2005) researched the origins of the rise of (Western) Europe during this era and provide econometric evidence supporting the hypothesis that Western European growth during this period resulted partly from the indirect effects of international trade on institutional development. In this paper, the differential growth of Western Europe during the period from 1500 to 1800 is almost completely accounted for by so called *Atlantic traders*, being Britain, Portugal, Spain, the Netherlands and France. Atlantic ports grew at a much faster rate than other European cities, while Mediterranean ports grew at rates similar to the inland cities. The paper suggests that the rise of Europe was largely due to the rise of Atlantic Europe and the following Atlantic Ports, and gives an example of how access to sea contributes to economic growth.

2.1.2.1 Economic contribution of ports

2.1.2.1.1 Employment

The literature shows different opinions regarding the relationship between ports and employment. Whether employment increases depends on the sector most active in the region near of the port. Fageda and Gonzalez-Aregall (2017) found that the level of employment in manufacturing sectors is higher in regions with larger ports. Researchers suggest that the existing and potential roles ports play in the regional economic development progress and employment are easily exaggerated. In a case study on Plymouth, Gripaios and Gripaios (1995) suggested that ports are not big employers of labor and they are no longer the interrelated industrial complexes they had once been: ports nowadays mostly serve industries far away from their own area. However, analysis by the National Bank of Belgium shows that in the case of Belgium, ports have indirect effects on employment that are even bigger than its direct effects, meaning the presence of ports facilitates jobs not directly involved with ports as well (Van Nieuwenhove, 2015).

In research on the economic contribution of ports to the local economies in Korea, Jung (2011) mentions that ports greatly contributed to economic development in the 1970's during the industrialization process in the Korean economy. Ports have an important function in heavy industries like petrochemical industries, which could not function without the inexpensive means of transport that shipping offers. However, the importance of Korea's ports supposedly shrank in the 1980's when the country's economic structure shifted from a manufacturing based economy to a service based one. Jung (2011) even found a trend, supported by local economic indicators, that port cities are lagging behind other areas economically, with decreasing percentages of GRDP (gross regional domestic product) in two representative port cities. Besides a less important role for ports in service based economies, a possible explanation for this decrease in GRDP could be that an increase in transport infrastructure endowments increases competitive pressure and generates an expansion of relevant markets for producers. This competition might give local producers an incentive to innovate and maintain or even expand their position. However, local producers that are not able to compete on efficiency may be hurt by the enlargement of the relevant markets which in the short run may cause unemployment and a reduction in growth (Bottasso, Conti, Ferrari, Merk & Tei, 2013).

Recent advances in transport technology have changed the role ports play in local economic development. Local employment benefits have decreased as containerization has made the movement of goods more capital intensive. Grobar (2008) found that household unemployment and poverty rates are significantly higher in port districts than in surrounding metropolitan areas, which suggests that ports are not necessarily a source of employment for the surrounding area. However, the higher unemployment and poverty rates can be explained by the local negative externalities

that large container ports generate, which drives down rents in the area surrounding the port which consequently attracts households with a low-income.

2.1.2.1.2 Productivity growth

The literature does not suggest any significant influence of ports on productivity growth other than the generally suggested positive relationship between the development of infrastructure and productivity.

2.1.2.1.3 Trade and transport costs

Increased port infrastructure contributes to economic growth by enabling larger exports, resulting from reduced distances of shipping and transportation (Martincus, Carballo & Cusolito, 2017). Countries with bad ports are an equivalent of 60% farther away from export markets than average countries (Clark, Dollar & Micco, 2004). Port efficiency is of key importance in determining transport costs and therefore also in determining the amount international trade conducted among countries. International trade transaction costs are heavily influenced by activities required at port level (e.g. towing and tug assistance, cargo handling, and pilotage), but include not only activities related to port infrastructure but also customs requirements and legal restrictions. Inefficiencies related to these port activities contribute to high handling and transport costs and form a barrier to conduct (international) trade.

Transport costs have a large impact on a country's competitive position. Large distances from world markets and poor transportation networks bring high transport costs and therefore give countries less favorable competitive positions. In Africa for example, where poor agricultural and health conditions are already barriers to growth, the situation is made worse by its exceptional disadvantages in transport costs. Estimates by the World Bank show that in 1995 the cost of a container shipment from the West African port of Dakar to Rotterdam, a distance of around 5000 kilometers, costed around the same as a shipment from Singapore to Rotterdam, which takes around 17000 kilometers. Inefficient container ports in South Asia cause the average cost of exporting or importing a container to be more than twice the cost of what it is in East Asia, causing South Asia's economic competitiveness to lag that of other regions, holding back its economic growth (Herrera Dappe & Suárez-Alemán, 2016).

