Infrastructure Development in the European Union

Examining the effect of Macroeconomic, Institutional and Capital Market Drivers on Infrastructure Investment

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João Pedro Gonçalves dos Santos

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Orientadora: Prof.ª Doutora Zélia Maria da Silva Serrasqueiro Teixeira

Co-orientador: Prof. Doutor Vítor Manuel Ferreira Moutinho

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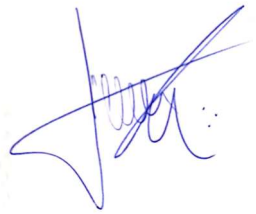

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Resumo

Este trabalho visa identificar os principais drivers que impulsionaram o investimento em infraestrutura na União Europeia (UE). Usando a análise econométrica de dados em painel, investigamos a importância relativa dos fatores macroeconômicos, do mercado de capitais e institucionais na determinação do investimento em infraestrutura. Todos os países da UE foram selecionados, exceto Malta e, os dados utilizados estão centrados entre os anos de 1997 e 2020. Especificamente, usamos o comando Generalized Method of Moments (GMM) para estimar os parâmetros em modelos de painéis dinâmicos. A utilização do comando econométrico GMM nesta pesquisa garante resultados mais precisos e robustos, permitindo o tratamento de problemas de endogeneidade e heterogeneidade não observada que são comumente encontrados na análise de dados em painel. Os resultados obtidos indicam que as variáveis macroeconômicas se sobrepõem às questões institucionais e ao nível de maturidade do mercado de capitais local. Nossas descobertas lançam luz sobre os fatores mais relevantes para impulsionar o investimento em infraestrutura na UE e podem guiar o desenvolvimento de políticas públicas mais eficazes nessa área.

Palavras-chave

investimento em infraestrutura, dados em painel, fatores macroeconômicos, mercado de capitais, fatores institucionais, políticas públicas, GMM

Resumo Alargado

O investimento em infraestrutura desempenha um papel fundamental no impulsionamento do crescimento econômico das economias globais. Ao buscar maximizar o desenvolvimento econômico local e promover o bem-estar social, os países têm realizado investimentos significativos nesse setor ao longo dos últimos séculos. No entanto, na segunda metade do Século XX surgiram debates sobre a maneira mais eficiente de investir no setor, inicialmente concentrados na capacidade e coordenação do setor público em promover ou não a expansão desse padrão de ativos físicos.

Com as transformações geopolíticas constantes e o fenômeno da financeirização à partir da década de 1980 surgiram novas perspectivas, apontando para a importância do mercado de capitais e da sofisticação das estruturas institucionais dos países como fatores que possivelmente influenciam a alocação de recursos e a viabilidade dos projetos de infraestrutura. Compreender esses impulsionadores se torna crucial para que os formuladores de políticas públicas possam planejar medidas efetivas que promovam o investimento nessa área e estimulem o desenvolvimento econômico local.

Nesse contexto, esta pesquisa tem como objetivo principal identificar os principais fatores impulsionadores do desenvolvimento de projetos de infraestrutura na Europa. Para isso, serão utilizados dados macroeconômicos, institucionais e do mercado de capitais de todos os países da União Europeia, com exceção de Malta, no período entre 1997 e 2020.

No que diz respeito à revisão da literatura, o foco recai sobre os principais aspectos da infraestrutura. Inicialmente, apresentamos o conceito de infraestrutura dentro de um contexto histórico, explicando quais são os tipos de ativos e os impactos de eventos socioeconômicos do Século XX na concepção de novos projetos de infraestrutura. Em seguida, discutimos estudos que sustentam o argumento de que a política institucional é um fator de risco para a promoção de investimentos nessa área. Destacamos também a importância do desenvolvimento do mercado de capitais na área de infraestrutura. Por fim, abordamos as perspectivas futuras do setor e os diferentes desafios enfrentados pelos países de acordo com suas respectivas condições econômicas.

