Master's Thesis in Economics

Final Version

On the road to prosperity:
The effect of the Belt and Road Initiative on host countries

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Abstract

This paper examines the economic effects of the Belt and Road Initiative (BRI) for 72 countries over the period 2002-2019. The main topic of the paper investigates whether BRI host countries benefit from improved infrastructure. This is analyzed using a random effects model. In this model, infrastructure is measured by an index that is constructed using a Principal Component Analysis. The econometric analysis shows that infrastructure is strongly correlated with GDP per capita. Furthermore, this baseline analysis is augmented with a Two-step System GMM estimation. The GMM estimation reveals that there is a causal effect going from infrastructure to GDP per capita. In addition to this main topic, five sub-topics are investigated. Two sub-topics consider the mediating effects of exports and productivity. No robust evidence is found that these factors mediate the relationship between infrastructure and GDP per capita. Another sub-topic considers whether debt distress inhibits positive effects of infrastructure. This also does not appear to be the case. The final two sub-topics look at the confounding effects of time and development. It is found that infrastructure investments have a long-lasting effect on economic performance, and the effect of infrastructure is less pronounced in developed countries compared to developing countries.

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Introduction

During his travels along the Silk Road, Marco Polo was fascinated by the way in which merchants used infrastructure to transport goods along the route. In his travelogue he wrote the following about this: “the transport of merchandise is to an extent that might appear incredible to those who have not had an opportunity of witnessing it” (Wright, 2010). This quote insinuates that the infrastructure of the Silk Road played an important role in facilitating transport and commercialization. Contemporary economists agree that the well-developed infrastructure of the Silk Road contributed to the economic development of countries along the route (Barisitz, 2017; Ahmad & Chicoine, 2021). In a speech in 2013, President Xi Jinping also recognized the economic importance of the Silk Road. During this speech he expressed the wish to revamp this historic trade route in the form of the Belt and Road Initiative (BRI) (Ministry of Foreign Affairs of the PRC, 2013). The BRI is a transcontinental development strategy aimed at improving infrastructure in developing countries. The main aim of this initiative is to improve infrastructure gaps along the historic Silk Road (Chin & He, 2016).

Most economic scholars are excited about the prospects of the BRI because they expect a positive effect on host countries (Wang, et al., 2020; Chin, et al., 2021). These scholars use traditional economic reasoning to argue in favor of the BRI. For example, it is believed that infrastructure leads to cost reduction, productivity, trade, FDI and technology transfers (Hall & Jones, 1999; Goetz, 2011; Bakar et al., 2012; Baita 2020). Despite this tendency in the literature, there is a substantial group of scholars who are critical about the BRI. These scholars question whether there are ulterior geostrategic motives behind the initiative. The Chinese debt trap diplomacy plays a key role in this strand of literature. The idea of this “diplomacy” is that indebted countries default on their loans and this allows Beijing to pressure them (Fasslabend, 2015; Brautigam, 2019). Because of such predatory lending, some scholars believe that the gains of the BRI do not always commensurate with project investments (De Soyres et al., 2019).

These two competing perspectives indicate that there is no consensus in the literature about the economic effects of BRI-related infrastructure investments. This ambiguity in the literature makes the BRI a relevant topic for research. The analysis in the current paper investigates whether countries that participate in the BRI benefit from improved infrastructure. Specifically, this paper seeks to answer the following question: *To what extent does infrastructure contribute to economic performance in BRI countries?*

The above question is examined using a random effects model. The dataset that is used in this econometric analysis consists of 72 BRI countries over the period 2002-2019. The results of the analysis show that infrastructure is strongly correlated with GDP per capita in BRI countries. This correlation alone is not sufficient to make meaningful inferences about the effect of the BRI. Therefore, a Generalized Methods of Moment (GMM) estimation is performed to address issues of endogeneity and to assess the causality of the relationship. This estimation indicates that there is a causal effect going from infrastructure to GDP per capita.

Furthermore, the current paper also investigates five sub-hypotheses. Two sub-hypotheses look at the mediating effects of exports and productivity. However, the econometric analysis found no evidence that exports or productivity mediate the effect of infrastructure on GDP per capita. Another sub-hypothesis considers whether debt distress inhibits positive effects of infrastructure. This also does not appear to be the case. Finally, there are two sub-hypotheses that investigate the confounding effects of time and development. The results show that the first, second and third lag of infrastructure have a positive effect on current GDP per capita. This suggests that infrastructure investments have a long-lasting effect on economic performance. Furthermore, it is found that infrastructure has a less pronounced effect in developed countries compared to developing countries.

The findings in this paper are relevant from an economic and academic perspective. From an academic perspective these findings clarify some of the ambiguity in the literature and they introduce new areas of research. The findings are also interesting for actors outside the academic realm. Among others, policymakers, economists, entrepreneurs and politicians can gain insights in how infrastructure affects economic activity. In particular policymakers from China and BRI host countries might get a better understanding of the implications of the BRI.

The remainder of the paper will have the following structure: Chapter 2 reviews the literature on the BRI and the linkages between infrastructure and economic performance. Chapter 3 gives an overview of the data and explains the methodological approach. Chapter 4 explains all variables that are included in the econometric analysis. The results of this analysis are presented in Chapter 5 and discussed in Chapter 6. Chapter 7 highlights certain limitations of the research and Chapter 8 formulates a conclusion.

Literature review

In a keynote speech at the Belt and Road Forum, President Xi Jingping identified that the economic development of countries along the BRI differs. This difference in development might be partially due to the "infrastructure gaps" in certain regions. President Xi even argued that "the lack of infrastructure has held up the development of many countries" (Xinhua, 2017). By investing in infrastructure, the BRI aims to release the growth potential of participating countries and achieve interconnected development. Several previous scholars have investigated the role of infrastructure in economic development. Few of them focused specifically on BRI countries, and the ones that did provide conflicting evidence. Certain scholars such as Wang et al. (2020) and Chin et al. (2021) find evidence that the infrastructure investments of the BRI are beneficial for host countries. De Soyres et al. (2019) on the other hand find that the effect might turn negative when the investment costs are accounted for. The literature thus finds conflicting results, which is why the relationship is perceived as inconclusive. This ambiguity warrants further research about the economic effects of the BRI.

Before delving into the literature about the BRI, it might be necessary to define infrastructure. Discussing all the possible definitions of infrastructure is beyond the scope of this paper. For this paper the definition of Aschauer (1989) appears to be suitable since it captures most of the relevant aspects of the BRI. Aschauer (1989) argues that infrastructure should include all the material and physical infrastructure that facilitates a sustainable functioning of the economy. In line with this, he describes 'core' infrastructure as consisting of "streets and highways, airports, electrical and gas facilities, mass transit and water systems". The exact scope of the BRI is still being deliberated, however these infrastructure indicators appear to play an important role in the initiative. Specifically, the World Bank (2019) and the OECD (2018) argue that investments in highways, airports, power grids, railways, ports and telecommunication can be related to the BRI. The current research defines infrastructure as the aggregate of these indicators, which together forms 'core' infrastructure in BRI countries.

It might be important to note that the BRI consists of more than infrastructure alone. It covers a wide variety of areas including policy dialogue, trade, and finance. Infrastructure does play a fundamental role since it is the foundation for regional cooperation, especially at the early stage of the initiative (OECD, 2018). The current research only focusses on infrastructure, which means that only a fraction of the initiative is covered.

Belt and Road Initiative (BRI)

Establishing a transcontinental infrastructure network is complicated and calls for a coordinated approach from all countries involved. The Communist Party of China (CPC) is often seen as the nexus of all BRI projects since it plays a particularly important role in coordinating the initiative (World Bank, 2019). Specifically, the CPC plays a leading role in the construction and financing of BRI projects.

The first role of the Chinese government is to facilitate the financing of the BRI. Because of this role, BRI projects are dominated by Chinese state-owned financial institutions. He (2020) estimates that state-owned policy and commercial banks provide 81 percent of total BRI funding. Figure 2 in the appendix depicts the BRI funding by source type, which reveals the influence of the CPC. Two policy banks named the China Development Bank (CDB) and the Export-Import Bank Of China (CEXIM) together provide about $341 billion in loans, which equates to roughly 45 percent of total funding. Overall, the pie chart indicates that the CPC has a large influence on funding. Figure 3 gives a more specific overview of the funding of BRI projects. This pie chart distinguishes how much each respective financial institution invests. Most BRI studies tend to focus on the role of the Asian Infrastructure Investment Bank (AIIB) and the Silk Road Fund (SFR) whilst other financial institutions are largely neglected. These institutions are the focal point because they were established for coordinating the BRI (Liu et al, 2020). However, figure 3 shows that they only provide a minor part of the funding. The combinative contribution of the AIIB and SRF is $19 billion in loans, which is small relative to the $765 billion of the total contribution. It is therefore more appropriate to look at the broad set of financial institutions involved in the BRI instead of focusing on the AIIB and SRF.

Economists tend to be critical about the financing processes of Chinese state-owned banks. Liu et al. (2020) postulate that corruption, unsustainable debt and non-transparency are common issues in these banks. Furthermore, the majority of BRI loans are going to developing countries with poor credit ratings. Most financial institutions would be unwilling to lend money to these countries because they deem it too risky or too costly. Chinese state-owned banks are willing to lend money, however they do pressure host countries into questionable contracts with high collaterals (Hurley et al., 2019). These collaterals serve as an insurance for a default on the loan. This loan-structure with high collaterals is a contentious topic of which the morality is sometimes questioned. Further issues with BRI funding will be elaborated when discussing the debt-trap diplomacy in a later part of the paper.

There are also several positive aspects related to these state-owned financial institutions. An example is that these institutions tend to use a streamlined procedure to loan money to BRI host countries. There are standardized procedures that are followed in terms of procurement, risk analysis and safeguard policy. This makes the funding process efficient and less opaque compared to their regular activities (Zhao et al., 2019). Furthermore, the state backing of these institutions means that they have far more resources available compared to most other lenders. This enables them to provide relatively cheap credit to a wide array of projects (Liu et al, 2020). Finally, state-owned banks tend to take a pragmatic stance regarding BRI loans. This means that the loans are not made on concessionary terms (Hillman & Sacks, 2021). These loans are thus not contingent on economic or political reform in host counties, which makes them more accessible to nations with debt or governance issues. In more general terms, Hillman and Sacks (2021) argue that Chinese lenders are often willing to pursue BRI projects even when they are faced with significant political and financial obstacles.

The second role of the Chinese government is to coordinate the construction of BRI projects. This coordination is often done indirectly using state-owned enterprises (SOE's). He (2020) argues that the majority of BRI projects are conducted by Chinese state-owned construction companies. According to his estimates, SOE's account for more than 60 percent of total projects and close to 80 percent of total value. There are various reasons why these Chinese SOE's dominate investments and construction contracts in BRI countries. The most notable reason is that Chinese SOE's receive a disproportional amount of financial support from state-owned banks (He, 2020). Major banks such as the Export-Import Bank of China and China Development Bank heavily favor loans to SOE's over loans to the private sector (CDB, 2017). This uneven financial support explains the dominance of SOE's in the construction of the BRI.

Several scholars are critical about the role of state-owned construction companies in the BRI. Critics such Hillman and Sacks (2021) argue that SOE's might drive out local companies. Local companies in host countries find it hard to compete with state-backed companies. These companies are massive in scale and offer everything from financing, building, equipment and even labor. This leaves little room for local firms to participate in the construction of the BRI, which inhibits spillovers to the local economy (Wernau, 2020). Furthermore, Zhang (1998) argues that SOE's have an inherent principal-agent problem which makes them less efficient compared to private companies. The problem is that the monitoring incentive of principals and work incentive of agents decrease with the degree of publicness in companies.

The World Economic Forum recognizes that Chinese SOE's tend to be less efficient compared to their private peers. However, they also argue that the legal and regulatory systems in China are not yet prepared to regulate giant corporations. The state-owned construction companies are among the largest corporations in the world and are strategically significant to the Chinese government. In order to regulate such corporations, one should have a strong institutional foundation. The Chinese legal and regulatory systems are not yet strong enough since they are currently going through crucial transformations with regards to intellectual property. Because of this, it might be better that the government retains direct control in the short run (Amir, 2019).

There are even scholars who argue that the involvement of Chinese SOE's might be beneficial for BRI host countries. In the last two decades, the Chinese government invested heavily in domestic infrastructure projects. Chinese construction companies constructed these projects and in doing so they gained knowledge about efficient construction processes. In consideration of this, BRI host countries might opt for Chinese SOE's because of their superior scale advantages and technological know-how (Qi & Kotz, 2019). Furthermore, SOE's have access to a large migrant workforce that can construct BRI projects. These workers already have experience with BRI-like projects due to the domestic infrastructure construction. The notoriously low costs of these workers might be beneficial for BRI countries (Muttarak, 2017).

Based on the above overview one can infer that the BRI is essentially a scheme which can be used to develop infrastructure. This scheme enables participating countries to borrow money from Chinese state-owned financial institutions to fund infrastructure projects. These projects are in turn carried out by Chinese state-owned construction companies.

Most infrastructure projects take place through six land corridors that roughly equate to the historic Silk Road. Similar to the historic trade route, these corridors are overland routes that connect China to Europe. Figure 1 in the appendix gives a rough overview of these corridors and the countries they pass through. In general, the countries along this "belt" tend to be ill-served by existing infrastructure. The BRI aims to improve this infrastructure, and in doing so it might strengthen economic growth across the region. Furthermore, an additional maritime corridor has been added which is called the 21st Century Maritime Silk Road. This is a complementary initiative which aims to further develop the sea routes between China and Europe. Despite being only one of the seven economic corridors, the 21st Century Maritime Silk Road is responsible for the bulk of the Belt and Road trade (World Bank, 2019).

Table 1 in the appendix lists each country that has a close connection to the BRI. Each country is also related to a specific economic corridor. This classification might be useful since it provides information about the types of infrastructure investments in a country. The World Bank (2019) for example shows that investments in the 21st Century Maritime Silk Road are mainly concentrated on ports, whilst investments in the China-Mongolia-Russia corridor are focused on railways. This is relevant since the relationship between infrastructure and economic performance might be contingent on the type of infrastructure (Estache & Garsous, 2012). Garsous (2012) for example finds that investments in the energy sector have a larger effect compared to other investments. This relative performance per infrastructure indicator will be further elaborated in the discussion section of the paper.

Infrastructure and Economic Growth

This part of the literature review describes how infrastructure affects economic activity. The review will be structured based on certain transmission mechanisms. These transmission mechanisms capture specific ways in which infrastructure affects economic performance.

Productivity is the first transmission mechanism through which infrastructure affects GDP per capita. Aschauer (1989) was one of the first economists to investigate the effect of infrastructure on economic growth. Therefore, his work is regarded as the seminal work in this field. His work established that investments in 'core' infrastructure contributes to the aggregate productivity in a country. This means that investments in roads, highways and airports increases productivity, which in turn affects economic growth. Specifically, Aschauer (1989) finds that a 1% increase in public infrastructure leads to an increase in productivity between 0.35% and 0.49%. Later researchers such as Hall and Jones (1999) corroborate his findings. They found that differences in the output per worker are driven by differences in infrastructure.

Several economists also argue that productivity affects the strength of the relationship between infrastructure and economic performance. The study by Rioja (2003) for example provides evidence that infrastructure is more effective in productive countries. He shows that the effect of infrastructure in Latin America is limited because infrastructure is used inefficiently. This inefficient use leads to a steady-state loss of approximately 40% in Latin American countries. Rioja (2003) even goes as far as to suggest that the effect can turn negative at very low levels of efficiency. A study by the McKinsey Global Institute also suggests that the effect of infrastructure can be much greater if it is used productively (Dobbs et al., 2013).

It might be important to note that low-productivity countries can also use infrastructure efficiently. Still, this is less likely because these countries tend to lack the know-how and capital that is necessary to efficiently use infrastructure. Rioja (2003) takes a similar stance and argues that developing countries have less efficient infrastructure because they lack knowledge about maintaining it. If infrastructure is not well-maintained, the quality might deteriorate and it can quickly become ineffective. In short, this section provides evidence that infrastructure might be more effective in productive countries since it is more efficiently used.

However, it is important to note that there is also a large group of scholars who believe that infrastructure investments have a stronger effect in less productive economies. These scholars rely on the argument that infrastructure investments have decreasing marginal returns (Estache & Fay, 2010). Decreasing marginal returns suggest that infrastructure is less effective in developed countries with high productivity. In general, it has been well-documented that the long-run effects of infrastructure might be stronger in low-productive economies. These economies are ill-served by existing infrastructure and therefore they can benefit more from infrastructure improvements (Garsous, 2012). However, the current study only has a time frame of 18 years, so it is unlikely that this long-term effect is captured. Instead, the current research looks more at the short-run effects of infrastructure. It is rather ambiguous whether the short run effects are more in line with the positive mediating effect or the negative mediating effect. Despite this ambiguity, it is reasonable to assume that the strength of the relationship between infrastructure and economic performance is contingent on the productivity in a country.