2.1.2.1.4 Attractiveness to FDI

Whether investments in ports increase attractiveness to FDI depends on the state of a country's economy and the presence of business clusters. The more developed a transport network is, the more efficient, reliable and flexible services and goods can be provided. The presence of ports contribute to the forming of business clusters: the geographical concentrations of connected businesses which are considered to increase productivity (Porter, 2000). These clusters provide economies of scale due to more reliability and lower transport costs. The local knowledge and competencies attract FDI trying to take advantage of this (Meersman & Nazemzadeh, 2017). An example of this can be found in China, where areas that qualified to be Special

Economic Zones in the 1980's which brought a significant volume of FDI into China, were all coastal areas which had a well-developed infrastructure and access to deep-water port facilities (Graham, 2004). However, Zhao, Xu, Wall and Stavropoulos (2017) found that even though a positive relationship between urban networks and ports exists, port cities currently do not exhibit any significant advantages over non-port cities in attracting FDI.

Developing economies with access to sea are more outward oriented and participate more in the world economy than developing economies that do not, which are therefore likely to attract more FDI. David Dollar (1992) states that outward oriented economies are able to use external capital for economic development, whereas inward oriented economies are dependent on their own capital for economic development. An example of this are the Latin American and African economies' inward orientation of production, which was one of the reasons these economies experiences debt crises which consequently inhibited their growth in the 1980's. The process of exporting, combined with easily available imported inputs and machinery, is believed to accelerate technological advance through productivity growth in developing countries.

2.1.3 Railways

When modern human civilization was introduced to trains, this form of transport drastically changed human expansion, industry, and the way people were moved from place to place. After the introduction of trains, lands that seemed unreachable before were closer than ever: the 5000 kilometer journey from the West to the East coast of the United States now only took a few days instead of one or two months. Trains have since been evolving, and are nowadays able to reach speeds of up to 300 to 500 kilometers per hour and carry more passengers or materials than ever before.

According to Rostow's *The Stages of Economic Growth,* "the introduction of the railroad has historically been the most powerful single initiator of take-offs (the take-off stage is characterized by dynamic, rapid and self-sustained economic growth and marks the beginning of the process of the transition from a traditional economy to a modern economy)," and had "three major kinds of impact on economic growth during the take-off period," being "lowered internal transport costs and bringing new areas and products into commercial markets; the development of a major new and rapidly enlarging export sector" and perhaps most importantly, "the development of modern coal, iron and engineering industries".

Mitchell (1964) disagrees with Rostow on the point that railways are a prerequisite for economic growth. He argues that the necessary conditions stated by Rostow for the economic "take-off" had already been met in the United Kingdom by the time railways were built, which suggests that the railways did not have a major impact on the economic development as much as Rostow claims it has. Railways did however have substantial direct effects through the employment of labor in the construction phase,

the stimulation of the iron and steel industries, and the development of the capital market and the level of social savings.

Fogel (1964) defined social savings as the difference between transport by rail and the next best alternative (at that time waterways). He conducted a historical study of the impact of railroad development on the American economic growth during the Nineteenth century and came to two conclusions, being that the primary impact on the costs of transport came from railways and that railways resulted in social savings. In his opinion, 'no single innovation was vital for economic growth during the 19th century', and rail development in the United States helped shaping economic growth in a particular direction but was not a prerequisite for it since the basis for economic growth was the knowledge acquired during the scientific revolution (Banister & Berechman, 2003).

Where in Britain railways were built around existing traffic, they served a very different purpose in the United States: extending and developing the sparsely populated frontier region at great speeds. New towns with communities that were developed around the railway systems were created. Railways have been credited as being the major force in the economic and geographic development of the United States.

Atack, Bateman, Haines & Margo (2010) constructed a county-level panel data-set that documented the spread of railroads in the Midwestern United States during the mid-nineteenth century. They linked these transportation data to standard census data for the same period in order to estimate the causal impact of the introduction of the railroad on a county's rate of growth of population density and its extent of urbanization, two important indicators of economic development and settlement. According to their estimates, the causal impact of the expansion of railroad networks on urbanization was large, explaining more than half of Midwestern urbanization in the 1850's. The causal impact on population density however, was small, which is consistent with Fishlow (1965), who also criticized Rostow's claim that the railroads constituted a "leading sector".

2.1.3.1 Economic contribution of railways

2.1.3.1.1 Employment

Railway development does not seem to have a significant long term effect on employment and productivity growth. A positive relationship can be found between railway development and employment. However, this contribution may not be significant since the majority of highway projects is funded by government funds, meaning that the jobs that result from these projects could have been created in any other sector (Chakrabarti, 2018; Jiwattanakulpaisarn, Noland & Graham, 2010). The literature seems to agree on the positive effect the development of railways have on growing local population through improved accessibility (Talebian, Zhou & Hansen, 2018; Gregory & Henneberg, 2010), which reduces regional inequality (Enflo, Alvarez-Palauk & Henneberg, 2018).