Referente à estrutura de dados, o painel tem como série temporal o período entre os anos de 1997 e 2020, divididos em três blocos: antes da crise (1997-2006), durante a crise (2007-2014) e pós-crise (2015-2020). A variável independente corresponde à fração da Formação Bruta de Capital Fixo voltada para a construção de estruturas e prédios. Em seguida, temos os seguintes blocos de variáveis dependentes: Macroeconómicas (Dívida do governo central, formação bruta de capital fixo (total), formação bruta de capital fixo (fração do Estado), formação bruta de capital fixo (fração dos agentes privados)). O segundo bloco contém as variáveis que refletem o mercado de capitais, nomeadamente: rating soberano, índice bolsista local, índice de desenvolvimento

financeiro e crédito doméstico do setor privado local. Por último, para representar o ambiente institucional, temos o índice de liberdade econômica.

Para alcançar os objetivos do estudo, utilizamos a metodologia de Quase-Máxima Verossimilhança (Quasi-Maximum Likelihood - QML) a fim de obter as estimativas. O QML pode ser considerado uma abordagem alternativa para a análise de dados em painel quando o horizonte de tempo não é tão longo. Normalmente, utiliza-se o Método dos Mínimos Quadrados Ordinários (Ordinary Least Squares - OLS) ou dos Mínimos Quadrados Generalizados (Generalized Least Squares - GLS) para efeitos aleatórios ou fixos, pois a condição nas observações iniciais geralmente produz estimativas mais enviesadas devido à correlação da variável dependente defasada e do termo de erro combinado.

O QML, por sua vez, adapta a função de verossimilhança incondicional e, portanto, pode ser uma estratégia alternativa se todas as suposições forem devidamente satisfeitas, considerando a eficiência e o desempenho das amostras finais. Embora esses estimadores sejam considerados eficientes, há uma compensação entre sua eficiência e robustez. No entanto, uma correção utilizada no QML é mais eficaz ao lidar com a endogeneidade da variável dependente defasada por períodos.

Dessa forma, apresentamos os seguintes resultados e conclusões:

O endividamento dos estados influencia negativamente a capacidade de gerar novos projetos de infraestrutura. Essa influência pode estar relacionada ao redirecionamento de gastos, ao risco fiscal e político, e à dificuldade de prever o cenário macroeconômico em momentos de crise.

O aumento da formação bruta de capital fixo está relacionado ao crescimento da demanda por novos projetos de infraestrutura. No entanto, a desaceleração significativa do coeficiente no período pós-crise pode sugerir um redirecionamento dessa variável, possivelmente negligenciando projetos de infraestrutura em favor de outras alocações com maior retorno sobre o capital investido.

Os modelos indicam que o Estado promoveu investimentos em infraestrutura não apenas durante períodos de crescimento econômico, mas também em momentos de incerteza no cenário macroeconômico, acelerando-os. Como o setor de infraestrutura tem um atraso intrínseco na conclusão dos prazos de execução de projetos, parece apropriado que ele seja promovido por um agente que também possui metas de longo prazo.

O setor privado substituiu temporariamente o Estado como protagonista nos investimentos durante a crise, mas após o período de crise, houve uma preferência por investimentos de curto prazo, indicando que o agente privado não conseguiu substituir ou complementar consistentemente o setor público no fomento de novos investimentos de longo prazo no setor de infraestrutura.

As variáveis de mercado e institucionais não forneceram resultados robustos e consistentes nos modelos para todos os índices selecionados. Existem hipóteses a serem consideradas nesse sentido, como a possível restrição de recursos para os projetos, um aumento significativo no custo de capital para atividades arriscadas após a crise financeira da última década, deterioração da institucionalidade do setor, bem como a alocação de recursos para atividades com retorno de curto prazo. Além disso, o quadro institucional do bloco não parece relevante para a tomada de decisão do agente económico em investir no setor de infraestrutura.

O resultado mais relevante da pesquisa foi a correlação positiva entre o investimento estatal e a expansão da infraestrutura no bloco. Mesmo durante a crise, o capital estatal impulsionou o progresso do setor e reforçou seu papel como promotor de projetos de longo prazo. Portanto, este modelo destaca a importância das variáveis macroeconômicas, com ênfase na formação bruta de capital fixo do Estado. Além disso, a pesquisa contribuiu para uma compreensão mais profunda dos impulsionadores da infraestrutura na região europeia, demonstrando a importância de direcionar recursos públicos para o setor, que pode gerar efeitos positivos no crescimento econômico, indicadores sociais e na competitividade dos países do bloco.