The second transmission mechanism is that infrastructure leads to lower costs. This argument is closely related the previous one since the most important way in which infrastructure lowers costs is by making transportation more efficient (i.e., more productive). Goetz (2011) and Button and Yuan (2013) both provide evidence for this. Goetz (2011) shows that infrastructure contributes to economic growth through facilitating easier access to resources and lowering the costs of intermediate products. Button and Yuan (2013) showed that hat air transport lowers the costs of transportation in a country which also leads to economic growth. Maliszewska and van der Mensbrugghe (2019) quantify the cost-reducing effects of the BRI. Their estimates indicate that BRI related cost reductions lead to a global real income increase of 0.7 percent in 2030. BRI countries capture approximately 82 percent of this gain, with China garnering 36 percent of the total global gain.

Trade (or exports) is the third mechanism through which infrastructure affects economic performance. This mechanism heavily relies on the proposition that infrastructure leads to lower costs. These lower costs in turn increase competitiveness which affects trade and exports (Snieska & Bruneckiene, 2009). Scholars such as Baita (2020) use structural gravity models to show how infrastructure affects bilateral trade flows between two countries. In these models the trade is determined based on the economic size of the countries and the distance between them. Infrastructure is then considered to be a factor that reduces the (negative) effect of distance on trade. Among others, Olarreaga (2016) and Rehman et al. (2020) provide empirical evidence that infrastructure facilitates trade/exports. So, better infrastructure leads to more trade, and trade is seen as a robust engine for economic growth. This idea is often referred to as the trade-led growth theory and it is one of the key ideas behind the BRI (Keho, 2017).

Furthermore, there is also a group of scholars that take a different perspective when analyzing the interaction between infrastructure and exports. Yeo et al. (2020) emphasize that the effect of infrastructure might be stronger in countries with an export-oriented economy. Specifically, they find that international trade/exports mediate the relationship between infrastructure and economic performance. The underlying rationale is that the logistic performance is stronger in export-oriented economies. A preexisting experience with exports led to a gradual development of trade-related logistics and an environment that is conducive to trade. Because of this, the effect of infrastructure on economic performance is believed to be greater in such export-oriented economies. Corroborative evidence for this has been found by Puertas et al., (2014). Their research shows that logistics performance is more important for exporting nations compared to importing nations.

Looking at it from the other perspective, it is also probable that the effect of infrastructure is smaller closed-off economies that are not export-intensive. Economies such as Uzbekistan, Tajikistan, Turkmenistan, Syria, and Iraq have limited experience with exports. The World Bank (2019) argues that these economies do not have the institutional environment in place to benefit from improved infrastructure. Institutional issues such as trade restrictions and border delays hamper cross-border trade, which in turn limtits the effects of infrastructure. The above overview shows quite some evidence that a pre-existing level of exports is beneficial for the effect of infrastructure on economic performance. However, it is important to point out that there might be a mutually reinforcing relationship between exports and infrastructure. This is the case because there are also scholars who suggest that the effectiveness of exports depends on the level of infrastructure in a country. Economists such as Ramirez (2021) point out that the effect of exports on economic performance is also mediated by the level of infrastructure in a country. This simultaneity makes it difficult to test the interaction econometrically, but the importance of it in the literature warrants a further assessment.

The fourth transmission mechanism is FDI. According to Bakar et al. (2012) and Kaur et al. (2016), infrastructure is one of the main determinants of foreign direct investment (FDI). Both find evidence that infrastructure such as railways and road networks play a crucial role in attracting FDI. Inflows of FDI have in turn been linked numerous positive effects such as productivity increases, skill and know-how improvements and technological improvements (Moura & Forte, 2013). In consideration of this, better infrastructure might accelerate economic development through attracting FDI.

Spillover effects are the fifth mechanism through which infrastructure affects economic performance. In a seminal paper, Kenneth Arrow (1962) introduced the intuition that knowledge ‘’trickles downs’’ from one firm to another. This trickling down is often referred to as spillover effects. Over the years, different types of spillovers effects emerged. One specific type looks at technology spillovers. Technology spillovers can be defined as the unintentional technological benefits to firms that come from R&D efforts of other firms without the costs being shared (Sun & Fan, 2017). Hu et al. (2019) found that regions with better infrastructure have more pronounced technology spillovers. Based on this, they infer that regional infrastructure is crucial in explaining heterogeneities in technology spillovers. The underlying intuition is that new technologies disseminate faster if there is well-developed infrastructure. In short, infrastructure might enhance economic performance by facilitating spillovers.

The final transmission mechanisms looks at direct and instantaneous effects of infrastructure. This effect materializes much faster, often within one year (Buchheim & Watzinger, 2017). One of the ways in which infrastructure can have a direct effect is through increased activity in related industries and employment effects. Especially the latter issue has received a lot of attention in the literature. Among others Estache et al. (2013) find that infrastructure projects significantly reduce short-term unemployment. This job creation is often a combination of direct employment in construction and employment in infrastructure- related industries. Buchheim and Watzinger (2017) corroborate the evidence of earlier studies and add that infrastructure investments have a particularly large effect during economic downturns. They refer to this as countercyclical infrastructure investments.

Confounders between Infrastructure and Economic Growth

Based on the reviewed literature, one can infer that there is a positive effect of infrastructure on economic performance. However, it is important to note that the effectiveness of infrastructure might be conditional on confounding factors. Esfahani and Ramirez (2002) for example argue that the benefits from infrastructure investments only materialize if institutional improvements are made. The underlying rationale is that effective governments can identify and carry out infrastructure investments that are conducive to growth. Conversely, governments in a poor institutional setting might be unable to identify beneficial investments or they might be unable to carry out the projects. Therefore, the effect of infrastructure is contingent on the institutional/organizational advancements in a particular country.

In a similar vein, Estache and Garsous (2012) argue that the effect of infrastructure depends on the complementarity between the development stage of a country and the type of infrastructure that is being invested in. Estache and Garsous (2012) give an overview of what type of infrastructure investments fit with a particular development stage. For example, it is argued that investments in water and sanitation are especially important in developing countries (e.g., Sub-Saharan Africa). The same could be said for investments in transportation infrastructure. Developing countries tend to be ill-served by existing infrastructure, which means that these countries can experience substantial benefits from improving transportation infrastructure. There are also infrastructure investments that appear to be beneficial for both developing countries and developed countries. Estache and Wren-Lewis (2011) for example show that investments in energy projects have positive payoffs at all stages of development.

In more general terms, one could argue that infrastructure investments have decreasing marginal returns. This means that the effect of infrastructure might be large in countries that are ill-served by existing infrastructure and smaller in countries that have well-developed infrastructure (Estache & Fay, 2010). Previous research by Garsous (2012) indeed found that it is more likely to find a positive effect of infrastructure if more developing countries are included in the sample. Based on this one can infer that the less developed the country, the more likely infrastructure matters. Garsous (2012) notes that infrastructure can still have positive effects in developed countries, however the focus should then be on dimensions such as bottlenecks, network effects or technological lags.

Another confounding factor that might affect the relationship between infrastructure and economic growth is time. Specifically, the benefits from infrastructure might only materialize over longer periods of time. Estache (2011) explains that time is particularly relevant for infrastructure investments because of the unusual cash flow profile. Investing in infrastructure calls for high short-term costs and slow but long income flows. Therefore, the longer the analysis, the more likely it is that a positive effect on GDP is observed. Empirical evidence for the long-run effect of infrastructure is found by Canning and Pedroni (2004). They find that infrastructure can have long-lasting effects on income if investments are made in undersupplied areas of infrastructure.

The current paper defines infrastructure as the aggregate of highways, airports, power grids, railways, ports and telecommunication. However, it is reasonable to assume that each of these indicators has a different effect on economic growth. Here again it is important to keep in mind that different kinds of infrastructure are important at different development levels. Certain types of infrastructure are important to maintain high growth and productivity levels, whilst others allow countries to catch up with developed countries (Hulten & Isaksson, 2007). Besides this caveat, there is plenty of research which indicates that certain infrastructure is more beneficial for economic growth than others. Hurlin (2006) makes a quantitative estimation of the different effect per infrastructure indicator. He estimates an output elasticity of 0,07 for transport, 0,052 for energy and 0,104 for telecommunication. The exact output elasticity differs significantly based on the sample, which is also expected given the previous explanation of complementary. Estache and Garsous (2012) provide a detailed overview of the research on the relative performance of infrastructure indicators. For the current research it seems warranted to assess the relative performance of infrastructure indicators in the analysis.

Risks of the BRI

This section of the literature review covers various points of critique related to the BRI. These critiques are not about the general relationship between infrastructure and economic growth. Instead, the focus will be on certain flaws and inconsistencies in BRI policy. Discussing these issues might be relevant since they can inhibit positive effects of infrastructure.

Previously, debt distress was alluded to as a possible inhibiting factor. Skeptics such as Fasslabend (2015) and Hillman and Sacks (2021) often use the idea of debt distress as an argument against the BRI. Host countries of the BRI tend to borrow large sums of money from Chinese state-owned banks to finance their infrastructure projects. This can lead to debt distress if the debtor country is unable to fulfill its financial obligations. The country in debt distress might be forced to default on the loan, which leads to a loss of collateral, higher borrowing costs and it harms growth/investments (Hakura, 2020). A report by the Center for Global Development found that at least eight countries are at a risk of debt distress due to BRI loans (Hurley et al., 2019). These countries are Djibouti, Kyrgyzstan, Laos, the Maldives, Mongolia, Montenegro, Pakistan, and Tajikistan. Each of these countries face rising debt-to-GDP ratios and at least 40 percent of external debt owed to China.

In recent years the concept of "debt trap diplomacy" was introduced within the context of BRI investments. This concept refers to the idea that indebted economies can be pressured to support China's geostrategic interests. The Chinese government has accrued a significant amount of leverage over BRI countries due to its creditor position. This leverage can be used to prevent BRI countries from challenging China on issues such as human rights and domestic politics (Chellaney, 2017). Furthermore, if a country is unable to meet its debt obligations the Chinese government can seize certain assets (i.e., collateral). These assets are for example a mine or a port (Hurley et al., 2019). There are already examples of the Chinese government extracting concessions from debtor countries. The most notable example is the case of Sri Lanka, which was forced to hand over a port to China. There are also various other cases such as Laos and Montenegro. In Laos Chinese state-run banks are funding a high-speed rail line that costs approximately half the country's GDP. Because of the high external debt to China, Laos was forced to cede control of its electric grid to a Chinese company (Barney & Souksakoun, 2021). Montenegro is the most recent "victim" of the debt trap diplomacy. In May of 2021, the Montenegrin government asked the EU for help with repaying a BRI loan. The EU refused to help and criticized Montenegro for being too dependent on China (Birnbaum, 2021).

The above overview provides various examples of the debt trap diplomacy. These examples are mainly based on anecdotal stories in news articles or on theoretical literature. Within the academic literature scholars warn about the debt trap narrative since the empirical evidence on the topic is scarce. Kratz et al. (2019) review China's external debt in various countries and find that asset seizures are a very rare occurrence. Aside from the single port in Sri Lanka, there are no cases to support the idea that the Chinese government seizes strategic assets when a country is not able to fulfill its financial obligations. Instead, it is much more common that there are debt renegotiations which result in an extensions of loan terms or a change in the repayment deadlines. Brautigam and Hwang (2016) and Eom et al. (2018) also found no evidence that China deliberately entangles low-income African countries in debt to extract a strategic advantage. It was found that China is only a major player in three African countries that were classified as debt distressed by the IMF. Brautigam (2019) further delves into the debt trap literature and investigates the stories of Sri Lanka, Djibouti, Venezuela and Angola. She concludes that there is little empirical research that corroborates the debt trap narrative in these countries. Instead, the argumentation is often based on anecdotal evidence and "conventional wisdom". This argumentation also relies on fear and negativity about China's overseas engagements, all of which contribute to an anti-China sentiment (Brautigam, 2019). Despite the ambiguous evidence on the debt trap diplomacy, a lot of attention is given to it in the literature. In consideration of this, debt considerations deserve attention in the analysis in the current paper.

In addition to the major debt risks of the BRI, Kugelman (2019) discusses two lesser-known problems that may inhibit positive outcomes of the BRI. The first one being security. By design, the BRI is envisioned to pass through developing countries in Asia and Africa. These areas include some of the world's most unstable regions. Volatile countries such as Pakistan, Iraq, Afghanistan and Syria are highly unstable or at war. It might be challenging to build out the BRI in areas that are prone to conflicts since infrastructure projects take a long time to complete. During the construction process conflicts might emerge that inhibit the development of the BRI. A second issue identified by Kugelman (2019) is water shortage. Large scale infrastructure development requires ample quantities of water. This water is not always widely available in BRI countries. For example, some of the most intensive infrastructure investments take place in Pakistan where water is notoriously scarce. Having BRI projects in such countries might lead to domestic tensions and an anti-BRI sentiment.

While several researchers acknowledge that the BRI has economic benefits for host countries, critics have charged that this body of literature ignores the possible ulterior motives behind the initiative. Outside the academic community, this narrative of ulterior motives seems to gain traction. Various news outlets insinuate that the BRI is a scheme to advance Chinese economic, political, and geopolitical interests. Such skepticism about the motives of the BRI might be driven by anti-China sentiment or anecdotal evidence (Brautigam, 2019). However, these critical points of view should not be neglected and therefore they are discussed below.

Lai (2020) identifies two possible ulterior motives behind the BRI. The first one being that China wants to export its excess manufacturing capacity. Currently, economists believe that China is producing at a lower output than it is capable of. This is referred to as excess capacity and it endangers the sustainability of China's economic growth (OECD, 2018). The BRI would enable China to devote this surplus capacity to construct infrastructure projects. If they do not manage to export this surplus capacity, a host of problems might arise such as unemployment, bankruptcies and social instability. Lai (2020) argues that the BRI can serve as a scheme to export China's excess capacity, which would prevent these problems form happening. A second ulterior motive is that the BRI enables China to secure inputs for its manufacturing sector. Energy inputs appear to be particularly important. The rapid development of the Chinese economy made China the world's largest demander for petroleum and other fuels (World Bank, 2019). Currently these inputs are imported through sea lanes in the South China Sea. The progression of the BRI would allow imports over land, which is argued to be less vulnerable to external sabotage and blockades.

Furthermore, Hillman and Sacks (2021) argue that an economic motive of the BRI is to reorient global commerce away from the United States and towards China. The new trade routes facilitate efficient transportation across the Eurasian continent, which might lead to a shift in international trade activities. Having trade activity concentrated on the Eurasian continent is especially beneficial for the underdeveloped western provinces in China. These provinces are largely excluded from world-trade due to their geographic location. The BRI enables the western provinces to participate in trade, and by doing so they might experience economic growth (Du & Zhang, 2017; Gibson & Li, 2018). This reduces the gap between inland and coastal provinces in China, which boosts political stability in the western provinces (Lai, 2020). The economic and political benefits to (western) China are of vital importance to the Chinese government, which is why they want to shift international trade activities to the BRI.

This section of the paper revealed that the Chinese government has various motives related to the BRI. At its core the initiative is still about economic integration, however other geostrategic considerations also appear to play a role. The question now remains whether the motives/benefits to China go at the expense of other countries. It is reasonable to assume that the BRI is not simply an altruistic endeavor for the Chinese government. China is a developing country that still has underdeveloped provinces in need of investments. In spite of this, the Chinese government decided to invest hundreds of billions of dollars in other developing nations to enhance their infrastructure. These investments are made because the CPC believes that there are long-term (economic) benefits to be had. Some scholars believe that the benefits for China go at the expense of countries not included in the BRI, specifically the US (Fasslabend, 2015; Hillman & Sacks, 2021). Others such as Wang et al. (2020) and Chin et al. (2021) believe that the benefits to China are not mutually exclusive. This would mean that the BRI does not go at the expense of other countries. The evidence on this issue is thus mixed.

Main Hypothesis

The literature review tries to elucidate the relationship between infrastructure and economic performance by discussing positive effects, negative effects and confounding factors. Based on this overview one can infer that the academic literature expects a positive relationship. The theoretical and empirical literature (i.e., transmission mechanisms) unambiguously suggest that infrastructure is beneficial for economic performance. The confounding factors place a footnote at the positive relationship. There appear to be various factor that confound with the relationship, yet none of these factors point toward a negative relationship

The literature review also gives an overview of various critiques on the BRI. It is important to note that these critiques are not about the general relationship between infrastructure and economic growth. Instead, they discuss flaws and inconsistencies in BRI policy that might inhibit positive effects of infrastructure. Furthermore, some of the issues discussed are not based on empirical evidence but rather they are theoretical or anecdotal. Still, these points of critique should not be neglected and deserve attentions in the analysis.