2.1.3.1.2 Trade and transport costs

Railway transportation does not seem to offer a significant benefit regarding transport costs compared to road and ports, other than being less expensive than transportation through the air and faster than transportation by sea. The contribution of railroad transportation to economic growth has been commonly assumed to come from the lowered transport costs. Jenks (1944) argues that, compared to pre-motorized forms of highway transportation the advantage of railroad transportation is obvious, but not compared to transportation via waterways:

"There is no convincing evidence, however, that railways have ever carried freight at lower costs either to shippers or to society than canals or waterways. The advantages that early railways showed over canals, such as speed, flexibility or service, and special adaptability to short hauls, are analogous to those of modern highway transport over the railroad."

Lean, Huang and Hong (2014) found that the railway played an important role in China's transport network. Bai & Qian (2010) found that the transportation sector in China as a whole has grown rapidly from 1978 to 2006, with growth rates of passenger/ton-kilometer close to the growth rate of GDP. However, the one mode of transportation that was lagging behind was the railway sector. This seems peculiar, considered only 30-40% of the demand for railway freight transport is met according to the Development Research Center of the State Council (2005). The shortage is in particular severe for the transportation of coal, and about 25% of coal transported out of the Shanxi province, China's biggest coal producing region, is now transported via highway. They suggest that (in this case) prices are too low for efficiency, which brings low rates of return to investment and discourages profit-oriented investors. If efficiency could be improved through more investments, the demand for railway transport could be met.

2.2 Overview

Based on the literature review, an overview regarding the contribution of ports and railways to economic development can be composed. This overview can be found in Table 1.

Table 1. Contribution of ports and railways to employment, productivity growth, transaction costs and FDI

	Employment	Productivity growth	Transaction costs	FDI
Ports	++	++	++	+
Railways	+	+	+/-	+/-

Note: A cell containing '++' indicates a strong positive relationship, '+' indicates a positive relationship and '+/-' indicates an insignificant relationship between the transport modality and the factor of economic growth based on the literature review.

Several studies have found the contribution of basic infrastructures to economic development to be very large (Aschauer 1989; Munnell (1990); Canning & Fay (1993)). A more recent survey of the existing literature created the consensus that public capital stimulates economic growth, albeit less substantially than was suggested in earlier studies (Romp & De Haan, 2007).

The main research question of this thesis is:

What is the relation between Poland's growth in GDP and Chinese investments in infrastructure coming from the Belt and Road Initiative?

Infrastructure positively contributes to GDP by providing direct and indirect employment opportunities and an increase in aggregate demand. A well-built transportation network stimulates economic growth by allowing for the optimal allocation of limited resources, which increases productivity (Shi, Bang & Li, 2016). When looking at the rates of return of infrastructure investments, rates vary greatly across different countries based on their economic status: countries that experienced the highest rates of return are newly industrializing economies, with some of them exceeding rates of 200% per year, and countries that are long established members of the developed world showed the lowest rates of return, with rates of about 5-25% per year. The literature suggests a concave relationship between transport endowment and economic growth: infrastructure investments in poor regions with poor quality infrastructure can raise far more people above the poverty line than infrastructure investments in regions with high quality infrastructure (Démurger, 2001; Canning & Fay, 1993; Chan-Kang, 2004). The closer a country is to being a member of the developed world, the lower are the rates of return.

Overall, the literature seems to suggest a positive relation between ports and a country's economy. Ports play a large role in economic development. They contribute to employment, lower transport costs and attract FDI. Ports have indirect effects on employment that are even larger than the direct effects (Van Niewenhove, 2015). However, unemployment and poverty rates are found to be significantly higher in port districts, which can be explained by local externalities produced by ports that drives

down rents in these areas, consequently attracting low-income households (Grobar, 2008). Ports contribute to economic growth by enabling larger exports that result from reduced shipping and transportation costs and distances, and have a large impact on a country's competitive position: countries with inefficient ports are an equivalent of 60% farther away from export markets than average countries and significantly hold back a country's economic growth (Clark, Dollar & Micco, 2004; Martincus, Carballo & Cusolito, 2017; Herrera Dappe & Suárez-Alemán, 2016). Ports contribute to the forming of business clusters, which are geographical concentrations of connected business that increase productivity and attract FDI trying to take advantage of these economies of scale and local knowledge (Porter, 2000; Meersman & Nazemzadeh, 2017).