Abstract

This work aims to identify the key drivers that have propelled infrastructure investment in the European Union. Using econometric analysis of panel data, we investigate the relative importance of macroeconomic, capital market, and institutional factors in determining infrastructure investment. All EU countries were selected (except Malta) and the data used are centered between the years 1997 and 2020. Specifically, we use the Generalized Method of Moments (GMM) command to estimate the parameters in dynamic panel models. The use of the GMM econometric command in this research ensures more accurate and robust results, allowing for the handling of endogeneity and unobserved heterogeneity problems that are commonly encountered in panel data analysis. The results achieved indicate that the macroeconomic variables overlap institutional issues and the level of maturity of the local capital market. Our findings shed light on the factors that are most relevant in driving infrastructure investment in the UE and can inform the development of more effective public policies in this area.

Keywords

infrastructure investment, panel data, macroeconomic factors, capital market, institutional factors, public policies, GMM.

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List of Acronyms

DCPbsn	Domestic Credit to Private Sector
DEBgov	Central Government Debt, Total
EU	European Union
Eurostat	European Statistical Office
FDIind	Financial Development Index
GFCFbsn	Gross Fixed Capital Formation, Total - Business
GFCFgov	Gross Fixed Capital Formation, Total - Government
GFCFtot	Gross Fixed Capital Formation, Total
GMM	Generalized Method of Moments
IEFind	Index of Economic Freedom
IMF	International Monetary Fund
LSEind	Local Stock Exchange Composite Index
N112G	Gross Fixed Capital Formation - N112G Other buildings and structures
RATind	Rating Index
S&P	Standard & Poor's

1. Introduction

Investment in infrastructure is an essential pillar for driving economic growth in global economies. Aiming to maximize local economic development and promote social well-being, for decades, countries have made substantial investments in diverse sectors (Crescenzi & Rodrigues-Pose, 2012).

The second half of the twentieth century observes the beginning of discussions concerning the most efficient way to invest in infrastructure. Initially, the debates concentrated on the efficiency of public and private investment.

Nevertheless, constant geopolitical transformations and the phenomenon of financialization changed the scenario. Other frontiers arose with potential influence on the determinants of resource allocation for the viability of infrastructure projects. In other words, the capital market development degree and countries' institutional structures sophistication. Understanding the importance of these drivers is essential for policymakers to schedule effective public policies that can promote infrastructure investment and stimulate economic growth (Asin & Munoz, 2023).

This research's foremost objective is to determine the development infrastructure projects leading drivers in Europe during the last few years. This study's methodological aspects are based on a data panel, elaborated with macroeconomic, institutional, and capital market variables, from all European Union (EU) countries, except for Malta, between 1997 and 2020.

Investigating the macroeconomic, capital market, and institutional factors' relative significance in driving infrastructure investment in the UE places in evidence the most critical investment drivers. Concerning results, they can help policymakers outline more effective public policies to promote infrastructure investment, stimulate economic growth, and benefit EU citizens.

The panel data analysis enables to investigator to account for unobserved heterogeneity and endogeneity issues, commonly verified in cross-sectional and time series data analyses. Therefore, we used the Generalized Method of Moments (GMM) econometric regressions and the Breitung, Kripfganz & Hayakawa (2022) dynamic panel model to estimate the parameters and acquire more precise and accurate data from the operation of the Difference-GMM and System-GMM models, respectively.

Regarding the literature review, the focus is on infrastructure's main aspects. Initially, we present the infrastructure concept in the historical context, explaining the impacts of 20th-century socioeconomic events on conceiving new infrastructure projects. Subsequently, we discuss studies supporting the argument of institutional political as a risk factor for promoting investments in the area. Finally, we introduced the importance of capital market development in the infrastructure area.

This work is structured as follows. The second chapter approaches the literature review. The third chapter presents the data and the methodology used. The fourth chapter discusses the estimation results. Finally, the fifth chapter conducts the research conclusions.

2. Literature review

The objective of the second chapter is to present the literature review. Aiming this purpose, we organize the section into three parts. First, we characterize the infrastructure concepts and the historical context in which the debate arises. Also, we differentiate the public and private sector's roles in infrastructure development.

Next, we submit the local political conjuncture, geopolitical and economic risks, and uncertainties. Third, we evidence questions derivative from the maturity of the local financial system and the degree of institutionality, with a focus on the institutionality degree potentialities and limits in viable new infrastructure projects viable.