The current paper bases its hypothesis on the academic literature about the general relationship between infrastructure and economic performance. In line with this literature, one can formulate the following hypothesis:

Main Hypothesis: *Infrastructure improvements lead to better economic performance in BRI countries*

Sub Hypotheses

The literature review also discussed sub-topics that examined certain peculiarities of the relationship between infrastructure and economic performance. One such sub-topic is that the effect of infrastructure is mediated by exports and productivity. The following two hypotheses look at these mediating effects:

Sub-Hypothesis 1: *Exports positively affect the relationship between infrastructure and economic performance in BRI countries.*

Sub-Hypothesis 2: *Productivity positively affects the relationship between infrastructure and economic performance in BRI countries.*

A second issue that was discovered in the literature review is that the effectiveness of infrastructure might be conditional on confounding factors. The development level of a country and the effect of time were identified as important confounders. Economists believe that infrastructure has a stronger effect in less developed the countries. As for time, it is argued that the benefits from infrastructure might only materialize over longer periods of time. The following two hypotheses examine these confounding factors:

Sub-Hypothesis 3: *The effect of infrastructure on economic performance is less pronounced in developed countries compared to developing countries.*

Sub-Hypothesis 4: *Infrastructure investments in the previous year positively affect this year's economic performance in BRI countries.*

Finally, there are various scholars who discuss flaws in BRI policy that might inhibit positive effects of infrastructure. Most critics cite debt distress as the most significant inhibiting factor. The rationale is that BRI host countries borrow large sums of money up to the point that they are unable to fulfill their financial obligations. These highly indebted economies then run into a myriad of economic and political issues. The following hypothesis considers how debt effects the relationship between infrastructure and economic performance:

Sub-Hypothesis 5: *Debt negatively affects the relationship between infrastructure and economic performance in BRI countries.*

Research Design

Methodology

This section of the paper describes the methodological approach used in the analysis. The baseline regression is performed using a random effects model with year dummies and economic corridor dummies (model 1). In this model *i* denotes the respective BRI country and *t* is the index for time.

(1) $GDP\ per\ Capita_{it} = \beta_0 + \beta_1\ Infrastructure_{it} + \beta_2\ Population_{it} + \beta_3\ Export_{it} + \beta_4\ Government\ Debt_{it} + \beta_5\ Stability_{it} + \beta_6\ Agriculture_{it} + \beta_7\ Productivity_{it} + \beta_8\ Financial\ Development_{it} + \delta_1 \sum_{i=1}^{7} Corridor_i + \delta_2 \sum_{t=1}^{18} Year_t + \varepsilon_{it}$

The Hausman test can be used to examine the appropriateness of the random effects model. This test indicates that there is a significant difference between the coefficients of the fixed effects model and random effects model, which means that the latter might be biased. However, various scholars such as Fielding (2004) and Bell et al. (2019) argue that the random effects model should not be abandoned because of a Hausman test. Instead, one should choose a model based on theoretical and statistical considerations. From a theoretical perspective, the random effects model is suitable because it uses both within-and- between unit variation. The fixed effects model on the other hand assumes that most variation takes place overtime (Bell & Jones, 2015). One could argue that the between-unit variation is more important for the current analysis, which would warrant the use of the random effects model. There are also several statistical arguments that support the use of this model. First and foremost, one should not blindly follow the results of the Hausman test since its applicability is limited when robust standard errors are used (Snijders & Bosker, 2011). Furthermore, the possible bias from time-invariant confounders can be partially controlled for using economic corridor dummies.

The above considerations justify that the random effects model is used as the baseline model in the paper. A more detailed description of the deliberation process can be found in section A1 in the appendix. The aim of the specified model (1) is to assess the main hypothesis of the paper. The hypothesized relationship is that infrastructure (β_1) has a positive and significant effect on GDP per capita. The other variables serve as controls and prevent that extraneous variables influence the relationship. In the previous section of the paper five additional sub-hypotheses were formulated as well. These can also be tested using model 1. However, the model must be altered to make each sub-hypothesis testable. The adjustments that are made are outlined below.

Firstly, the mediating effects of exports and productivity are assessed using interaction effects. One model includes an interaction between exports and infrastructure and another model includes an interaction between productivity and infrastructure. Secondly, there are two confounding factors examined: time and development. The confounding effect of development can also be assessed using interaction effects. This is done by interacting infrastructure with a dummy variable that indicates if a country is considered "developed" by the IMF. The confounding effect of time is examined using the first, second and third lag of infrastructure. These lags are used as explanatory variables to gauge the temporal effect of infrastructure. The final hypothesis considers how debt distress inhibits the positive effect of infrastructure. To analyze this, a dummy variable is constructed which indicates if a country exceeds a debt to GDP threshold of 70%, 80% or 90%. These three respective dummies are in turn interacted with infrastructure to assess the negative confounding effect of debt.

Important to note is that the random effects model is not able to assess the causality of the relationship. The subsequent section of the paper explains how a Generalized Methods of Moments Estimation (GMM or Arellano-Bond estimator) can be used to solve issues of endogeneity and make inference about the causality.

Robustness Check – GMM Model

The baseline model can be used to analyze whether infrastructure is correlated with GDP per capita. If such a correlation is found it can mean one of two things. It could mean that there is an effect of infrastructure on GDP per capita, however it could also mean that GDP per capita affects infrastructure. This issue of endogeneity (i.e., reverse causality/simultaneity bias) can be addressed using a GMM model. A GMM model can control for endogeneity since lags of the endogenous regressors can serve as internal instrumental variables (IV). This allows us to distinguish between the endogenous and exogenous effect of infrastructure (Arellano & Bond, 1991; Roodman, 2009). If the exogenous part has a significant effect, one might infer that there is a causal relationship running from infrastructure to GDP per capita.

(2) $$GDP\ per\ Capita_{it} = \beta_0 + \phi_1\ GDP\ per\ Capita_{it-1} + \beta_1\ Infrastructure_{it} + \beta_2\ Population_{it} + \beta_3\ Export_{it} + \beta_4\ Government\ Debt_{it} + \beta_5\ Stability_{it} + \beta_6\ Agriculture_{it} + \beta_7\ Productivity_{it} + \beta_8\ Financial\ Development_{it} + \delta_1 \sum_{i=1}^{7} Corridor_i + \delta_2 \sum_{t=1}^{18} Year_t + \varepsilon_{it}$$

The above model (2) is used to examine whether infrastructure causally affects GDP per capita. Note that the model differs from the previously specified model since it looks at the dynamic relationship. The GMM method is a dynamic panel estimator, which is why the lagged dependent variable is included as an explanatory variable (ϕ_1). The exact workings of the GMM model is beyond the scope of this paper. For the current paper it suffices to understand which econometric problems are addressed using this method. Mileva (2007) argues that a GMM estimation can solve issues such as autocorrelation, unobserved heterogeneity, and reverse causality/simultaneity. The latter issue is solved because endogenous regressors are instrumented with their lagged values, which makes them pre-determined and therefore uncorrelated with the error term (Arellano & Bond, 1991). Unobserved heterogeneity is addressed since the GMM method transforms the regressors using first differencing. This removes fixed country-specific effects and solves issues related to unobserved heterogeneity.

A GMM model can be specified in several different ways. The current research uses a specification called a Two-step System GMM. The decision to use a System GMM is mainly motivated by the fact that the Difference GMM might be biased. Bond et al. (2001) suggest a three-step approach to identify a possible bias in the Difference GMM estimator. Following their steps, it appeared that the Difference GMM is upward biased, which would warrant the use of the System GMM. A two-step approach is chosen because the standard errors of the one step approach are always asymptotically inefficient when using a System GMM estimation (Roodman, 2009). Furthermore, the covariance matrix used in the two-step estimation is robust to panel-specific autocorrelation and heteroskedasticity (Mileva, 2007). This might be relevant for the analysis since autocorrelation and heteroskedasticity are present in the data. Section A2 in the appendix gives a more detailed description of the deliberation process that led to the Two-step System GMM. This deliberation looks both at statistical and theoretical considerations.

Data

As indicated in the previous section, panel data will be used for the analysis in the paper. This panel dataset follows 72 countries that are either directly part of the BRI or have a close connection to it. Table 1 in the appendix gives an overview of the 72 countries and relates each country to an economic corridor of the BRI. For these countries data seems to be widely available for the period 2002-2019. This means that the panel data will have more observations than years, which corresponds to a short and wide data structure.

For the sake of completeness, two particularities of the dataset should be scrutinized: the level of analysis and the timeframe. Starting with the latter, the timeframe runs from 2002 to 2019. This might seem surprising given the fact that the BRI was only revealed in 2013. However, there is ample evidence which suggests that the Chinese government already made substantial investments in overseas infrastructure projects before the BRI was unveiled. For example, Liu et al. (2020) show that approximately 55 percent of China's FDI in BRI countries pre-dates the announcement in 2013. It is reasonable to assume that part of this FDI is invested in infrastructure. Furthermore, a report by the Asian Development Bank notes that infrastructure already was the focus of outward FDI before 2013 (Li, 2013). With this outward FDI, China helped developing countries to construct roads, bridges, and telecommunication networks. Therefore, it seems warranted to look at the period before the official announcement.

From a statistical perspective, the timeframe from 2002 to 2019 has some benefits as well. The benefit is that larger samples tend to lead to more precise inferential results. If the timeframe would be strictly determined by the announcement of the BRI, the econometric analysis can only include six years. Several statistical tests such as unit root tests and panel cointegration tests cannot be performed on a six-year timeframe (Baumöhl & Lyócsa, 2011). Furthermore, having such a short timeframe might lead to issues with regards to generalization, non-normality, overfitting, reproducibility, and it reduces the statistical power of the model (Stock & Watson, 2007). Various previous studies about the BRI use a timeframe that starts before 2013 to prevent these issues (Gibson & Li, 2018; Iqbal et al., 2019; Wang et al., 2020).

Furthermore, the timeframe should be chosen such that the inferential results are not contingent on the particularities of the period that is analyzed. For the current analysis, it is reasonable to assume that the likelihood of a negative effect increases if only crisis-years are included. Conversely, a positive effect is more likely if economic boom years are considered. Therefore, it is important that the timeframe is long enough to capture cyclical upswings and downswings. In consideration of this, the analyzed period should at least have the length of an average business cycle. Business cycles capture the alternation between expansionary and contractionary phases in economic activity. The current timeframe includes at least two business cycles. The first one being the early 2000's recession and the subsequent economic recovery. The second one is the Great Recession (2007-2009) and the gradual recovery from 2010 onward (NBER, 2021). The current timeframe thus includes several periods of economic upswings and downswings, which makes it less likely that the inferential results are contingent on the period that is analyzed.

The second aspect of the dataset that should be discussed is the level of analysis. The current research uses country-level data, which restricts the study to an analysis on the aggregate level. This can be considered a limitation since an analysis on the lower levels (e.g., provinces) might have been valuable. Economists such as Snieska and Bruneckienė (2009) and Hu et al. (2019) postulate that infrastructure is highly heterogeneous in certain countries. This means that there are large variations in the quantity and quality of infrastructure between various regions within in a country. Internal infrastructural heterogeneity cannot be assessed with the current dataset. The decision to opt for country-level data is mainly driven by pragmatic considerations. There is simply no widespread provincial data for the variables in the current dataset. Therefore, this study is restricted to a country-level analysis.

Furthermore, the dataset appears to be unbalanced since there are missing values for certain years (i.e., gaps). These missing values can best be addressed using a dummy variable adjustment method. In this method the mean per country is used to replace missing values. Ample scholars such as Stock and Watson (2007) and Snijders and Bosker (2011) argue that this method is appropriate for dealing with gaps in panel datasets under certain assumptions. However, from a theoretical point of view the dummy variable adjustment method is not suitable for infrastructure variables. The reason for this is that imputing the mean per country leads to sharp drops in infrastructure for certain years. This is theoretically not viable since infrastructure is almost always monotonically increasing. To overcome this issue, the last non-missing adjacent observation for a particular country is imputed instead. The relatively strong assumptions underlying this method appear to be valid since countries tend to report new infrastructure data only if a project is completed (McKinsey, 2016; Serebrisky et al., 2018). This would mean that the infrastructure remained relatively unchanged from the last reported value. Therefore, the proposed method for dealing with missing data seems warranted.

Statistical Tests - Baseline model

Having discussed the particularities of the dataset, we can continue with assessing the statistical fit of the data. Several statistical tests are conducted to assess issues such as normality, multicollinearity, heteroskedasticity, stationarity and autocorrelation. Below each of these tests are shortly discussed and the main findings are outlined. Section A3 in the appendix gives a more elaborate explanation of the statistical tests and goes more in depth about the implications.

Firstly, the normality of the data is assessed using histograms of each variable. The histograms show that GDP per Capita, Population, Export, Government Debt, Agriculture and Productivity are non-normally distributed. Therefore, these variables are logarithmically transformed to make the data more in line with the normality assumption.

The second issue to consider is multicollinearity. Multicollinearity exists when there is a substantial correlation between the regressors in the model. The current paper suspects substantial collinearity if the correlation among regressors exceeds 0.8 (Wooldridge, 2006). Table 3b in the appendix shows that there is no pairwise correlation that exceeds this threshold.

The third statistical test looks at heteroscedasticity. Heteroscedasticity refers to a non-constant variance of the error term. A Breusch-Pagan test can be used to assess this issue. It appears that the regression on the current dataset suffers from heteroscedasticity since the Breusch-Pagan test rejects the hypothesis of a "constant variance". To control for this, robust standard errors are used in the regression (Wooldridge, 2006).

The fourth statistical test examines whether the data is (non)stationary. Stationarity refers to a data structure where a shift in time does not change the statistical properties of the distribution. In the current dataset, non-stationarity is assessed using unit root tests. Several different tests are performed including the augmented Dickey–Fuller test and Levin-Lin-Chu test. These tests show that (log) GDP per capita and infrastructure are stationary.

The final issue to consider is whether the residuals are correlated overtime (i.e., autocorrelation). A Wooldridge test for autocorrelation is used to examine this issue. The test shows that first-order autocorrelation is likely to be present in the data. Therefore, a heteroscedastic and autocorrelation consistent (HAC) covariance matrix is used in the regression (West, 2010).

Statistical Tests - GMM model

In addition to the previous statistical tests, two additional tests must be performed to assess the statistical fit for the GMM model. The main diagnostic tests are the Hansen test and the Arellano-Bond test. Roodman (2009) argues that it is vital to assess these statistics since the GMM method can only provide reliable estimates if certain statistical requirements are met.

The Arellano-Bond test assesses the validity of the instruments by looking at serial correlation in the data. AR(1) looks at first order serial correlation and AR(2) looks at second order serial correlation. Especially the latter can have distortionary effects on the estimation, which is why the focus often lies on assessing AR(2) (Mileva, 2007). If AR(2) is significant, it means that there is second order serial correlation in the data and this has implications for the validity of the instruments. In a GMM estimation, lagged values of endogenous regressors are used as instrumental variables to account for issues of endogeneity. If there is second order serial correlation these lags are not appropriate to use as instruments (Roodman, 2009).

Table 7a shows the results for the Two-step System GMM estimation. At the bottom of the table all diagnostic statistics are indicated. There it shows that the AR(2) is highly insignificant for each of the specified models, which indicates that no second order serial correlation is present. According to Mileva (2007), the absence of second order serial correlation justifies the use of the lags of endogenous regressors as instruments in the GMM estimation. So, the lags appear to be valid instruments since they are robust to serial correlation.

The Hansen test assesses the validity of the instruments by looking at the overidentifying restrictions of the model. Such a test examines the exogeneity of the instruments. In line with this, the test has a null hypothesis that states that the instruments are exogenous (Mileva, 2007). The p-value on the Hansen test should therefore be insignificant to infer that the instrument set is valid. Intuitively, one might think that a higher p-value is better. However, there is a tendency to infer that the Hansen statistic should be between 0.10 and 0.25. Roodman (2009) suggests this rule of thumb since the lower bound (0.10) is reasonably larger than a significance level of 0.05, and the upper bound is small enough to not suspect severe p-value inflation.

The diagnostic statistics show that nearly all models have a Hansen test within the "sweet spot" indicated by Roodman (2009). Model 2 is the only exception since it has a p-value of 0.075. This is below the lower bound of 0.10, which means that one should be cautious when interpreting the results for this model. All other models satisfy the Hansen test conditions.

Variables Model

GDP per Capita

The dependent variable in the model is GDP per capita measured in terms of purchasing power parity (PPP). This variable measures the economic performance of a BRI country in a particular year. Data on GDP per capita is published by several sources such as the IMF (2021a) and the World Bank (2021a). The current research uses data from the IMF in the main analysis. Several previous researchers used GDP per capita to proxy for the economic performance of countries (De Soyres et al., 2019; Wang, et al., 2020).