Research on the literature regarding the economic impact of railways revealed a link between infrastructure and economic growth: railways are a factor that contribute to economic growth and help shape it into a certain direction (Lean, Huang & Hong, 2014; Banister & Berechman, 2003). Railway development does not seem to have a significant effect on employment and productivity growth. Even though a positive relationship between railway development and employment can be found, this can be explained by the government funding of these projects, which means that the jobs resulting from these projects could have been created in any other sector (Chakrabarti, 2018; Jiwattanakulpaisarn, Noland & Graham, 2010). The development of railway systems have a positive effect on increasing populations in non-metropolitan areas because of improved accessibility, and railways contribute to reducing regional inequality (Enflo, Alvarez-Palauk & Henneberg, 2018). Common consensus exists regarding the positive role railways play in lowering transport costs, though the advantage of railway transportation compared to waterways is not as obvious and large as it is compared to pre-motorized forms of transportation (Jenks, 1944).

By stimulating employment, trade, and attracting FDI, ports positively contribute to GDP. Railway transportation seems to offer no significant benefit and therefore no significant contribution to GDP compared to other means of transportation, except for being less expensive than planes and faster than ships. Even though the relationship may not be as strong as the relationship between ports and GDP, the literature still suggests there is a positive relationship between railway development and GDP.

3. Data and methodology

This chapter describes the research design, the data that is used and the analyses that are conducted. The relationship between BRI-related investments in Polish infrastructure and GDP is analyzed using a multiple regression analysis.

3.1 Research design

The main question in this study is:" *What is the relation between Poland's growth in GDP and Chinese investments in infrastructure coming from the Road and Belt Initiative?"* In this study a descriptive research design is used with the help of quantitative data. Descriptive research answers the question of *what* is going on, in contrast to explanatory research, which explains *why* it is going on (De Vaus, 2001). The methods used in this research are a literary review and desk research. The theoretical framework is a preparatory element and is the academic foundation of the operationalized concepts used. The desk research is used to gather existing data and to give an answer to the aforementioned research question based on statistics.

3.2 Data collection

In this research the effect of BRI-related investments on the GDP growth in Poland will be studied using a multiple regression model. The first step that needs to be taken to conduct a regression is to collect the data relevant for the research. The data collected are GDP growth rates, the growth rates of BRI-related infrastructure investments, nominal interest rates, inflation, FDI in millions of euros, consumption expenditure in percentage of GDP, the industrial production index, unemployment in percentage of total labor force and public expenditures in percentage of total GDP. The data is taken from the period of 2010 to 2016. This time period is chosen because this is the time period in which the BRI was formed and started to take place. Also, no data regarding FDI in Poland is available for the time period before 2010. The data is taken from the International Monetary Fund (hereafter referred to as IMF), the National Bank of Poland, Eurostat, the World Bank and the OECD will be used to construct a panel data set for the regression.

3.2.1 Dependent variable

The goal of this study is to analyze the effect of BRI-related investments in Poland's railways and ports to GDP growth. The independent variable therefore is GDP growth which is measured in growth rates. GDP is chosen because it is a useful measure for researching economic growth since it measures the monetary value of final goods and services produced in a country calculated in a specific period, usually on an annual basis. Total GDP divided by the average total population of a region is per capita GDP and is often used compare the standards of living between different countries. Even though GDP per capita has major advantages when it comes to comparing standards of living, it fails to account for factors like wealth distribution, externalities and non-market transaction which also influence standards of living. However, for this research it is a useful measure because the goal of this research is not to research the effect of

BRI-related investment on living standards in Poland but the effect of BRI-related investments on the total production of Poland. The data set is provided by the IMF.

3.2.2 Variable of interest

The variable of interest in this research is BRI-related investments in infrastructure. Due to the vague definition of what investments fall under the BRI and a lack of coherent data regarding Chinese investments in Poland, it is difficult to distinguish what part of Chinese investments fall under the BRI (Bachulska, 2017). To decide what the BRI-related investments in infrastructure in Poland are, the percentage of Chinese investments in infrastructure from the period of 2010-2016 found by the European Think-Tank Network on China will be applied to Chinese FDI in Poland (Seaman, Huotari & Otero-Iglesias, 2017). The outcomes of these calculations are used for the analyses.

The data provided by the National Bank of Poland (NPB) will be used to calculate BRI-related investments. In 2016, the Chinese investments in Poland took a noticeable rise (Seaman, Huotari & Otero-Igeslias, 2017). The Polish Embassy in Beijing estimates the level of Chinese investment to be much higher (EUR 198.5 million) than data from the NPB show (EUR 123.3 million). The difference in the data seems to come from the different methodologies used for calculating Chinese investments, with the embassy including investments by Chinese companies registered worldwide instead of only companies registered in China. For this research the data provided by the NPB will be used because it offers data over the specific time period that is needed for this research.