2.1 Exploring the Importance of Infrastructure: Historical Context and the Roles of Public and Private Sectors

Stimulating the construction and maintenance of physical structures for telecommunications, energy, transport, and sanitation is a significant axle of economic development and social well-being in modern capitalist society (Bogart, 2020). That is because investment in infrastructure allows for the mass allocation of physical and human capital. Donaldson (2018) explains that this phenomenon generates productivity gains and a relevant improvement in the levels of employment, income, and consumption of the local economy. As observed in the railway expansion in India in the 19th century, the railway infrastructure promotion engendered a 15% increase in local agricultural income (Donaldson, 2018).

The current literature consensus characterizes three types of infrastructure. The first is based on the physical structure, contemplating telecommunications, transport, and energy projects. The second class refers to social infrastructure, including projects such as hospitals and schools. The third type is rural infrastructure to support agriculture and livestock. (Kumari & Sharma, 2017).

These subject matters as local economies need new infrastructure projects, whether new to developing countries lacking the infrastructure or for old physical structures renovation in already developed economies. In the latter case, the new infrastructure projects commonly aim to update structures no longer energetically and environmentally efficient. As a result of this growing need, The Global Infrastructure Hub (2020) estimated that by 2040, it will be necessary approximately 94 trillion dollars in infrastructure investment.

However, some challenges make it impossible to expand new infrastructure projects, including obstacles to environmental licensing and possible disputes between local political actors (Grafenstein et al., 2021).

This research objective is to elucidate the drivers for investment in infrastructure in the European Union (UE) based on the analysis of macroeconomic, institutional, and capital market indicators.

Assuming that investment in this sector is a challenge for 21st-century economies, investigations suggest possible sector courses could largely contribute to the topic.

It is important to stress the extent of the different challenges faced by developing economies and northern economies. On the whole, the limits tend to be distinct according to the levels of institutionality and development achieved by countries.

The financing of infrastructure projects can have different types of instruments, means of accumulation, and subsequent capital expenditure. Nonetheless, two actors maintain decision-making power over the elaboration and construction of structures. They are the public and private sectors (Zhang et al., 2016).

At the end of the 1970s, with the financialization of capitalist economies, emerged the consensus about private entities endue better governance and economic efficiency when managing physical assets. Thereby, what was once managed by public agents became the target of constant waves of acquisitions by private agents (Gamble, 2019). Afterward, there has been a considerable increase in participation from private capital in already established infrastructure projects and investment in new physical structures (Li et al., 2019).

Until the second half of the 20th century, the private capital focus was providing services between companies. With this new conjuncture, non-state agents began to offer solutions for public services, such as transport, health, and energy (Demirel, 2021).

Nevertheless, the private agent's capital accumulation occurs more safely and linearly in financial channels to the detriment of investment in tangible economic activities (Boyer, 2000). This characteristic conforms to an obstacle for new subsidies to projects in the sector. Another fundamental aspect of private participation analysis in infrastructure projects is the subsequent administration of the asset. The uncertainty in profit generation is a barrier to capital allocation in projects with high costs and long maturation times. Moreover, latent civil society's dissatisfaction concerning the quality of private sector services is correlated to these entities' challenge to balance profit and good service, parameters hardly achieved (Mor & Sehrawar, 2006).

Regarding public agents, is a consensus that most infrastructure projects already established were conceived by. Since until the end of the last century, the accountability for expanding and maintaining public services was the responsibility of the public sector budget. The state, in this sense, the public official group, decides the capital flow destination.

The main criticism of this model resides in the argument that political agents lack the perception of civil society's needs. Consequently, usually allocate resources in areas that perpetuate the already established power structure. Likewise, to what occurs with private agents, society also criticizes inefficiency in the administration of the public good (Grimsey & Lewis, 2002).

Conversely, capital-intensive structures with long-term financial returns become feasible almost exclusively by the public sector since it does not tend to rationalize profit as a vital need for project implementation. However, the well-known budget deficit of the national state present in the last fifty years precluded new physical structures from building and even maintaining ports, highways, and already established sanitation and energy systems (Coate & Morris, 1995).

Concerning private investment, the current literature reflects that this financing source does not arise singly. From the 1990s onwards, private capital becomes a financing source for infrastructure only with structural support and State guarantees through public-private partnerships. The bind risk to large-scale projects makes it unattainable for investors to be the pivot for this operation type, given that the capital market offers more expressive return rates with less risk and mainly greater liquidity of the capital invested (Sader, 2000).