Infrastructure Index

In the literature review infrastructure was defined as the aggregate of highways, airports, power grids, railways, ports, and telecommunication. This multi-dimensional definition means that infrastructure can best be measured using a composite index. The table below outlines all indicators that are included in the index, and for each indicator a proxy and source are provided.

Indicator	Proxy	Source
Port activity	Container port traffic in 20-foot containers (TEU)	World Bank (2021b)
Air transport	Air freight in metric tons times kilometers traveled	World Bank (2021c)
Telecommunication	Mobile cellular subscriptions per 100 people	World Bank (2021d)
Power grids	Percentage of the population with electricity access	World Bank (2021e)
Railway network	The length of the railway network in kilometers	World Bank (2021f)
Road network	The length of the road network in kilometers	Wang & Zhang (2020)

Table 1a: Indicators included in the Infrastructure Index

A Principal Component Analysis (PCA) is used to construct the index. This technique creates a new variable (i.e., index) that is based on a linear combination of the original set. The PCA can do this because the infrastructure indicators are highly correlated. This correlation allows us to reduce these variables to one variable which captures as much of the variation in the original set as possible. The linear combination that explains the maximum variation is called the first principal component. A second principal component explains as much as possible of the remaining variability. This sequence repeats until all principal components are found (Abeyasekera, 2006). For the current research the first principal component is used as the composite infrastructure index. This appears to be a relatively good index since the first principal component explains a substantial amount of the variability (approximately 67%).

Control Variables

To prevent that the relationship between infrastructure and GDP per capita is confounded by extraneous variables, a set of control variables is included in the model. These variables ensure that the measured effect is not influenced by other confounding factors. Seven control variables are included in the model. Table 2 shows all the control variables and the corresponding proxies. The sources of each proxy are indicated in the table as well.

Name	Proxy	Source
ln Population	Population of a country in millions of people (log)	Feenstra et al., (2015)
ln Exports	Exports of goods and services as a percentage of GDP (log)	World Bank (2021h)
ln Government Debt	Central Government Debt as a percentage of GDP (log)	IMF (2021b)
Stability	Perception of political instability and/or political violence	WGI (2021)
ln Agriculture	Value added of agriculture as a percentage of GDP (log)	World Bank (2021g)
ln Productivity	Gross value added at factor cost in constant 2010 USD (log)	World Bank (2021h)
Financial Development	Index measuring the efficiency of markets and institutions	IMF (2021c)

Table 2a: Control variables and corresponding proxies

Population

The current research uses GDP per capita as a proxy for economic performance. This measure consists of a demographic component and an economic component. The economic component looks at the Gross Domestic Product (GDP) and the demographic component looks at the population of a country. There is always an interplay between these components when measuring GDP per capita. For example, if the growth rate of the population exceeds the growth rate of GDP, there might be a decrease in GDP per capita despite the GDP increasing. For this reason, it is reasonable to assume that population is negatively correlated with GDP per capita.

However, from a pure economic perspective there is little consensus on the actual effects of population on economic growth. Headey and Hodge (2009) outline a broad economic debate about the effects of population size. This debate is beyond the scope of this paper. For this paper it suffices that we discovered that population is likely to be negatively correlated to GDP per capita purely because of the operationalization of this variable.

Exports

The argument that exports affect economic performance goes back to classical theories by Adam Smith and David Ricardo. The rationale of their theories is that each country maximizes its welfare if it focusses on the activities in which it has a competitive advantage and subsequently trades with other countries (Krugman & Obstfeld, 1994). This neoclassical argument has been expanded to the export-led growth theory. In this theory it is often argued that countries gain from trade between economies with different capital-labor ratios (Dornbusch et al. 1980). Another argument for a positive relationship is that international competition forces industries to improve technological change and keep costs relatively low (Lee & Huang, 2002).

Controlling for exports might be particularly relevant in the current research since exports differ significantly between BRI countries. The World Bank (2019) shows that certain countries in the BRI have closed economies due to international conflicts or geographic characteristics. These countries are for example Afghanistan, Nepal, Pakistan, and Syria. At the same time, there are countries in the BRI with highly open economies. This difference in the relative importance of exports makes it all the more relevant to control for it in the model.

Government Debt

Economists tend to infer that debt has a positive impact on long-term growth while its short-term effect is negative (Abdulkarim & Saidatulakmal, 2021). The current research has a timeframe of 18 years, which makes it more susceptible to short-run effects. Therefore, one would expect that debt has a negative effect on GDP per capita. The underlying rationale is that the cost of debt can become a large burden to countries. However, an additional issue is that a high debt-to-GDP ratio can create uncertainty in the economy, which might reduce the willingness of investors to invest (Saungweme et al., 2019). In more general terms high debt-to-GDP ratios threatens economic growth through higher interest rates, higher inflation, distortionary taxation and crowding-out of private investments. (Mhlaba et al., 2019)

According to the World Bank (2019), the debt taken on by BRI host countries to finance infrastructure projects differs significantly. Certain developing countries such Montenegro, Laos and Pakistan see a sharp increase in the debt-to-GDP ratio whilst developed economies such as South Korea and New Zealand do not. This difference in the debt-to-GDP ratio might explain some of the variation in GDP per capita, which is why it is controlled for in the model.

Stability

When it comes to stability, the key theoretical argument is that instability creates uncertainty in the economy. If a country is highly unstable, risk-averse economic actors might hesitate to participate in economic initiatives. Instead, these actors "exit" the economy and invest abroad. Similarly, foreign investors are also more inclined to invest in stable countries. These two forces combined means that unstable countries run a risk of a lack of capital (Alesina et al., 1991). Furthermore, Murphy et al. (1991) argue that instable countries are an easy target for rent-seekers. Weak or unstable governments are more inclined to please lobbyists and pressure groups, thus leading to a direct effect of rent-seeking on policy.

Kugelman (2019) argues that the BRI passes through some of the world's most instable countries such as Iraq, Afghanistan and Syria. At the same time, the BRI passes through stable regions in Europe and Asia. This heterogeneity in terms of stability might explain some of the variation in GDP per capita, which makes it an important control in the model.

Agriculture

Recent empirical studies yield conflicting evidence about the effect of agriculture on GDP per capita (Awokuse & Xie, 2014). Instead of delving into this vast literature, it might better to look at the operationalization of agriculture. Agriculture is proxied using the added value of agriculture as a percentage of GDP. This operationalization makes it more likely that the effect is negative rather than positive. The reason for this is that other sectors play a smaller role if a larger share of GDP comes from agriculture. It has been well-documented that agriculture is generally the least productive sector in the economy (Matsuyama, 1992). This means that it is not conducive to growth if the agricultural sector grows relative to other sectors. Therefore, it is reasonable to assume that agriculture is negatively related to GDP per capita.

Productivity

The link between productivity and economic performance is relatively straightforward. A country can increase its level of economic growth by one of two ways, either it can create more labor effort or it can increase productivity (Krugman, 1997). In many BRI countries the labor force growth has slowed down, which means that these countries must increasingly look at productivity to maintain their rate of output. An additional benefit of productivity is that it increases the competitive position relative to other countries (Korkmaz, & Korkmaz, 2017).

The above explanations indicate that a productive labor force is a perquisite for sustainable economic growth. The importance of productivity has been empirically proven by among others Jorgenson (1995) and Krugman (1997). In consideration of this economic evidence, it is reasonable to assume that productivity is an important determinant of GDP per capita in BRI countries. For this reason, the model controls for productivity.

Financial Development

The proposition that a good financial system is beneficial for economic growth is hardly new. The seminal work of Schumpeter (1911) already found that the banking system is crucial for economic growth since it facilitates an efficient allocation of savings, it encourages innovations, and it ensures that funds go to productive investments. Later studies expanded on his work and corroborated his findings. For example, Diamond (1984) shows that a well-developed financial system is better able to channel savings to the most profitable investments. Furthermore, Greenwood and Jovanovic (1990) argue that information costs decrease if financial intermediaries are well-developed, which leads to better capital allocation.

The financial development of countries in the BRI differs markedly. Certain developing countries have a near nonexistent financial system whilst other countries have well-developed financial intermediaries (He, 2020). This difference in the level of financial development might explain some of the variation in GDP per capita, which is why we should control for it.

One caveat that must be mentioned is that the discussion of the control variables did not address issues regarding the causality. However, it is reasonable to assume that there are issues of reverse causality and/or simultaneity for the controls in the model. This means that on the one hand these controls affect GDP per capita, but GDP per capita also affects these controls. The presence of endogeneity might affect the coefficient size and significance level.

Results

Results Main Hypothesis

Table 3a shows the regression results for the baseline analysis. This regression uses a random effects model with year dummies and economic corridor dummies. Model 1 until 7 show the process of sequentially adding control variables until we arrive at the final model (8). Model 9 shows the dynamic specification of the baseline model. The results indicate that there is a positive correlation between infrastructure and GDP per capita in BRI countries. In the final model (8), the regression coefficient is 0.0762 and it has a corresponding p-value of 0.000. This positive and significant sign is in line with the hypothesized positive relationship.

Baseline Model

	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita	(5) ln GDP per Capita	(6) ln GDP per Capita	(7) ln GDP per Capita	(8) ln GDP per Capita	(9) ln GDP per Capita
Infrastructure Index	0.125^{***}	0.143^{***}	0.157^{***}	0.144^{***}	0.124^{***}	0.124^{***}	0.0760^{***}	0.0762^{***}	0.0101^{***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)
ln Population		-0.520^{***}	-0.503^{***}	-0.510^{***}	-0.487^{***}	-0.311^{***}	-0.553^{***}	-0.554^{***}	-0.0186^{***}
		(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
ln Export			0.0187	0.0152	0.0195	0.00601	0.0256	0.0260	0.00315
			(0.365)	(0.379)	(0.265)	(0.752)	(0.173)	(0.168)	(0.549)
ln Government Debt				-0.0722^{**}	-0.0592	-0.0452	-0.0524	-0.0509	-0.00241
				(0.045)	(0.115)	(0.308)	(0.181)	(0.194)	(0.582)
Stability					0.0804^{**}	0.0609^{*}	0.0180	0.0191	0.00863^{***}
					(0.016)	(0.056)	(0.497)	(0.497)	(0.010)
ln Agriculture						-0.240^{***}	-0.183^{**}	-0.186^{**}	-0.00815^{**}
						(0.002)	(0.015)	(0.011)	(0.032)
ln Productivity							0.470^{***}	0.476^{***}	0.0194^{***}
							(0.000)	(0.000)	(0.001)
Financial Development								-0.0904	-0.0190
								(0.711)	(0.509)
Lag ln GDP per Capita									0.943^{***}
									(0.000)
Corridor Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	8.566^{***}	12.26^{***}	12.06^{***}	12.40^{***}	12.20^{***}	11.54^{***}	0.0267	-0.104	0.224^{*}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.988)	(0.953)	(0.063)
N	1170	1134	1116	1116	1116	1116	1062	1044	1003
Overall adj. R^2	0.3926	0.4045	0.4524	0.4535	0.4607	0.6845	0.9340	0.9337	0.9979

Robust standard errors are used to control for autocorrelation and heteroscedasticity. *p*-values in parentheses:
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3a

The results in the final model (8) show that some control variables do not significantly affect GDP per capita. These variables are exports, debt, stability, and financial development. Debt and stability did have significant effects in prior models, however the significance disappeared as more controls were included. The control variables population, agriculture and productivity do significantly affect GDP per capita. In line with the hypothesized relationship, population has a negative effect. It has a regression coefficient of -0.553 and is significant at the 1 percent level. Agriculture also negatively affects GDP per capita. The variable agriculture has a coefficient of -0.186 and a corresponding p-value of 0.011. Productivity is the only control which positively affects GDP per capita. It has a regression coefficient of 0.476 and is significant at the 1 percent level.

Finally, model 9 shows the dynamic specification of the baseline model. In this model, the lag of GDP per capita is included as an explanatory variable. The incorporation of this variable means that the model looks at the dynamic relationship between infrastructure and GDP per capita. This dynamic model corroborates the findings of the baseline model. The regression coefficient on infrastructure is 0.0101 and is significant at the 1 percent level. This positive and significant sign corroborates the findings of the baseline model. Furthermore, nearly all results for the control variables are the same as well. The only notable difference is that stability significantly affects GDP per capita in model 9 whereas it has an insignificant effect in model 8. In the dynamic model (9), stability has a coefficient of 0.00863 and a corresponding p-value of 0.010. This positive sign is in line with the hypothesized relationship.

Results Sub-Hypotheses

The first two sub-hypotheses consider the mediating effects of exports and productivity. Model 1 and 2 in table 4a assess these effects for the baseline random effects model. In model 1, the mediating effect of exports is examined using an interaction term between exports and infrastructure. This interaction term has a regression coefficient of -0.0163 and a corresponding p-value of 0.266. The insignificance of this term means that export is not an important mediator. Model 2 examines the mediating effect of productivity. Again, it appears that productivity is not an important mediator since the term is insignificant (p-value of 0.163). Based on these results one would infer that exports and productivity do not mediate the relationship between infrastructure and GDP per capita.

Mediating effects of Exports and Productivity

	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita
Lag ln GDP per Capita			0.947^{***}	0.943^{***}
			(0.000)	(0.000)
Infrastructure Index	0.131^{**}	-0.0253	-0.00593	0.0102
	(0.016)	(0.273)	(0.486)	(0.693)
ln Population	-0.549^{***}	-0.550^{***}	-0.0146^{**}	-0.0187^{***}
	(0.000)	(0.000)	(0.009)	(0.001)
ln Export	-0.00371	0.0232	0.0110^{*}	0.00315
	(0.920)	(0.188)	(0.068)	(0.558)
ln Government Debt	-0.0454	-0.0473	-0.00324	-0.00243
	(0.231)	(0.223)	(0.459)	(0.580)
Stability	0.0176	0.0162	0.00820^{**}	0.00863^{***}
	(0.531)	(0.556)	(0.014)	(0.010)
ln Agriculture	-0.190^{***}	-0.186^{**}	-0.00662^{*}	-0.00818^{**}
	(0.008)	(0.011)	(0.069)	(0.031)
ln Productivity	0.481^{***}	0.482^{***}	0.0160^{***}	0.0195^{***}
	(0.000)	(0.000)	(0.007)	(0.001)
Financial Development	-0.0512	-0.0975	-0.0190	-0.0190
	(0.829)	(0.683)	(0.509)	(0.508)
Infra * ln Export	-0.0163		0.00449^{**}	
	(0.266)		(0.048)	
Infra * ln Productivity		0.0144		-0.00000349
		(0.163)		(0.998)
Corridor Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
_cons	-0.204	-0.333	0.229^{*}	0.224^{*}
	(0.906)	(0.846)	(0.055)	(0.064)
N	1044	1044	986	986
Overall adj. R^2	0.9391	0.9394	0.9979	0.9979

Robust standard errors are used to control for autocorrelation and heteroscedasticity.
p-values in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4a

The robustness of this finding is assessed using the dynamic random effects model. It appears that the interaction term between exports and infrastructure is positive and significant in model 3. The interaction has a regression coefficient of 0.00449 and a corresponding p-value of 0.048. This indicates that there is a stronger effect of infrastructure in countries with relatively high exports relative to GDP. However, I would be cautious when making inferences based on this result since this interaction term could also indicate that the effect of exports on GDP per capita is stronger in countries with better infrastructure. Both interpretations of the interaction term are intuitively probable, which warrants a further elaboration of this result in the discussion section of the paper. Model 4 examines the mediating effect of productivity. Similar to the baseline model, the interaction term is insignificant (p-value of 0.998). This corroborates the finding that productivity does not mediate the relationship between infrastructure and GDP per capita.

The second set of sub-hypotheses examine the confounding effects of development and time. In table 5a, two (sets of) models are included that assess these issues. The effect of time is examined using the first, second and third lag of infrastructure (model 1 until 3). Each lagged value of infrastructure has a positive and significant effect on current levels of GDP per capita. This indicates that infrastructure might have a long-lasting effect on economic performance in BRI countries. Secondly, the effect of development is assessed using an interaction term between a developed country dummy (IMF classification) and infrastructure (model 4). This interaction term has a regression coefficient of - 48.72 and a p-value of 0.000. This is in line with the hypothesis that infrastructure has a less pronounced effect in developed countries.