3.2.3 Control variables

Other variables that are included in this study are control variables. They will be added to the regression in order to minimize biases. The third variable that is included in this study is interest rates. Interest rates influences GDP because it influences private investments which is a part of aggregate demand, a determinant of GDP. Interest rates decide the cost of borrowing. Therefore, it influences the level of investment spending, with lower interest rates equaling lower costs of borrowing and high interest equaling higher costs of borrowing. This data set is provided by the OECD.

The fourth variable that is needed in this study is the level of inflation. Inflation is the rate at which the price level of goods and service in an economy increases over a period of time. The most used measure of inflation is the consumer price index (hereafter referred to as CPI), which measures the weighted average of the prices of a sample of representative items at a certain period in time. It indicates whether an economy is experiencing inflation (or deflation). Higher price levels reduce the purchasing power per unit of money and discourages investments and savings, which has an influence on GDP. This dataset is provided by the OECD.

The fifth variable in this study is FDI. Foreign direct investments are investments made by companies in businesses or business interests located in other countries. FDI is associated with growth in GDP because of the influx of capital and an increase in tax revenues. FDI can lead to competition in the host countries, which can lead to more productivity and greater efficiency. FDI may also have an influence on employment opportunities for the local population. This data set is provided by the NPB.

The sixth variable in this study is household final consumption expenditure (hereafter referred to as HFCE). HFCE measures the expenditure by households on the consumption of goods and services and represents consumer spending. HFCE is important to take into account because consumer spending influences GDP. This data set is provided by the OECD.

The sixth variable needed in this study is the Industrial Production Index (hereafter referred to as IPI). IPI is an economic indicator which refers to the output of industrial establishments like manufacturing, mining, electricity, gas and steam industries and air conditioning, relative to a base year. The IPI needs to be taken into account because it expresses the changes in the volume of the production output, which influences GDP. This data set is provided by Eurostat.

The seventh variable that will be included in this study is unemployment. Even though GDP can grow even if employment does not, it is generally believed that there is a strong tendency for GDP to grow if employment rises (or unemployment declines).This relationship was observed by economist Arthur Okun, from whom the Okun's law followed, an empirically observed relationship between unemployment and losses in a country's GDP. This data set is provided by the World Bank.

The eighth and final variable that will be included in this study is government spending. Government spending includes the consumption and investments by governments as a share of GDP. Government spending provides an indication of the approach regarding the delivering of public goods and services, and is an indication of the size of a government. This data set is provided by the OECD.

Finally, the model will include an error term. If the model represents an incomplete relationship, the error term equals the amount at which the equation may differ.

3.3 Methodology

To test the relationship between the variables, a regression analysis is used to determine the effect of BRI-related project investments in Polish infrastructure on GDP. Multiple regression analysis is used to predict the value of a variable based on the value of other variables. The variable that will be predicted is the dependent variable; the variables that are used to predict the value of the dependent variable are independent variables. Conducting a multiple linear regression analysis consists of three stages: analyzing the correlation and directionality of the data, estimating the model, and evaluating the validity and usefulness of the model. The Data is organized

in a manner that makes analysis using the Statistical Package for Social Sciences (SPSS) possible by calculating the growth rates of the variables.

The following model is used to establish the relationship between GDP and the different variables:

$$Y = C + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon$$

Where:

Y= Economic growth as measured by GDP growth rate

C = Constant to be estimated

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8$ = Coefficient of determination

X_1 = BRI-related investments in infrastructure

X_2 = Interest rates (nominal interest rates)

X_3 = Inflation (CPI)

X_4 = FDI

X_5 = HFCE (% of GDP)

X_6 = IPI

X_7 = Unemployment (% of total labor force)

X_8 = Government spending (% of GDP)

ε = error term

3.3.1 Correlation analysis

In order to find out whether the variables and growth in GDP correlate, a Pearson correlation analysis is conducted. Table 2 shows the correlation matrix between the different variables and growth rate of GDP.

Since multiple variables will be used in this research, it is important to test for multicollinearity. Multicollinearity occurs when two or more independent variables moderately or highly correlate with each other. One of the assumptions when conducting a multiple regression study is that the X variables are independent of each other. When variables are correlated, this is not the case. Multicollinearity influences the calculation of the coefficients since the variables partly depend on each other, which reduces the reliability of the calculated coefficients. It can result in magnitudes and opposite signs of coefficients that are different than expected.

One of the ways multicollinearity can be detected is by creating a correlation matrix which shows the Pearson correlation between all the different pairs of independent variables. There is no definitive agreed upon value when interpreting correlation analyses in terms of what is equal to multicollinearity, but a popular cut off score that is used often is a correlation of 0.8 (Lin, 2007).

Table 2. Correlation matrix

	GGDP	GBRI	GINT	GINF	GFDI	GEXP	GIPI	GUNP	GOV
GGDP	1	-.210	-.470	-.797	-.505	-.633	.513	-.470	.223
GBRI	-.210	1	-.091	-.096	.221	-.230	.455	-.325	-.042
GINT	-.470	-.091	1	.524	.422	.676	-.809	-.193	-.270
GINF	-.797	-.096	.524	1	.808	.932**	-.482	.511	-.112
GFDI	-.505	.221	.422	.808	1	.730	-.174	.042	.225
GEXP	-.633	-.230	.676	.932**	.730	1	-.537	.435	-.306
GIPI	.513	.455	-.809	-.482	-.174	-.537	1	-.031	.047
GUNP	-.470	-.325	-.193	.511	.042	.435	-.031	1	-.423
GOV	.223	-.042	-.270	-.112	.225	-.306	.047	-.423	1

*Note: Pearson Correlation. N=6. ** Correlation is significant at the 0.01 level.*

There are multiple variables that have a correlation equal, larger or close to 0.8 (marked yellow in Table 2): the variables inflation (GINF) and household final consumption expenditures (GEXP) correlate at .932; interest rates (GINT) and Industrial Production Index (GIPI) correlate at -.809; the variables inflation (GINF) and FDI (GFDI) correlate at .808; growth rate of GDP (GGDP) and inflation correlate at -.797.

The correlation matrix shows a possible case of multicollinearity. To find out whether this is the case, the strength of the multicollinearity needs to be calculated. Collinearity diagnostics can be calculated by SPSS to determine the strength of the multicollinearity by using a Variance Inflation Factor (hereafter referred to as VIF). The VIF-value shows whether there is multicollinearity between two or more variables. As with the Pearson correlation, there is no definitive agreed upon value when interpreting VIF-values in terms of what is equal to multicollinearity, but it is often assumed to be present when a VIF-value is larger than 4.0 and the tolerance is lower than .250 (the VIF is equal to the inverse of the tolerance) (Rutherford, 2002). The calculated statistics variables can be found in Table 3.

Table 3. Collinearity Statistics

		Collinearity Statistics	
Model		Tolerance	VIF
1	GBRI	.552	1.811
	GINT	.197	5.089
	GINF	.715	1.398
	GIPI	.174	5.762
	GGOV	.815	1.226

Dependent Variable: GGDP

The VIF-values for the variables interest rates (5.089) and Industrial Production Index (5.762) are both higher than 4.0. When Industrial Production Index is removed from

the variables, the VIF-value of interest rates (1.585) is lower than 4.0 (Table 4). However, the VIF-values of inflation (6.303) and FDI (7.387) are higher than 4.0.

Table 4. Collinearity Statistics without variable GIPI

Model		Collinearity Statistics	
		Tolerance	VIF
1	GBRI	.555	1.803
	GINT	.631	1.585
	GINF	.159	6.303
	GFDI	.135	7.387
	GGOV	.485	2.062

Dependent Variable: GGDP

Table 5. Collinearity Statistics without variables GIPI and GINF

Model		Collinearity Statistics	
		Tolerance	VIF
1	GBRI	.454	2.201
	GINT	.300	3.334
	GFDI	.332	3.014
	GUNP	.309	3.231
	GGOV	.298	3.360

Dependent Variable: GGDP

When excluding both inflation and the Industrial Production Index, the variables show acceptable levels with no VIF-values higher than 4.0 (Table 5). The correlation matrix between the different variables without inflation and Industrial Production Index (Table 6) also shows no Pearson correlation equal, close or larger than 0.8.

If the variables that cause multicollinearity are retained, no reliable inferences on the individual coefficients can be made. Therefore the variables inflation (GINF) and Industrial Production Index (GIPI) will be removed.

Table 6. Correlation matrix without GIPI and GINF

	GGDP	GBRI	GINT	GFDI	GEXP	GUNP	GGOV
GGDP	1	-.210	-.470	-.505	-.633	-.470	.223
GBRI	-.210	1	-.091	.221	-.230	-.325	-.042
GINT	-.470	-.091	1	.422	.676	-.193	-.270
GFDI	-.505	.221	.422	1	.730	.042	.225
GEXP	-.633	-.230	.676	.730	1	.435	-.306
GUNP	-.470	-.325	-.193	.042	.435	1	-.423
GGOV	.223	-.042	-.270	.225	-.306	-.423	1

Note: Pearson Correlation. N=6

3.3.2 Regression analysis

Now that the correlation analysis has been conducted, the regression can be run. Running a regression requires somewhat of a “trial and error” approach to find the best model. To pick the best model, the adjusted R-squared, a modified version of R-squared, from different models is compared.