Lagged effect and effect of development level

	Lagged Effect			**Developed**
	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita
Infrastructure Index				48.80^{***} (0.000)
Lag 1 Infrastructure Index	0.0799^{***} (0.000)			
Lag 2 Infrastructure Index		0.0862^{***} (0.000)		
Lag 3 Infrastructure Index			0.0916^{***} (0.000)	
Developed Country				23.72^{***} (0.000)
Infra * Developed Country				-48.72^{***} (0.000)
ln Population	-0.555^{***} (0.000)	-0.548^{***} (0.000)	-0.533^{***} (0.000)	-0.565^{***} (0.000)
ln Export	0.0254 (0.126)	0.0223 (0.118)	0.0175 (0.166)	0.0247 (0.192)
ln Government Debt	-0.0510 (0.179)	-0.0525 (0.144)	-0.0547 (0.106)	-0.0509 (0.191)
Stability	0.0152 (0.592)	0.00914 (0.758)	0.00304 (0.923)	0.0177 (0.522)
ln Agriculture	-0.194^{***} (0.007)	-0.210^{***} (0.002)	-0.229^{***} (0.001)	-0.197^{**} (0.007)
ln Productivity	0.484^{***} (0.000)	0.482^{***} (0.000)	0.468^{***} (0.000)	0.483^{***} (0.000)
Financial Development	-0.0867 (0.704)	-0.0551 (0.795)	0.0213 (0.912)	-0.0653 (0.783)
Corridor Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
_cons	-0.237 (0.895)	-0.126 (0.942)	0.236 (0.888)	-23.93^{***} (0.000)
N	986	928	870	1044
Overall adj. R^2	0.9359	0.9373	0.9382	0.9343

Robust standard errors are used to control for autocorrelation and heteroscedasticity. *p*-values in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5a

The final sub-hypothesis looks at how debt distress might inhibit positive effects of infrastructure. Model 1 in table 6a includes an interaction term between government debt and infrastructure. This term has a regression coefficient of 0.0333 and a corresponding p-value of 0.359. This might be a first indication that debt does not significantly affect the relationship between infrastructure and economic performance in BRI countries. The insignificant effect of

Inhibiting effect of Debt

	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita	(5) ln GDP per Capita
Infrastructure Index	-0.0562	0.0172	0.0831^{***}	0.0768^{***}	0.0828^{***}
	(0.689)	(0.318)	(0.000)	(0.000)	(0.000)
ln Government Debt	-0.0628	-0.00174			
	(0.120)	(0.674)			
Infra * ln Gov Debt	0.0333	-0.00188			
	(0.359)	(0.661)			
Lag ln GDP per Capita		0.943^{***}			
		(0.000)			
70% Debt to GDP			-0.0441		
			(0.617)		
Infra * 70% Debt to GDP			-0.00851		
			(0.816)		
80% Debt to GDP				-0.0719	
				(0.467)	
Infra * 80% Debt to GDP				0.0212	
				(0.514)	
90% Debt to GDP					-0.143
					(0.323)
Infra * 90% Debt to GDP					-0.00710
					(0.725)
ln Population	-0.558^{***}	-0.0185^{***}	-0.561^{***}	-0.558^{***}	-0.559^{***}
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
ln Export	0.0153	0.00365	0.0287	0.0298	0.0288
	(0.370)	(0.450)	(0.199)	(0.178)	(0.197)
Stability	0.0183	0.00856^{**}	0.0313	0.0323	0.0306
	(0.512)	(0.011)	(0.234)	(0.215)	(0.241)
ln Agriculture	-0.188^{**}	-0.00824^{**}	-0.196^{***}	-0.195^{***}	-0.200^{***}
	(0.011)	(0.030)	(0.009)	(0.009)	(0.009)
ln Productivity	0.477^{***}	0.0194^{***}	0.484^{***}	0.485^{***}	0.484^{***}
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Financial Development	-0.0633	-0.0198	-0.153	-0.146	-0.150
	(0.796)	(0.485)	(0.548)	(0.561)	(0.546)
Corridor Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes
_cons	-0.0258	0.221^{*}	-0.427	-0.458	-0.424
	(0.988)	(0.064)	(0.823)	(0.809)	(0.825)
N	1044	986	1044	1044	1044
Overall adj. R^2	0.9331	0.9979	0.9307	0.9313	0.9323

Robust standard errors are used to control for autocorrelation and heteroscedasticity. *p*-values in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6a

debt is further corroborated by model 2. The interaction term between debt and infrastructure is also insignificant in this dynamic model (p-value 0.661). To assess the robustness of these findings, three additional models are included that consider whether debt becomes harmful at a certain debt-threshold. A dummy variable indicates if a country exceeds a debt to GDP threshold of 70%, 80% or 90%. These dummies are interacted with infrastructure in three separate models. None of the interaction effects show a significant effect, which means that no evidence is found that debt inhibits positive effects of infrastructure.

Causality

Table 7a shows the results of the Two-Step System GMM estimation. Model 1 is the main model to examine the causality between infrastructure and GDP per capita. In this model, the regression coefficient on infrastructure is 0.109 and it has a corresponding p-value of 0.017. This result is in line with the hypothesized relationship. Because the GMM estimation uses lags of endogenous regressors as internal instruments, one can infer that there truly is a causal effect going from infrastructure to GDP per capita. Furthermore, the control variables have the same sign and significance level as in the baseline model. The only notable difference is that government debt has a significant effect in the GMM model and not in the baseline model.

Model 2 and 3 examine whether exports and productivity are important mediators in the relationship. In model 2, the interaction term between infrastructure and exports has a regression coefficient of 0.0490 and a p-value of 0.030. This result would indicate that infrastructure has a stronger effect on GDP per capita in countries with a high exports relative to GDP. However, the statistical tests indicate that model 2 has a Hansen statistic of 0.075. This is below the lower bound of 0.10, which is why I am not confident to make strong inferences based on this result. Model 3 includes the interaction term between infrastructure and productivity. Similar to the baseline analysis this term is insignificant.

Model 4 considers whether debt distress inhibits positive effects of infrastructure. The interaction term between debt and infrastructure has a coefficient of -0.0406 and a p-value of 0.589. The insignificant effect means that debt does not significantly affect the relationship between infrastructure and GDP per capita. This is in line with the previous findings. Finally, model 5 assesses the confounding effect of time. The lagged value of infrastructure has a positive and significant effect on current levels of GDP per capita. Because of this one can infer that last year’s infrastructure investments causally affect this year’s GDP per capita.

Two-Step System GMM

	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita	(5) ln GDP per Capita
Lag ln GDP per Capita	0.458^{***}	0.632^{***}	0.529^{***}	0.486^{**}	0.476^{***}
	(0.008)	(0.000)	(0.006)	(0.009)	(0.005)
Infrastructure Index	0.109^{**}	-0.0815	-0.331	0.267	
	(0.017)	(0.337)	(0.312)	(0.377)	
ln Population	-0.224^{***}	-0.0475	-0.219^{**}	-0.241^{**}	-0.212^{**}
	(0.005)	(0.383)	(0.026)	(0.028)	(0.012)
ln Export	0.00854	0.131^{**}	0.00321	0.0453	0.0467
	(0.860)	(0.021)	(0.785)	(0.420)	(0.525)
ln Government Debt	-0.0805^{***}	-0.0837^{**}	-0.0641^{*}	-0.0708^{*}	-0.0860^{***}
	(0.008)	(0.034)	(0.058)	(0.054)	(0.000)
Stability	-0.0398	0.0121	-0.0426	-0.0369	-0.0265
	(0.104)	(0.691)	(0.130)	(0.268)	(0.235)
ln Agriculture	-0.140^{***}	-0.0969	-0.123^{**}	-0.130^{**}	-0.109^{**}
	(0.006)	(0.076)	(0.019)	(0.023)	(0.017)
ln Productivity	0.192^{**}	0.0349	0.196^{**}	0.216^{*}	0.191^{**}
	(0.013)	(0.436)	(0.033)	(0.058)	(0.031)
Financial Development	-0.192	0.254	-0.352	-0.366	-0.231
	(0.536)	(0.506)	(0.341)	(0.424)	(0.342)
Infra * ln Export		0.0490^{**}			
		(0.030)			
Infra * ln Productivity			0.0181		
			(0.240)		
Infra * ln Gov Debt				-0.0406	
				(0.589)	
Lag Infrastructure					0.0720^{*}
					(0.096)
Corridor Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes
_cons	2.477^{*}	3.039^{*}	1.592	1.735	1.895
	(0.092)	(0.038)	(0.277)	(0.304)	(0.186)
Hansen test of overid.	0.183	0.075	0.159	0.108	0.196
AR(1) test	0.140	0.095	0.064	0.031	0.191
AR(2) test	0.651	0.326	0.413	0.826	0.545
No. of Instruments	41	43	43	43	41
Number of Groups	58	58	58	58	58
N	986	986	986	986	986

Robust standard errors are used to control for autocorrelation and heteroscedasticity. *p*-values in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7a

Discussion

The discussion consists of two sections. The first section tries to retrospectively interpret the results. This is done by summarizing the results, and by contextualizing them relative to the existing literature. The second section assesses the relative performance per economic corridor and the relative performance per infrastructure indicator.

Interpreting the results

It would be obvious to start with assessing the magnitude of the effect of infrastructure. However, there are two reasons why the size of the coefficients on infrastructure should not be interpreted in the current research. The first reason is that the random effects model does not address issues of endogeneity. This means that reverse causality and/or simultaneity might distort the size of coefficients. Because of this, interpreting the magnitude of the effect will inevitably lead to erroneous inferences. The GMM model does address issues of endogeneity, but even there the coefficient size does not hold any value. The reason for this is that infrastructure is measured as an index. Such an index is not meant to be interpreted in terms of size since a one-point increase in the index does not hold any economical meaning. Therefore, this section of the paper does not discuss the magnitude of the effect.

Instead of interpreting the magnitude of the effect, this section tries to further explain the results by looking at three distinct topics. Firstly, a short summary of the findings is given. Secondly, an explanation is provided that discusses why no evidence was found for the mediating effects of exports and productivity. Thirdly, the finding that debt has no inhibiting effect on infrastructure is contextualized relative to the existing literature.

Summary

The aim of this paper is to investigate whether BRI countries benefit from improved infrastructure. In line this, the research seeks to answer the following question: to what extent does infrastructure contribute to economic performance in BRI countries? The econometric analysis found a positive and significant correlation between infrastructure and GDP per capita in BRI countries. This relationship was found both in the random effects model and in the GMM model. The GMM method controls for endogeneity and therefore we can infer that infrastructure indeed positively contributes to economic performance in BRI countries. This finding is in line with the main hypothesis in the paper.

This positive effect of infrastructure is not necessarily universal in all countries. In the discussion of the transmission mechanisms, it was identified that the effectiveness of infrastructure might be mediated by exports and productivity. However, the econometric analysis found no evidence for the mediating effects of exports and productivity in BRI countries. Several models are run that include an interaction term between infrastructure and exports/productivity. These interaction terms show no robust evidence for the presence of mediating effects. Therefore, the first two sub-hypotheses of the paper are rejected.

Furthermore, the relationship between infrastructure and GDP per capita has several intricacies that should be considered. One such intricacy considers whether the effect of infrastructure is less pronounced in developed countries. This is assessed using an interaction term between a developed country dummy and infrastructure. The econometric analysis shows that this term is negative and significant. This finding is in line with the hypothesis that infrastructure has a less pronounced effect in developed countries. Therefore, we can accept the third sub-hypothesis in the paper.

Another intricacy that is assessed concerns the effect of time. The econometric analysis shows that the first, second and third lag of infrastructure have a positive and significant effect on current levels of GDP per capita. Based on this, one can infer that infrastructure investments have long-lasting effects on economic performance in BRI countries. This finding is in line with the hypothesis that previous investments in infrastructure positively affect current levels of economic performance. In consideration of this, we can accept the fourth sub-hypothesis.

Finally, the issue of debt distress is considered. There is a tendency among economists to cite debt distress as the most significant inhibiting factor of the BRI. It is believed that debt negatively affects the relationship between infrastructure and economic performance in BRI countries. This is tested in the econometric analysis by interacting government debt and infrastructure. The results show that this interaction effect is insignificant, which indicates that debt does not affect the relationship. This issue is further analyzed by investigating whether debt becomes harmful at a certain debt-threshold. A dummy variable indicates if a country exceeds a debt to GDP threshold of 70%, 80% or 90%. None of the interaction effects with these respective dummies have a significant sign. Based on this, one can infer that there is no evidence for the inhibiting effect of debt. Therefore, the fifth sub-hypothesis is rejected.

The effect of exports and productivity

In the summary of the findings it was noted that the first two sub-hypotheses are rejected. These sub-hypotheses are rejected because the econometric analysis found no concrete evidence for the mediating effects of exports and productivity. This result is quite surprising since these effects play an important role in the literature. Before we can infer that the effects are absent, we must be critical about the methods that are used to assess them.

The current research uses interactions between export/productivity and infrastructure to capture these mediating effects. Form a conceptual perspective this seems appropriate since these interactions indicate how export/productivity affect the relationship between infrastructure and GPD per capita. However, in retrospect there are some issues that might explain the insignificant results. One issue is that only the interaction between current export/productivity and current infrastructure is considered. Yet, it is reasonable to assume that the mediation effects do not materialize instantaneously. For example, the mediating effect of productivity is based on the idea that infrastructure is more efficiently used in productive economies. The paper of Rioja (2003) explains the underlying intuition that infrastructure deteriorates faster in developing (low productive) economies because it is not well-maintained. This deteriorating in turn leads to a less efficient use of infrastructure. However, it is important to consider that infrastructural deterioration takes times. Because of this, it is probable that the mediating effect of productivity only materializes over longer periods of time. This might explain why the (current) interaction terms do not find a significant effect. Future researchers could investigate this issue by including interactions between lagged values of infrastructure and current values of productivity.

Another issue is that the BRI passes through countries that are not active in international trade (World Bank, 2019). This is the case because the BRI seeks out countries that are ill-served by existing infrastructure. By focusing on these countries, the BRI unintentionally targets countries that have relatively few exports. This has implications for the mediating effects. On the one hand, one could argue that these countries can benefit from infrastructure investments because there is a lot of room for improvement in terms of exports. However, on the other hand it might take a long time for positive effects to materialize since their current economic system is not catered to use the infrastructure. This ties into the previous argument that countries need a longer adaptation time to benefit from infrastructure. The insignificant sign of the control variable exports substantiates the proposition that a large group of BRI countries is not active in international trade. Because of the relative unimportance of trade, the mediating effect of exports might take longer to materialize. In consideration of this, it is not surprising that this effect is not found in the current analysis.

Inhibiting effect of debt

The econometric analysis also found no evidence for the fifth sub-hypothesis. This sub-hypothesis considered whether debt inhibits positive effects of infrastructure. The fact that no evidence is found is surprising since previous scholars have provided strong theoretical evidence that substantiates the inhibiting effect of debt (Fasslabend, 2015; Chellaney, 2017; Hillman and Sacks, 2021). Still, there are some retrospective arguments that explain the contradictive results. The first argument is that the number of countries that are at a risk of BRI-related debt distress is relatively small. These countries have a specific profile such as rising debt-to-GDP ratios and at least 40 percent of external debt owed to China. Hurley et al. (2019) only found eight countries that satisfy these conditions: Djibouti, Kyrgyzstan, Laos, the Maldives, Mongolia, Montenegro, Pakistan, and Tajikistan. From a statistical point of view, it is understandable that no significant relationship is found because only eight countries run a risk of debt distress. The entire BRI consists of at least 72 counties, so it is unlikely that these eight countries can drive an overall significant effect.

A second argument is that the "evidence" is largely anecdotal. Among others, Fasslabend (2015) and Chellaney (2017) cite debt distress as one of the main inhibiting factors related to the BRI. However, their arguments are based on theoretical reasoning and anecdotal evidence. It is indeed true that there are several anecdotal stories of countries that run into troubles due to BRI-related debt. The stories of Montenegro, Sri Lanka and Laos are often told by critics of the BRI to support the debt narrative. By focusing on these stories, one might get the impression that there are widespread debt-issues related to the BRI. However, this does not appear to be the case since there is little to no empirical evidence that supports this. This is also the conclusion of Brautigam (2019). She critically reviewed the literature on the Chinese debt-trap diplomacy and concluded that the narrative is almost entirely driven by theoretical arguments and anecdotal evidence. She describes this issue as follows: "the simple narrative and the conventional wisdom are contradicted or put into question by field research and empirical findings". This quote insinuates that the logic of the Chinese debt narrative is intuitively probable, but there is simply little to no empirical evidence to back it up.

So, the fact that we did not find evidence for the inhibiting effect of debt is less surprising if we contextualize it relative to the existing literature. It simply appears that the substantiation of sub-hypothesis 5 has a disproportional focus on theoretical arguments and a lack of empirical substantiation. This lack of empirical evidence should have been a warning sign to be cautious when formulating the hypothesis. However, the literature review did not critically assess the nature of the evidence that was provided for the inhibiting effect of debt.