The R-squared can take value between 0 and 1 and shows the explanatory power of the independent variable on the dependent variable: the larger the value of R squared,

the higher is the proportion of the variance in the dependent variable that is predictable from the independent variable. The R-squared increases when more variables are included to the model because more variance can be explained by it.

Whereas the R-squared will always increase when more variables are added to the model, the adjusted R-squared will only increase if the new variable improves the model above what would be obtained by probability. The adjusted R-squared is a modified version of R-squared and compares the explanatory power of a regression model that contains different numbers of predictors. The adjusted R-squared increases when significant variables are added to the model and decreases when useless variables are added to the model. Therefore it is better to compare the adjusted R-squared of the different models in multiple regression analysis. That way the model with variables that have the best fit can be chosen and the model with a possible artificially high R-squared resulting from useless variables can be avoided.

The computed R-squared and adjusted R-squared for the different models can be found in Table 7.

Table 7. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.515[a]	.265	-.224	.09169
2	.602[b]	.362	-.595	.10464
3	.885[c]	.782	.456	.06112
4	.889[d]	.791	-.045	.08469
5	1.000[e]	1.000	.	.

a. Predictors: (Constant), GFDI, GBRI

b. Predictors: (Constant), GINT, GBRI, GFDI

c. Predictors: (Constant), GUNP, GINT, GBRI

d. Predictors: (Constant), GUNP, GFDI, GBRI, GINT

e. Predictors: (Constant), GGOV, GBRI, GINT, GFDI, GUNP

The model with the highest adjusted R-squared is Model 3 (.456). All the other models have a negative adjusted R-squared value. When more variables are added to the model and the adjusted R-squared becomes negative, it indicates that the model does not fit the data. Therefore Model 3, the only model with a positive adjusted R-squared including the variables GUNP (unemployment), GBRI (BRI-related investments) and GINT (interest rates), will be chosen for the multiple regression.

4. Results

This section discusses the results from the quantitative research.

After removing variables causing multicollinearity and choosing the model with the highest adjusted R-squared, the model with the variables GBRI (BRI-related investments), GINT (interest rates) and GUNP (unemployment) is chosen for the multiple regression. Table 8 shows the computed regression coefficients.

Table 8. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.065	.402		5.132	.036
	GBRI	-.049	.033	-.520	-1.470	.279
	GINT	-.401	.205	-.665	-1.951	.190
	GUNP	-.683	.320	-.767	-2.138	.166

a. Dependent Variable: GGDP

Taking all factors at zero, growth rate of GDP is 2.065. A unit increase in BRI-related investments decreases growth rate of GDP with -.049 and a unit increase in interest rates and unemployment decreases growth rate of GDP with -.401 and -.683 respectively.

The regression coefficients in Table 8 are used to come up with the following model:

$$\mathbf{Y = 2.065 - .049X_1 - .401X_2 - .683X_3}$$

Where:

Y= Economic growth as measured by GDP growth rate
X_1 = BRI-related investments in infrastructure
X_2 = Interest rates (nominal interest rates)
X_3 = Unemployment (% of total labor force)

As can be seen in Table 8, the variables have a p-level of .279, .190 and .166, meaning none of them are significant at a p-level of 0.05. Therefore there appears to be no significant relation between BRI-related investments and growth rate of GDP.

5. Conclusion

This section includes the conclusion and answers the research question. It also discusses the limitations of the research and provides recommendations for future research.

The goal of this study was to research the effect of BRI-related investments on the growth of GDP in Poland. To answer the research question a literature review and quantitative research was conducted. The research question is:

'What is the relation between Poland's growth in GDP and Chinese investments in infrastructure coming from the Belt and Road Initiative?'

The first result of this study is that none of the conducted quantitative analyses show a significant relation between BRI-related investments and growth in Poland's GDP. The effect possibly exists, but the data of this research could not prove its significance.

Based on the literature review, infrastructure positively contributes to GDP in multiple ways: investments in infrastructure provide employment opportunities, create well-built networks which allow for the optimal allocation of limited resources and lower transport costs which enable larger volumes of trade.

Investments in ports stimulate the forming of business clusters, which increase productivity and attract FDI. Efficient ports lead to lower transport costs which stimulates trade. Railways offer no significant benefit regarding transport costs compared to ports other than being less expensive. Railways also have the possibility to connect inland areas which are difficult or impossible to reach by sea, and stimulate accessibility.

According to the literature review there is a positive relationship between investments in ports and railways. This indicates that in case of the BRI, investments in infrastructure in Poland positively contribute to Poland's GDP because it allows for larger exports resulting from reduced shipping and transportation costs.