Relative performance

This section of the paper assesses the relative performance per economic corridor and the relative performance per infrastructure indicator. Discussing these types of relative performance is relevant since it gives us an understanding of the factors that drive the positive effect of infrastructure. The econometric analysis showed that the aggregate infrastructure index has a positive effect on economic performance in BRI countries. However, it might be the case that this effect is driven by certain well-performing corridors. This possibility is examined using the relative performance per economic corridor. Furthermore, the relative performance per infrastructure indicator allows us to examine the isolated effects of indicators.

Table 8a shows the relative performance per economic corridor. The relative performance is assessed by comparing the performance of each corridor to the overall performance of the BRI. This is done using interaction terms between corridor dummies and infrastructure. These terms appear to be insignificant for all models except for the China-Mongolia-Russia corridor. The interaction between infrastructure and the CMR corridor has a coefficient of -0.0936 and a p-value of 0.011. This indicates that the CMR corridor performs significantly worse compared to the overall BRI. The negative coefficient is even greater than the positive sign of infrastructure, which suggests that infrastructure worsens economic growth. In other words, the overall effect of infrastructure on economic growth is negative for countries in the CMR corridor. However, this result should not be taken at face value because issues of endogeneity are not addressed. It might simply be the case that the reverse relationship affects the size of the coefficients. Still, the fact that all other interaction terms are insignificant means that the performance of these corridors does not differ significantly from the overall BRI. The implication of this is that the overall positive effect of the BRI is not driven by certain well-performing corridors. Instead, it appears that there are widespread positive effects in every corridor except for the underperforming China-Mongolia-Russia (CMR) corridor.

Relative performance of Economic Corridors

	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita	(5) ln GDP per Capita	(6) ln GDP per Capita	(7) ln GDP per Capita
Infrastructure Index	0.0828*** (0.003)	0.0766*** (0.000)	0.0685** (0.004)	0.0780*** (0.000)	0.0762*** (0.000)	0.0763*** (0.000)	0.0766*** (0.000)
BCIM Corridor	-0.940*** (0.000)						
Infra * BCIM Corridor	-0.0118 (0.725)						
CWA Corridor		-0.894* (0.087)					
Infra * CWA		0.0848 (0.921)					
CIP Corridor			-0.799*** (0.000)				
Infra * CIP Corridor			0.0203 (0.563)				
CMR Corridor				-0.805*** (0.009)			
Infra * CMR Corridor				-0.0936** (0.011)			
CP Corridor					-0.618** (0.043)		
Infra * CP Corridor					-0.114 (0.492)		
NELB						-1.008 (0.142)	
Infra * NELB						0.417 (0.713)	
21st-C MSR							-0.699*** (0.005)
Infra * 21st-C MSR							-0.00549 (0.965)
N	1044	1044	1044	1044	1044	1044	1044
Overall adj. R^2	0.9345	0.9355	0.9341	0.9340	0.9324	0.9333	0.9349

This table only displays the main results. The full models (including the control) are displayed in table 4b in the appendix. Robust standard errors are used to control for autocorrelation and heteroscedasticity. *p*-values in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8a

Furthermore, table 9a examines the relative performance per infrastructure indicator. In the main analysis, infrastructure is measured by a composite index that is constructed using a Principal Component Analysis (PCA). This index is useful since it allows us to capture a broad conception of infrastructure, which is required given the scope of the BRI. However, the downside of this index is that one cannot see which infrastructure indicators drive the positive effect. This is especially important considering that the literature review revealed that certain infrastructure indicators have stronger effects than others (Estache & Garsous, 2012).

The results show that air transport and mobile subscriptions do not significantly affect GDP per capita. This means that these indicators contribute less to the overall effect of infrastructure compared to the other indicators. Port activity, electricity access, rail lines and road network do significantly affect GDP per capita in BRI countries. Port activity has a regression coefficient of 0.0198, and electricity access has a coefficient of 0.00455. The coefficients of rail lines and road network are respectively 0.0137 and 0.0942. These are all significant at the 1% level, except for rail lines which is significant at the 5% level. The implication of this is that the positive effect of the overall index is driven by these significant infrastructure indicators. It might be important to reiterate that the size of the coefficients cannot be interpreted. The reason for this is that the random effects model does not address issues of endogeneity. Therefore, it might be the case that part of the coefficient size comes from the effect of infrastructure on GDP per capita, but part also comes from the reverse relationship. Because of this, interpreting the size of the coefficients will lead to erroneous inferences.

Relative performance per Indicator

	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita	(5) ln GDP per Capita	(6) ln GDP per Capita
Port Activity	0.0198^{***} (0.000)					
Air Transport		-0.00101 (0.588)				
Mobile Subscriptions			0.0891 (0.152)			
Electricity Access				0.00455^{***} (0.000)		
Rail Lines					0.0137^{**} (0.023)	
Road Network						0.0942^{***} (0.001)
N	1044	1044	1044	1044	1044	1044
Overall adj. R^2	0.9272	0.9314	0.9264	0.9337	0.9232	0.9292

This table only displays the main results. The full models (including the control) are displayed in table 5b in the appendix. Robust standard errors are used to control for autocorrelation and heteroscedasticity. *p*-values in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9a

Despite the inability to interpret the size of the coefficients, these two discussions about the relative performance hold some valuable information. First and foremost, the results imply that the effects of the BRI is relatively homogenously spread between the different corridors. There are thus no specific well-performing corridors that drive the positive effect. The only notable outlier is the underperforming CMR corridor. Furthermore, the results show that the effect of the aggregate index is driven by four significant indicators. These four indicators are port activity, electricity access, rail lines and road network. Policymakers and politicians can use this information to allocate funds towards infrastructure investments that are relatively more effective. The finding that the China-Mongolia-Russia corridor underperforms might also motivate policymakers to investigate how the BRI can be made more beneficial in these countries.

An additional benefit of discussing these areas of relative performance is that they introduce new topics of research. Specifically, it would be interesting to combine the relative performance per economic corridor and the relative performance per infrastructure indicator. Combining these two areas would lead to a comprehensive research that examines whether the performance of infrastructure indicators differs per economic corridor. It seems intuitively probable that investments in ports have a strong effect in the 21-st century maritime silk road, whilst its effect might be negligible in the China-Mongolia-Russia corridor. Conversely, one would think that investments in railways are relevant for the China-Mongolia-Russia corridor and these investments would be less important in the 21-st century maritime silk road. Assessing this relative performance results in 42 different combinations of infrastructure indicators and corridors. Such a comprehensive overview holds valuable information about the differing performance of infrastructure indicators per economic corridor.

In a broader sense, the above discussion revealed that one cannot assume a certain degree of universality in the effect of infrastructure. In the literature review, the effect of infrastructure was assumed to be homogenous across all corridors and indicators. This was most apparent in the discussion of the transmission mechanisms. The possibility that these transmission mechanisms are heterogenous among corridors or indicators was not considered. The above findings indicate that this assumption of universality/homogeneity is too simplistic. These erroneous assumptions are more elaborately discussed in the limitations section.

Limitations

Despite the aim to control for as many flaws as possible, the research is affected by some limitations. The most general and frequently occurring limitations pertain to the data which is used. From the start it was obvious that there is no perfect measure for infrastructure. This is the case because the concept of infrastructure is exceedingly broad. Depending on the definition, “infrastructure” can include everything from social contingencies to hard infrastructure. To narrow down the definition, it was identified that investments in highways, airports, power grids, railways, ports, and telecommunication are particularly relevant for the BRI. This made the operationalization a bit easier. However, it is still challenging to find appropriate proxies since one must consider both the quantitative and qualitative perspective.

Luckily, this is not the first paper that encountered these issues. The academic literature shows that a Principal Component Analysis (PCA) can be used for combining infrastructure indicators into one index (Sahoo et al., 2012). Such an index can capture the broad scope of the BRI since it includes all relevant indicators. Therefore, this index gives the closest approximation of the level of infrastructure in a BRI country. However, there are also several caveats related to this method. One such caveat is that the index captures the combined effect of all infrastructure indicators. This means that we can only investigate the overall effect and we cannot assess which infrastructure indicator is driving it. Furthermore, the magnitude of the effect cannot be assessed using this index. Interpreting the size of the effect is not possible because a one-point increase in the index does not hold any economical meaning. The above overview shows that the aggregate infrastructure index solves some of the issues of operationalizing infrastructure. However, it also introduces two limitations to the research.

Another problem related to the data is that infrastructure is commonly measured on the country-level. There are very few countries that report infrastructure data on the provincial/regional level, and therefore the current research is forced to perform an analysis on the country-level. This might be problematic because infrastructure is inherently regional. The regional nature of infrastructure becomes apparent when one considers investments in roads, railways, ports and airports. These investments are all concentrated on specific geographical regions. The effects might go beyond the boundaries of these regions, but it is likely that the effect is significantly stronger in the direct vicinity of the investments. The regional nature of infrastructure can be illustrated using the example of Gwadar City Port in Balochistan province in Pakistan. It is reasonable to assume that the economic effects of this new port are larger in Balochistan province compared to the other provinces in Pakistan. The other provinces certainly experience some benefits of the new port since it increases the connectivity of Pakistan as a whole. However, the economy of Balochistan province likely sees larger effects since the local economy also benefits from construction and employment. This example illustrates an investment in a port, but this illustration also holds for roads, railways, airports and power grids. So, from a conceptual perspective it would be better to assess the relationship between infrastructure and GDP per capita on the meso-level rather than the macro-level. However, this is not possible due to the restrictions imposed by the data. The fact the current paper cannot assess these regional heterogeneities is a limitation. Still, this limitation could not have been prevented since it is externally imposed by the scarcity of infrastructure data.

There are several limitations beyond the data as well. One such limitation is that the literature review did not critically assess whether the transmission mechanisms between infrastructure and economic performance hold for BRI countries. It is assumed that the effect through FDI, exports and productivity is valid in every country. However, the universality of these effects is not necessarily substantiated by the papers in the literature review. For example, the effect through exports is based on the studies of Snieska and Bruneckiene (2009) and Baita (2020). Neither study considers a set of countries that is comparable to the BRI. Baita (2020) looks at economies in West-Africa whilst Snieska and Bruneckiene (2009) look at regional competitiveness in Lithuania. Both studies find evidence that infrastructure affects economic performance through exports. However, the countries on which this evidence is based is in no way comparable to BRI host countries. In consideration of this, it might have been too simplistic to assume that the effect is universal and that it holds in every BRI country. This explanation only considers exports, but the same argument could be made for FDI and productivity.

Even if we assume that the transmission mechanisms are universal, they might have a more intricate working than explained in the literature review. The literature review deliberately looked at the general workings of these transmission mechanisms because the issue should remain tractable. Furthermore, it was believed that a highly detailed description deviates too much from the main topic. However, in hindsight it appears that the transmission mechanisms are rather intricate and that the current explanation is too simplistic. One particularity that should have been considered is that the transmission mechanisms only materialize over longer periods of time. It is intuitively probable that the effects of exports and productivity do not materialize instantaneously. The fact that the literature review did not investigate this can be considered a limitation of the paper.

Another limitation is that the literature review should have investigated whether the mediating effects differ per economic corridor or per infrastructure indicator. As explained previously, the current literature review relies on assumptions of universality and homogeneity. The mediating effects of productivity and exports are thus assumed to be similar for all economic corridors. However, it might as well be possible that the effects differ per economic corridor. For example, it is reasonable to assume that the mediating effects of exports is important for the 21-st century maritime corridor, whilst the mediating effect of productivity is relevant for the China-Indochina Peninsula corridor.

Furthermore, the mediating effects of exports and productivity are only discussed within the context of the aggregate infrastructure index. The emphasis therefore lies on how the effect of the aggregate index is mediated. However, it is reasonable to assume that the mediating effects are not homogenous among different infrastructure indicators. For example, electricity might be strongly mediated by productivity, and less so by exports. Conversely, investments in ports might be strongly mediated by exports whilst the effect of productivity is limited. In retrospect this heterogeneity in the strength of the mediation should have been considered in the literature review. The overreliance on assumptions of universality/homogeneity might explain why the econometric analysis found no evidence for the mediating effects of exports and productivity. Future researchers are therefore advised to take these intricacies into account.

The final limitations that should be discussed pertain to the methodological approach. In the paper it has been well-recognized that the baseline analysis (random effects model) is rather simplistic. This simplicity is not necessarily problematic for the analysis as a whole because the baseline model is augmented by a GMM method. However, the GMM method itself is also subject to scrutiny. One of the most frequently noted disadvantages is that the outcome of the estimation can be highly contingent on the specification of the model. Specifically, the choices that a researcher makes regarding instrumentation might substantially impact the results (Piper, 2014). When specifying a GMM model, it is up to the researcher to indicate which regressors are potentially endogenous and which are strictly exogenous. If a high number of regressors is treated as endogenous, more instruments need to be employed which will ultimately affect the results. Furthermore, researchers can also affect the instrument count by changing the lag length of the instrumentation. The chosen lag length might affect the results of the GMM estimation as well. Piper (2014) argues that the flexibility/complexity of the GMM model specification warrants a certain degree of caution when discussing the results. The GMM method gives the researcher a lot of freedom in the specification, but the lack of hard guidelines means that one can never be sure that the chosen specification is correct Therefore, even if the results seem robust, one must be cautious with discussing them since they are highly contingent on the model specification.

There are various diagnostic tests that are used to assess the appropriateness of the GMM specification. However, these tests themselves are also rather complex and ambiguous. The main statistic used to assess the specification is the Hansen test (J statistic). This test should have an insignificant p-value to infer that the collective instrument set is exogenous. Yet, Roodman (2009) argues that an insignificant p-value alone is not sufficient. He says the following about this: "because of the risks, do not take comfort in a Hansen test p-value below 0.1. View higher values, such as 0.25, as potential signs of trouble". Instead of the conventional significance levels, Roodman (2009) recommends a 'common sense' p-value between 0.10 and 0.25. This range of values is not a hard cut-off point but rather a rule of thumb that can be used to guide the specification. Such an ambiguous threshold for the diagnostic statistics is troublesome for researchers since it is difficult to gauge when their specification is appropriate.

The above discussion gives an overview of various limitations of the GMM method. Most limitations stem from the relative complexity of the model specification and its diagnostic tests. This complexity makes it easier to generate invalid estimates. Despite these limitations, the GMM method is still used in the current paper. The GMM method is used because there is simply no alternative technique that addresses endogeneity in a panel-data setting. Section A2 in the appendix explains why alternative techniques (e.g., 2SLS analysis) cannot be used in the current research. In consideration of this, the GMM estimation seems like a valid method, even when taking its limitations into account.

Conclusion

The proposition that infrastructure is beneficial for economic performance is well-established in the academic literature. Several scholars have provided theoretical and empirical evidence that support this positive relationship (Hall & Jones, 1999; Goetz, 2011; Baita, 2020). However, within the context of the Belt and Road Initiative (BRI) the relationship appears to be contested (Fasslabend, 2015; De Soyres et al., 2019). There is no consensus whether BRI-related infrastructure investments are beneficial for host countries. The current research analyzes this issue and in doing so it aims to clarify the ambiguity in the literature.

The literature review provides an overview of the linkages between infrastructure and GDP per capita. These so-called transmission mechanisms point towards a positive relationship. However, the literature review also looks at certain flaws and inconsistencies in BRI policy that might inhibit these positive effects. Among others, issues such as debt, security and ulterior motives might prevent the positive effects of the BRI. Furthermore, the literature review considers several confounding factors that affect the relationship between infrastructure and GDP per capita. Development and time are found to be important confounders.

The relationship between infrastructure and GDP per capita is analyzed using a random effects model. The results indicate that infrastructure is positively correlated with GDP per capita in BRI counties. This is in line with the hypothesized positive relationship; however, the random effects model is not able to assess the causality of the relationship. Therefore, an additional analysis is performed using a Two-Step System GMM estimation. This estimation corroborates the positive and significant effect of infrastructure. Based on this result one can infer that infrastructure causally affects GDP per capita in BRI countries.

Furthermore, five additional sub-hypotheses are formulated based on the literature review. Two of these sub-hypotheses consider the mediating effect of exports and productivity. The analysis shows no robust evidence that exports or productivity are important mediators in the relationship between infrastructure and GDP per capita. Another sub-hypothesis considers whether debt distress inhibits positive effects of infrastructure. This also does not appear to be the case. Finally, there are two sub-hypotheses that look at the confounding effects of time and development. The analysis shows that both time and development significantly affect the relationship between infrastructure and GDP per capita

The discussion section tries to explain the results of the paper by contextualizing them relative to the existing literature. This showed that there are some retrospective arguments that support the (unexpected) results. Furthermore, the discussion section assesses the relative performance per economic corridor and the relative performance per infrastructure indicator. Assessing these issues gives a more in-depth insight in the workings of the BRI and it introduces new areas of research. The shortcomings of the current research are outlined in the limitations section. Among others, it has been identified that the paper has data related issues, a shallow literature review and there are some caveats regarding the methodological approach.