Even though no supportive results followed from the quantitative research, it can be concluded from the literature review that the relation between Poland's growth in GDP and Chinese investments in infrastructure coming from the Belt and Road Initiative is positive.

5.1 Limitations

The first formulated limitation of this research is the lack of data regarding BRI-related investments in Poland. Due to the vague definition of exactly constitutes the BRI, it is difficult to define what projects exactly fall under the initiative. Therefore it was not possible to use the exact amount of the investments, and a relatively rough estimate of the size of the investments had to be made. For future study it is important to have accurate data regarding BRI-related investments to improve the quality of the findings.

A second limitation of this research is the low amount of observations used. Since the BRI did not officially took shape before 2013, the amount of data and number of observations that could be included was limited. This resulted in low R-squared values and negative adjusted R-squared values, indicating the models did not fit the data, possibly because there were too many predictors trying to explain too little information. This made it difficult to effectively answer the research question, because the model used only included three variables. Future study should use more data to get more effective answers.

5.2 Recommendations

A recommendation for future research is to include qualitative data to the research. By conducting interviews for example, insights regarding the relation between the BRI and Poland's growth in GDP can be generated that cannot be deducted from quantitative research. Qualitative research may give a more complete picture regarding the GDP growth in Poland and its relation to BRI-related investment projects than statistics and a literature review alone.

Another recommendation is to compare Poland to other countries where BRI-related projects have taken place and to see whether the effect on GDP growth is the same in those countries as it is in Poland. As described in the theoretical framework, there is a concave relationship between infrastructure investments and economic growth. It would be interesting to compare Poland to other countries where BRI-related projects are taking place, like for example Laos, Thailand, Pakistan or Kenya. Those countries have a lower GDP than Poland, which could result in different effects of BRI-related projects on GDP growth. It is possible that those countries, that have less developed economies, will show higher returns to investments in infrastructure than Poland, which already is developed economy.

A final recommendation for future research is to include a larger date set over a longer period of time. It is interesting to research the effects of BRI-related projects on GDP on the long term. Since the BRI is a relatively young project, it is interesting to follow the influence it has on GDP over the course of the next multiple years. More data will most likely lead to more relevant and significant results, from which more useful conclusions can be drawn.

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Appendix

Appendix 1. Growth rate BRI-related investments

Year	Million euros	Growth Rate
2010	18.495	
2011	29.78	0.621
2012	22.11	1.347
2013	11.36	1.946
2014	32.78	0.347
2015	48.02	0.683
2016	34.05	1.410

National Bank of Poland (2018).

Appendix 2. Nominal interest rates

Year	Interest Rate in %
2010	5.78
2011	5.96
2012	5.00
2013	4.03
2014	3.52
2015	2.70
2016	3.04

OECD (2018), Long-term interest rates (indicator).

Appendix 3. Inflation rate – Consumer Price Index (CPI)

Year	Inflation Rate in %
2010	2.58
2011	4.24
2012	3.56
2013	0.99
2014	0.05
2015	-0.87
2016	-0.66

OECD (2018), Inflation (CPI) (indicator).

Appendix 4. Other FDI

Year	Other FDI in millions of euros
2010	175986.5
2011	170227.5
2012	173995.8
2013	168494.5
2014	178223.9
2015	157103.1
2016	161343.7

National Bank of Poland (2018).

Appendix 5. Household final consumption expenditure (% of GDP)

Year	Household final consumption expenditure in % of GDP
2010	61.57
2011	61.47
2012	61.52
2013	60.94
2014	60.05
2015	58.44
2016	58.50

OECD (2018), Household spending (indicator).

Appendix 6. Industrial Production Index

Year	Industrial Production Index
2010	100
2011	106.7
2012	108.1
2013	110.6
2014	114.4
2015	119.9
2016	123.3

Eurostat (2018), Production in industry – annual data.

Appendix 7. Unemployment (% of total labor force)

Year	Unemployment in %
2010	9.64
2011	9.63
2012	10.09
2013	10.33
2014	8.99
2015	7.5
2016	6.16

World Bank (2018), Unemployment, total (% of total labor force).

Appendix 8. Government spending (% of GDP)

Year	Government spending % of GDP
2010	45.8
2011	43.9
2012	42.9
2013	42.6
2014	42.3
2015	41.6
2016	41.2

OECD (2018), General government spending (indicator).

Appendix 9. GDP Poland and growth rate

Year	GDP in billions of euros	Growth rate
2010	406364.46	
2011	448267.85	0.907
2012	424754.97	1.055
2013	444729.68	0.955
2014	462263.63	0.962
2015	404826.06	1.152
2016	399626.51	1.013

IMF (2018), GDP.