Despite these shortcomings, the findings of the current paper contribute to the existing literature in three ways. Firstly, this paper clarifies some of the ambiguity in the literature about the effects of BRI-related infrastructure investments. Based on the results in the paper, one can infer that infrastructure investments have a positive effect on BRI host economies. Secondly, this paper enhances our general understanding of the role of infrastructure. The sub-hypotheses assess the role of infrastructure more in-depth by looking at mediating effects, confounding factors, and inhibiting factors. Thirdly, this research introduces various new directions of research. Future scholars are motivated to investigate topics such as the heterogenous performance of infrastructure indicators or the relative performance of economic corridors.

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Appendix

Economic Corridors of the BRI

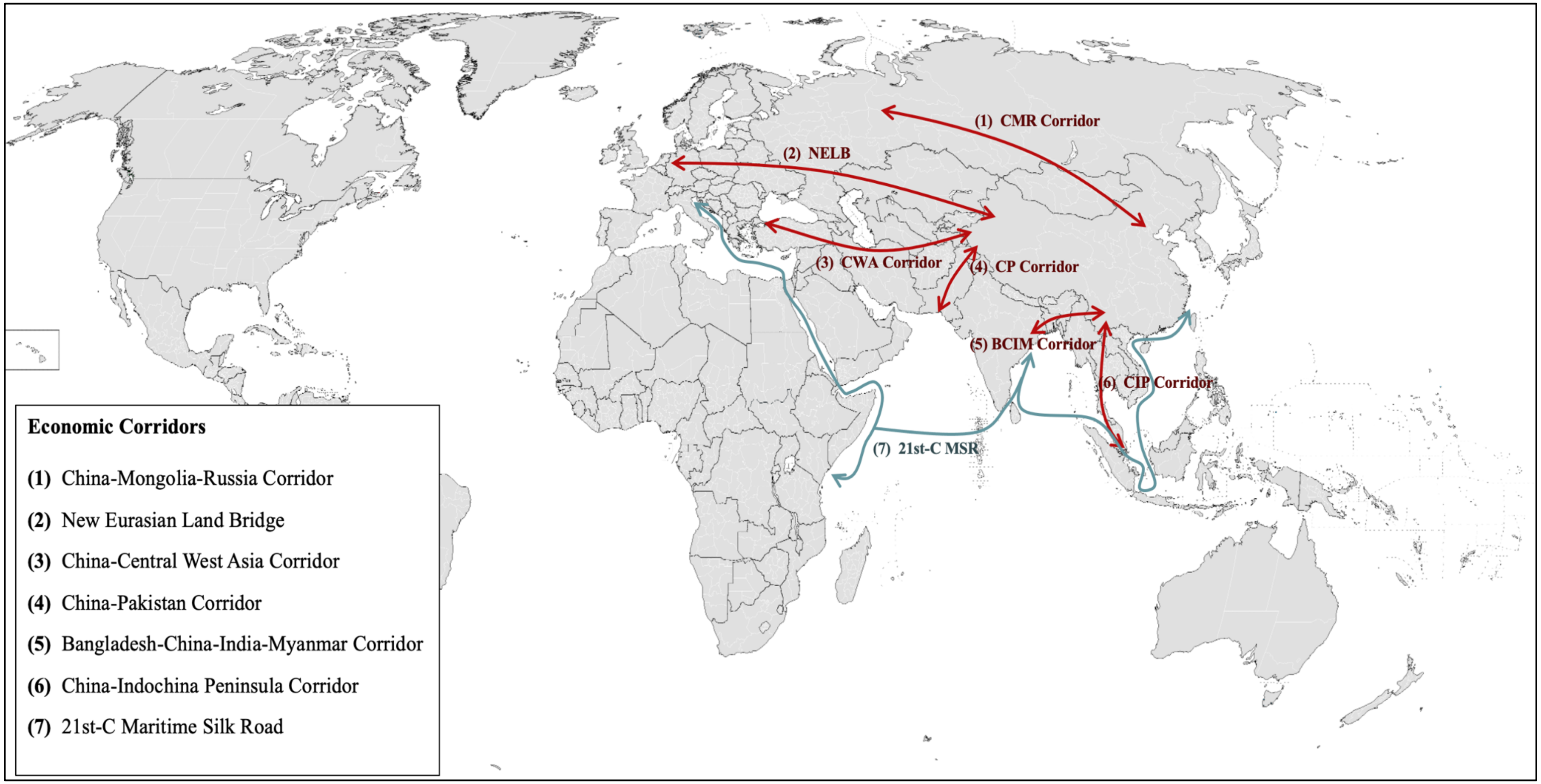
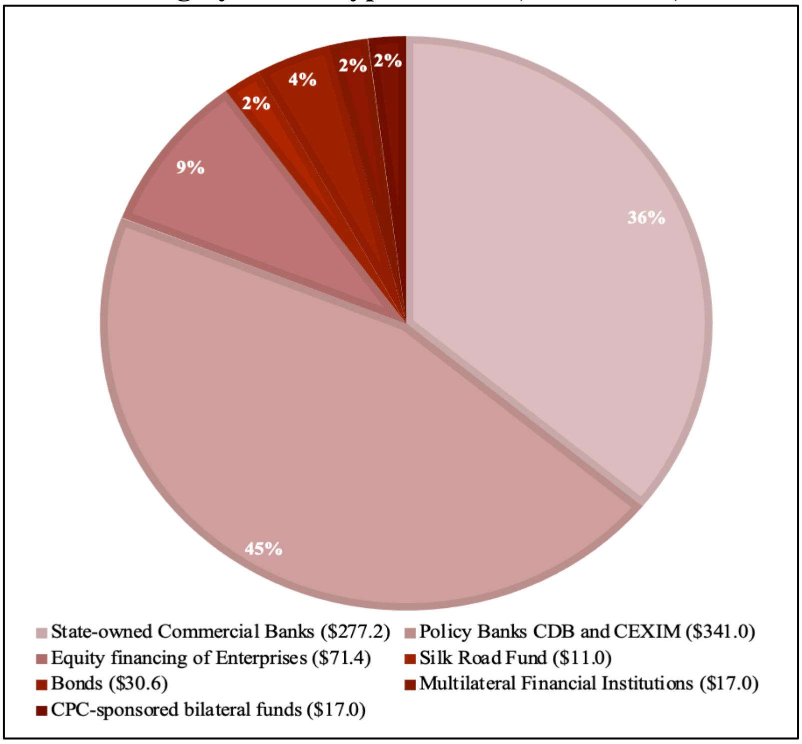


Figure 1

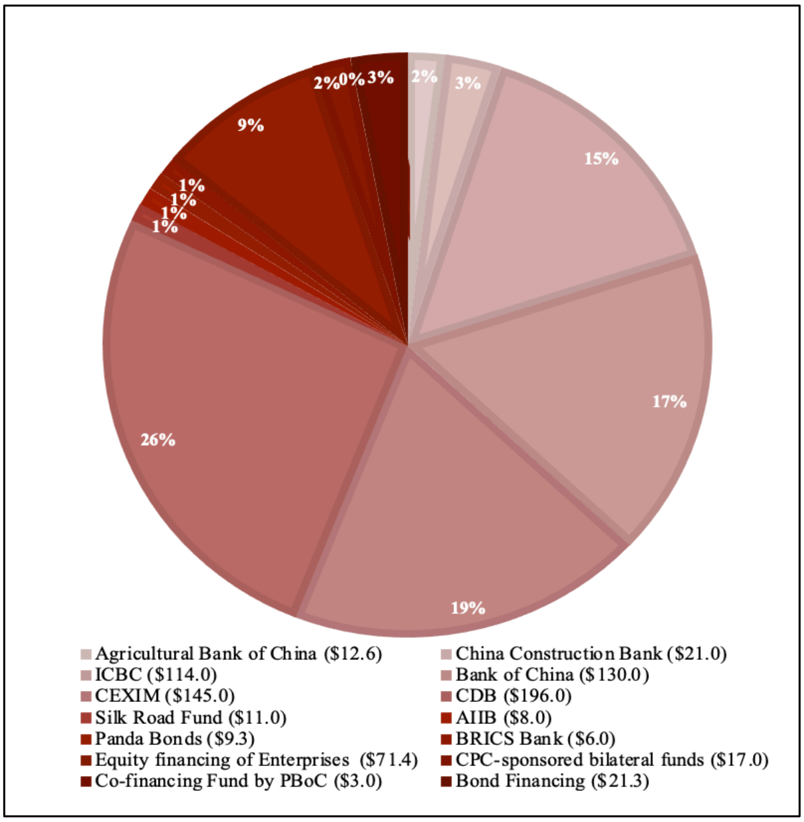
BRI Funding by source type in 2018 (US$ billion)



Source: Funding data is based on the work of He (2020).

Figure 2

BRI Funding by source in 2018 (US$ billion)



Source: Funding data is based on the work of He (2020).

Figure 3

Countries included in the BRI

	Economy	Economic Corridor		Economy	Economic Corridor
1	China	All	**37**	Singapore	China-Indochina Peninsula
2	Bangladesh	Bangladesh-China-India-Myanmar	**38**	Thailand	China-Indochina Peninsula
3	Bhutan	Bangladesh-China-India-Myanmar	**39**	Timor	China-Indochina Peninsula
4	India	Bangladesh-China-India-Myanmar	**40**	Vietnam	China-Indochina Peninsula
5	Myanmar	Bangladesh-China-India-Myanmar	**41**	Belarus	China-Mongolia-Russia
6	Nepal	Bangladesh-China-India-Myanmar	**42**	Estonia	China-Mongolia-Russia
7	Sri Lanka	Bangladesh-China-India-Myanmar	**43**	Latvia	China-Mongolia-Russia
8	Albania	China-Central West Asia	**44**	Lithuania	China-Mongolia-Russia
9	Armenia	China-Central West Asia	**45**	Mongolia	China-Mongolia-Russia
10	Azerbaijan	China-Central West Asia	**46**	Russia	China-Mongolia-Russia
11	Bosnia and Herzegovina	China-Central West Asia	**47**	Afghanistan	China-Pakistan
12	Bulgaria	China-Central West Asia	**48**	Pakistan	China-Pakistan
13	Croatia	China-Central West Asia	**49**	Bahrain	China-Pakistan
14	Georgia	China-Central West Asia	**50**	Kuwait	China-Pakistan
15	Iran	China-Central West Asia	**51**	Oman	China-Pakistan
16	Iraq	China-Central West Asia	**52**	Qatar	China-Pakistan
17	Israel	China-Central West Asia	**53**	Saudi Arabia	China-Pakistan
18	Jordan	China-Central West Asia	**54**	UAE	China-Pakistan
19	Kyrgyzstan	China-Central West Asia	**55**	Yemen	China-Pakistan
20	Lebanon	China-Central West Asia	**56**	Czech Republic	New Eurasian Land Bridge
21	Macedonia	China-Central West Asia	**57**	Hungary	New Eurasian Land Bridge
22	Moldova	China-Central West Asia	**58**	Slovakia	New Eurasian Land Bridge
23	Montenegro	China-Central West Asia	**59**	Slovenia	New Eurasian Land Bridge
24	Palestine	China-Central West Asia	**60**	Poland	New Eurasian Land Bridge
25	Romania	China-Central West Asia	**61**	Kazakhstan	New Eurasian Land Bridge
26	Serbia	China-Central West Asia	**62**	Ukraine	New Eurasian Land Bridge
27	Syria	China-Central West Asia	**63**	Egypt	21st-C Maritime Silk Road
28	Tajikistan	China-Central West Asia	**64**	Ethiopia	21st-C Maritime Silk Road
29	Turkey	China-Central West Asia	**65**	Indonesia	21st-C Maritime Silk Road
30	Turkmenistan	China-Central West Asia	**66**	Kenya	21st-C Maritime Silk Road
31	Uzbekistan	China-Central West Asia	**67**	Maldives	21st-C Maritime Silk Road
32	Brunei	China-Indochina Peninsula	**68**	Morocco	21st-C Maritime Silk Road
33	Cambodia	China-Indochina Peninsula	**69**	New Zealand	21st-C Maritime Silk Road
34	Laos	China-Indochina Peninsula	**70**	Panama	21st-C Maritime Silk Road
35	Malaysia	China-Indochina Peninsula	**71**	South Korea	21st-C Maritime Silk Road
36	Philippines	China-Indochina Peninsula	**72**	South Africa	21st-C Maritime Silk Road

Note: This list contains the 65 economies that were indicated as BRI countries in the initial Action Plan (Chin & He, 2016). Furthermore, seven additional economies have been added in line with the OECD (2018) since these economies have a close connection to the BRI. The OECD (2018) also relates each economy to a specific economic corridor. This classification has been adopted as well.

Table 1b

A1: Motivation for the Random effects model

From a purely statistical point of view, the fixed effects model might be the most appropriate method for the econometric analysis. The Hausman test has a prob>chi2 of 0.0000, which suggests a systematic difference in coefficients between the random effects model and the fixed effects model. The fact that we reject the null hypothesis indicates that there is likely a covariance between the unique errors (ai) and the regressors. This leads to biased coefficients if we use the random effects model (Adkins & Hill, 2011). The fixed effects model has less restrictive assumptions and allows for this correlation, therefore one would prefer the fixed effects model from a statistical point of view. However, one should not put too much emphasize on the Hausman test since its applicability is limited when robust standard errors are used. It might instead be better to focus on the theoretical substantiation of the model.

The fixed effects model makes an assumption of homogeneity, which means that the variation among units is assumed to be limited and that the majority of variation takes place within units overtime. A random effects model on the other hand uses both within-and- between unit variation (Bell & Jones, 2015; Bell et al., 2019). In the current analysis one could argue that the between-country variation is even greater than the within-country variation. Therefore, it would not be correct to go for a fixed effects estimation. However, the random effects model has the requirement that there is no correlation between the unit-level (time invariant) effects and the explanatory variables. In the current model there are inevitably some time invariant factors that affect regressors. An example could be geographic characteristics being correlated with infrastructure. This correlation between unit-level time invariant effects and regressors leads to biased estimates when using the random effects model (Snijders & Bosker, 2011).

To control for time invariant effects, one could include region dummies in a random effects model (Bell & Jones, 2015). These dummies control for certain time-invariant characteristics of (groups of) countries. In the current analysis it would make sense to identify these “regions” as economic corridors. The economic corridor dummies can control for shared time-invariant characteristics of countries related to an economic corridor. For example, a substantial number of countries in the China-Central West Asia corridor are landlocked. The idea is that these dummies capture a sufficient part of the time-invariant characteristics, which would allow us to use the random effects model instead of the fixed effects model (Bell & Jones, 2015). The use of the random effects model in turn enables us to construct a theoretically sensible model which examines the variations both within-and- between countries.

The above explanation indicates that statistical precision and theoretical substantiation should both be considered when choosing a model. For the current paper the theoretical considerations clearly indicate that the random effects model is more suitable for the analysis. However, the Hausman test suggests that a fixed effects model should be used. There are three motivations that justify the use of the random effects over the fixed effects. Firstly, the main analysis uses robust standard errors to control for heteroscedasticity. According to Snijders and Bosker (2011), one should not blindly follow the results of the Hausman test since its applicability is limited when robust standard errors are used. The authors warn that scholars often erroneously interpret the test in this context. Secondly, the economic corridor dummies control for a substantial part of the time-invariant characteristics of countries. This in turn reduces the bias from time-invariant confounders when using the random effects model (Bell & Jones, 2015). Thirdly, there is ample literature such as Fielding (2004), Snijders and Bosker (2011) and Bell et al. (2019) that suggests that the random effects model should not be abandoned because of a Hausman test. Instead, one should choose a model based on conceptual considerations such as the between unit variation and the use of cross-level interactions.

These three motivations justify that the baseline model is estimated using a random effects model. The strength of this model is its relative simplicity that allows for flexibility in modeling. However, it also has one glaring shortcoming. This shortcoming is that the model is not able to address issues of endogeneity. To address the endogeneity and assess the causality, a robustness check is done which uses a Generalized Methods of Moments estimation (GMM).

A2: Generalized Methods of Moments Specification

Comparing the GMM method to a 2SLS analysis

The GMM method is not the only econometric technique that can address endogeneity. Arguably the most popular technique is a two stage least squares (2SLS) analysis with instrumental variables. However, this method is not applicable for the current research since there are no suitable exogeneous instruments for infrastructure. Any instrumental variable should satisfy the exclusion restriction assumption, which means that the instrument only affects GDP per capita through infrastructure. The instrument itself should thus be uncorrelated with GDP per capita. Furthermore, the exogenous instrument should be strongly correlated with the endogenous variable (infrastructure). Previous scholars found various exogenous instruments that satisfy these conditions. For example, Donaldson (2016) used historical routes and Duranton and Turner (2011) used planned routes as instruments for infrastructure. Another group of scholars used geographical and geological determinants to instrument for infrastructure (Cariolle, et al., 2017). However, these instruments cannot be used in the econometric analysis of this paper.

It is important to recognize that the current paper uses panel data, which consists of a cross-sectional dimension and a time dimension. The instrumental variables proposed by previous scholars are all time-invariant (historic) instruments. These instruments cannot be used in the current paper because they do not capture the time dimension of the data. Scholars that use time-invariant instruments in a panel-data setting only focus on the cross-sectional effect whilst the time series effect is neglected. It would therefore be wrong to use one of the previously proposed instruments in the econometric analysis. One issue that you would likely encounter is that the correlation between the exogenous variable and the endogenous regressor is limited (weak instrument). Intuitively, this correlation would be expected to be limited since we try to estimate differing levels of infrastructure using the same time-invariant instrument. Weak instrumentation in turn leads to a large variance, making the IV method unreliable.

To the best of my knowledge, there are no instrumental variables for infrastructure that satisfy all requirements in a panel data setting. The absence of a suitable instrument means that a two stage least squares analysis with instrumental variables cannot be used to address endogeneity. In consideration of this, the GMM method is the most appropriate econometric technique to addresses endogeneity in a panel-data setting.

Difference GMM vs System GMM

There are two types of GMM estimators, the Difference GMM and the System GMM. Bond et al. (2001) describe a three-step process that can be used to decide which estimator is most applicable for the analysis at hand. First one should run a pooled OLS estimation and the resulting coefficient on the lagged dependent variable is the upper bound. Secondly, one runs a fixed effects estimation and the corresponding coefficient on the lagged dependent variable is the lower bound. Thirdly, one runs a Difference GMM estimation. The coefficient on the lagged dependent variable is compared to the upper/lower bound. If the coefficient is below/above one of the bounds, the Difference GMM is biased and the System GMM is preferred.

For model 2, the estimates from the Difference GMM appear to be upward biased. Both the estimates from the one-step and two-step Difference GMM are higher than the pooled OLS estimates. This means that the estimates of the Difference GMM exceed the upper bound. Bond et al. (2001) argue that in this case the System GMM is preferred over the Difference GMM.

There are additional arguments that support the use of the System GMM. Statisticians tend to infer that the gains from the System GMM are more pronounced when the number of countries is relatively large compared to the time period. This is the case because the Difference GMM has poor finite sample properties, especially when the series is highly persistent. In such a persistent series the lagged values are only weakly correlated with the first differences, which might lead to weak instruments in the Difference GMM (Blundell & Bond, 1998). Arellano and Bover (1995) show that the System GMM corrects for this bias. The dataset used in the econometric analysis has a relatively large number of countries (58) compared to the time period (18). Therefore, it might be better to use the System GMM to prevent the above problem.

One-step Estimation vs Two-step Estimation

Another issue that should be considered is deciding whether to run a one-step or two-step estimation. There are two arguments that support the use of a two-step estimation. Firstly, the covariance matrix used in the two-step estimation is robust to panel-specific autocorrelation and heteroskedasticity (Mileva, 2007). The statistical tests indicate that both issues are relevant for the analysis at hand. Secondly, for a System GMM estimation the one-step standard errors are always asymptotically inefficient (Roodman, 2009). Therefore, it is better to use a two-step estimation when using the System GMM.

Two-step System GMM

Based on the above explanation, the Two-step System GMM appears to be the most applicable estimator for the analysis at hand. The command *xtabond2* is used to run this estimation in STATA. The variables listed after the xtabond2 command constitute the full dynamic model of the paper. This includes both the endogenous and exogenous regressors. The gmmstyle and ivstyle brackets distinguishes between these two types of regressors;

xtabond2 LN_GDP_PC l.LN_GDP_PC Infrastructure_Index3 LN_Population ExportPerc FDI GovDebt Capital_Stock Corruption LN_Agri LN_ProductivityUSD i.region i.Year, gmmstyle(l.LN_GDP_PC Infrastructure_Index3 LN_Population ExportPerc FDI GovDebt Capital_Stock Corruption LN_Agri LN_ProductivityUSD, lag(1 2) collapse eq(level)) ivstyle(i.region i.Year, eq(level)) robust twostep orthogonal small

The variables listed in the "gmmstyle" brackets are assumed to be endogenous to GDP per capita. These variables are lag GDP per capita, infrastructure, population, export, FDI, government debt, capital stock, corruption, agriculture and productivity. These variables all affect GDP per capita, however there is also a reverse effect from GDP per capita to these variables. To overcome this issue of endogeneity, the lags of the endogenous variables are used as internal instrumental variables (IV). Using these lags as instruments allows us to distinguish between the endogenous and exogenous effects on GDP per capita. Furthermore, in the command it is also specified that the instrument set should be collapsed to ensure that the number of instruments does not outnumber the number of groups (Mileva, 2007).

The variables listed in the "ivstyle" brackets are assumed to be exogenous to GDP per capita. There are only two variables that are assumed to be exogenous. These variables are the region dummies and year dummies. One can confidently say that GDP per capita does not affect these two controls. Therefore, these variables themselves are used as their own instruments.

At the end of the STATA command there are three additional specifications listed. Firstly, the robust part tells STATA that robust standard errors should be used in the estimation. Secondly, the orthogonal specification means that forward-orthogonal deviations (FOD) are used. This might be necessary since the first differences of u_{it} can be serially correlated (Arellano & Bover, 1995). Thirdly, "small" tells STATA to use small-sample adjustments. These adjustments mean that STATA reports t-statistics instead of z-statistics, and the Wald chi-squared test instead of the F-test (Mileva, 2007).

A3: Statistical Tests – Baseline Model

This section gives an elaborate overview of the statistical tests performed in the paper. The tests consider issues of normality, multicollinearity, heteroskedasticity, stationarity and autocorrelation. These tests and the respective results are outlined below. Furthermore, the implications of the results are explained.

The normality of the data is assessed manually using histograms of each individual variable. Non-normally distributed data is logarithmically transformed to make the data more in line with the normality assumption. Upon assessment of the histograms, GDP per Capita, Population, Export, Government Debt, Agriculture and Productivity appear to be non-normally distributed. Normalizing these variables is deemed appropriate since they have skewed distributions, and it is theoretically sensible for these particular variables.

The second issue to consider is multicollinearity. Multicollinearity refers to a statistical property where an independent variable is correlated with other independent variables to a substantial degree. This issue must be addressed since a high pairwise correlation among regressors increases the variance and standard errors. This ultimately leads to a decrease in the statistical power of the model (Adkins & Hill, 2011). Therefore, we must ensure that there is no severe collinearity in the dataset. Statisticians tend to suspect problematic collinearity if the correlation exceeds 0.8 (Wooldridge, 2006; Adkins & Hill, 2011). In consideration of this, the current paper suspects substantial collinearity at $|r| >0.8$. Table 3b in the appendix shows that there is no pairwise correlation among regressors that exceeds this threshold. The highest pairwise correlation is 0.7386 between the variables Population and Productivity. This is below the threshold of $|r| >0.8$, which means that no variables should be dropped from the model.

Heteroscedasticity refers to a non-constant variance of the error term. The presence of heteroscedasticity means that the Ordinary Least Squares estimation no longer generates the best estimates. "Best" in this sense refers to estimates with the lowest variance. Another issue is that the standard errors are biased which might lead to unreliable tests (Adkins & Hill, 2011). A Breusch-Pagan test can be used to assess whether the residuals are homoscedastic. It appears that the regression on the current dataset has a non-constant variance of the residuals (i.e., heteroscedasticity). The Breusch-Pagan test has a value of 0.000, which means that the hypothesis of a "constant variance" is rejected. The presence of heteroskedasticity warrants the use of robust standard errors in the regression (Wooldridge, 2006).

Another statistical property that should be considered is (non)stationary. Stationarity is defined as a data structure where a shift in time does not change the statistical properties of the distribution. In this context, “strict stationarity” means that the distribution in terms of mean, variance and covariance does not change over time (Palachy, 2019). A departure from stationarity might distort the regression and lead to erroneous inferences. The most common problem with non-stationary data is that the results might be spurious in that they indicate a relationship where one does not exist (Baumöhl & Lyócsa, 2011). In the current dataset, non-stationarity is assessed using unit root tests. These tests examine whether there is a stochastic trend in a time series (i.e., random walk or drift). If a unit root is present, the mean and variance change over time and this leads to an unpredictable pattern in the data. Several different tests are performed including the augmented Dickey–Fuller test, Levin-Lin-Chu test and Harris-Tzavalis test. These tests all show that the infrastructure index is stationary. This stationarity is to be expected because the infrastructure index is standardized and constructed using a Principal Component Analysis. All unit root tests also indicate that log GDP per Capita is stationary. This is also not surprising since the tests are performed on a logarithmically transformed variable. Such a transformation often makes variables stationary. Considering that the main variables in the model are stationary, no further actions should be taken.

Autocorrelation is the final statistical property that should be considered for the baseline model. Autocorrelation means that residuals are correlated overtime (Stock & Watson, 2007). If this issue is present, the number of observations used to calculate the t-statistic might be incorrect, which in turn leads to an overestimation of the reliability. It is reasonable to assume that there is some degree of autocorrelation in the data. The reason for this is that there are groups of countries in the BRI that have similar economic structures (Jenish, 2013). An example of this are the economies in Central Asia (e.g., Kyrgyzstan, Kazakhstan, Tajikistan) that are all highly dependent on commodities such as gold and oil. If the prices of these commodities fluctuate, it is likely that some autocorrelation will occur. Other sources of autocorrelation might be business cycles or (economic) crises. Autocorrelation is assessed using the Wooldridge test for autocorrelation in panel data (Drukker, 2003). The null-hypothesis of this test is that there is no first-order autocorrelation. However, this hypothesis is rejected since the test has a corresponding F-value of 0.000, which indicates that autocorrelation is present in the data. To control for this, a heteroscedastic and autocorrelation consistent (HAC) covariance matrix is used (West, 2010).

Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ln GDP per Capita	1,170	9.359	1.005	6.958	12.042
Infrastructure Index	1,170	0	1	-4.559	0.483
ln Population	1,134	2.449	1.749	-1.224	7.268
ln Exports	1,134	3.648	0.771	-2.308	5.434
ln Government Debt	1,170	3.482	0.932	-1.247	5.846
Stability	1,170	-.304	.981	-3.181	1.615
ln Agriculture	1,170	1.821	1.312	-3.561	3.999
ln Productivity	1,116	24.705	1.770	20.249	28.618
Financial Development	1,116	0.312	0.158	0	0.797

Table 2b

Pairwise correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) ln GDP per Capita	1.0000								
(2) Infrastructure Index	0.6491*	1.0000							
(3) ln Population	-0.3751*	-0.2449*	1.0000						
(4) ln Export	0.5539*	0.4755*	-0.3842*	1.0000					
(5) ln Government Debt	-0.2369*	-0.0677*	0.1417*	-0.0830*	1.0000				
(6) Stability	0.5704*	0.3560*	-0.5348*	0.4672*	-0.2201*	1.0000			
(7) ln Agriculture	-0.8594*	-0.4504*	0.3760*	-0.5378*	0.1612*	-0.4751*	1.0000*		
(8) ln Productivity	0.3113*	0.2182*	0.7386*	-0.0275	0.0016	-0.1259*	-0.1999*	1.0000	
(9) Financial Development	0.6432*	0.3954*	0.1638*	0.3772*	0.0404	0.2563*	-0.6256*	0.5973*	1.0000

p-values in parentheses: * $p < 0.05$

Table 3b

Relative performance of Economic Corridors

	(1) ln GDP per Capita	(2) ln GDP per Capita	(3) ln GDP per Capita	(4) ln GDP per Capita	(5) ln GDP per Capita	(6) ln GDP per Capita	(7) ln GDP per Capita
Infrastructure Index	0.0828*** (0.003)	0.0766*** (0.000)	0.0685** (0.004)	0.0780*** (0.000)	0.0762*** (0.000)	0.0763*** (0.000)	0.0766*** (0.000)
BCIM Corridor	-0.940*** (0.000)						
Infra * BCIM Corridor	-0.0118 (0.725)						
CWA Corridor		-0.894* (0.087)					
Infra * CWA		0.0848 (0.921)					
CIP Corridor			-0.799*** (0.000)				
Infra * CIP Corridor			0.0203 (0.563)				
CMR Corridor				-0.805*** (0.009)			
Infra * CMR Corridor				-0.0936** (0.011)			
CP Corridor					-0.618** (0.043)		
Infra * CP Corridor					-0.114 (0.492)		
NELB						-1.008 (0.142)	
Infra * NELB						0.417 (0.713)	
21st-C MSR							-0.699*** (0.005)
Infra * 21st-C MSR							-0.00549 (0.965)
ln Population	-0.552*** (0.000)	-0.549*** (0.000)	-0.553*** (0.000)	-0.556*** (0.000)	-0.559*** (0.000)	-0.555*** (0.000)	-0.551*** (0.000)
ln Export	0.0265 (0.165)	0.0265 (0.160)	0.0265 (0.166)	0.0258 (0.171)	0.0260 (0.167)	0.0261 (0.169)	0.0263 (0.164)
ln Government Debt	-0.0511 (0.192)	-0.0509 (0.193)	-0.0514 (0.191)	-0.0511 (0.194)	-0.0510 (0.193)	-0.0511 (0.195)	-0.0509 (0.193)
Stability	0.0193 (0.489)	0.0190 (0.496)	0.0191 (0.496)	0.0175 (0.535)	0.0192 (0.495)	0.0193 (0.489)	0.0191 (0.496)
ln Agriculture	-0.185** (0.012)	-0.186** (0.011)	-0.185** (0.012)	-0.186** (0.012)	-0.188*** (0.010)	-0.186** (0.012)	-0.186** (0.011)
ln Productivity	0.476*** (0.000)	0.477*** (0.000)	0.476*** (0.000)	0.478*** (0.000)	0.478*** (0.000)	0.476*** (0.000)	0.477*** (0.000)
Financial Development	-0.0927 (0.704)	-0.0852 (0.726)	-0.0919 (0.705)	-0.0720 (0.773)	-0.0939 (0.701)	-0.0924 (0.706)	-0.0861 (0.724)
Corridor Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	-0.126 (0.943)	-0.156 (0.930)	-0.115 (0.948)	-0.153 (0.932)	-0.105 (0.954)	-0.0831 (0.963)	-0.143 (0.936)
N	1044	1044	1044	1044	1044	1044	1044
Overall adj. R^2	0.9345	0.9355	0.9341	0.9340	0.9324	0.9333	0.9349

Robust standard errors are used to control for autocorrelation and heteroscedasticity. p-values in parentheses:
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4b

Separate effect of Infrastructure Indicators

	Port Activity	Air Transport	Mobile	Electricity	Rail Lines	Roads
	(1)	(2)	(3)	(4)	(5)	(6)
	ln GDP per Capita	ln GDP per Capita	ln GDP per Capita	ln GDP per Capita	ln GDP per Capita	ln GDP per Capita
Port Activity	0.0198***					
	(0.000)					
Air Transport		-0.00101				
		(0.588)				
Mobile Subscriptions			0.0891			
			(0.152)			
Electricity Access				0.00455***		
				(0.000)		
Rail Lines					0.0137**	
					(0.023)	
Road Network						0.0942***
						(0.001)
ln Population	-0.571***	-0.560***	-0.585***	-0.554***	-0.611***	-0.573***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln Export	0.0338*	0.0292	0.0342**	0.0260	0.0307	0.0309
	(0.070)	(0.153)	(0.047)	(0.168)	(0.102)	(0.109)
ln Government Debt	-0.0579	-0.0532	-0.0510	-0.0509	-0.0563	-0.0580
	(0.155)	(0.161)	(0.227)	(0.194)	(0.148)	(0.151)
Stability	0.0402	0.0381	0.0378	0.0191	0.0406	0.0385
	(0.190)	(0.209)	(0.211)	(0.497)	(0.171)	(0.208)
ln Agriculture	-0.182**	-0.193***	-0.177**	-0.186**	-0.184**	-0.188**
	(0.015)	(0.005)	(0.016)	(0.011)	(0.013)	(0.011)
ln Productivity	0.502***	0.504***	0.516***	0.476***	0.486***	0.490***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Financial Development	-0.183	-0.0499	-0.178	-0.0904	-0.167	-0.167
	(0.445)	(0.818)	(0.488)	(0.711)	(0.502)	(0.488)
Corridor Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
_cons	-0.917	-0.665	-0.970	-0.522	-0.826	-0.604
	(0.615)	(0.729)	(0.587)	(0.767)	(0.650)	(0.740)
N	1044	1044	1044	1044	1044	1044
Overall adj. R^2	0.9272	0.9314	0.9264	0.9337	0.9232	0.9292

Robust standard errors are used to control for autocorrelation and heteroscedasticity. *p*-values in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5b