The private capital participation in infrastructure projects leading benefit is the allocation of new technologies, the improvement in processes, and the greater dynamism in the project's final delivery. Such characteristics strive to make, as faster as possible, the operational structure to initiate commercial exploitation and recover the invested capital. However, the current literature reveals a preference for part of private investors to acquire existing constructions and proceed with commercial exploitation (Percoco, 2014).

Even though, at the first moment, privatization and private sector participation in the infrastructure area may seem beneficial to civil society. It is essential to point out that privatization can be considered a corruption movement where the asset transfer financed by the public capital becomes private without any tangible counterparts for the population. Furthermore, the privatization phenomenon materializes in States weakened by recurrent public deficits. Thus, take a place assets' poor pricing, where market concentration generates benefits only for some interest groups to the detriment of society (Hoff & Stiglitz 2005).

Not least, the participation of private capital in infrastructure projects leads to an increase in productivity, whereas these go hand in hand with massive labor cuts and primary services price increases, such as energy, sanitation, and telecommunications. This phenomenon implies the reduction of income by two levels: first by gross salary mass reduction through unemployment levels increase and second by the capital transfer from workers to private investors groups (Andres et al., 2008).

Meanwhile, some gaps make private investment unfeasible in countries most need this capital volume. At the local extent, low levels of institutionality do not allow private capital allocation because these characteristics represent a high risk for the operation. At a global level, the privatized capital flow remains concentrated in industrialized countries, which already afford infrastructure defined.

Risk perception is inherent to all infrastructure projects and deters private capital also the public sector's interest in participating in new projects. Thus, the literature elucidates some significant risk patterns such as market risk, institutional and operational risk.

The risk linked to market issues addresses the possible resources lacking for project completion in a more latent way. This risk is more associated with private investment depending on market fluctuations which can decapitalize the project during its execution. In addition, poorly designed projects with inadequately measured return expectations can lead the private sector to give up in the first phase of construction (Nijkamp & Rienstra, 1995).

However, this risk is not private capital exclusively. Public resources can be unfeasible by a possible tax loss caused by a recession or even a state agent interests transfer. Equally important are other institutional risks as regulatory risks (capital transfer between countries or contract breach) and especially environmental license release (Thobani, 1999).

Moreover, infrastructure projects are subject to construction itself risks, natural disasters, wars, and even theft. These factors aren't fully controllable by public entities and affect the state and the private sector resource allocation (Matsukawa & Habeck 2007).

2.2 Institutional Frameworks in the Financial System

From the second half of the 20th century on, with the 1970s oil crises and the leading economies' financialization, the financial sector promoted considerable impacts on the new infrastructure projects' capitalization structure due to investor behavior paradigm changes. The trading investor behavior summed to the speed at which transactions occur converts investment in infrastructure less attractive than other products offered by the market (Barber et al., 2013).

Equally important are the indices created to assess a given region or country, allowing it possible to measure the quality of the financial sector. The Financial Development Index aims to aggregate information on the efficiency and access to the capital market (International Monetary Fund, 2022). The financial sector development promotes positive effects on investment consolidation in each country. It occurs because the capacity to absorb capital for a project is closely related to market liquidity, established institutional standards, the banking sector development, and other factors. (Levine & Zervos, 1998).

In infrastructure projects, the capital cost becomes an influential factor in promoting or not to be created projects. In this sense, financial development tends to reduce funding costs, thereby countries with developed capital markets constitute more rational choices for investors (Rajan & Zingales, 1998).

In this context, it is important to stress that financial sector development consolidated the creation of proprietary indices offered by private institutions, the rating indices. Rating agencies are financial system private institutions aiming to compile, classify and subsequently provide

information to market agents on different data, such as credit risk and companies' and countries' defaults. In brief, rating agencies are an instrument for correcting gaps in credit information in the global financial system.

The credit risk rating agencies, emergence occurred at the end of the 19th century. Initially, this new business model's main objective was to assess large companies in the northern hemisphere. The substantial development of the capital market and the growing number of industrial and financial conglomerates at a given moment led the market agents to develop standardized ways of assessing credit risk and the mentioned sectors (Iwata, 2012).

The agencies apply a methodology based on statistical indicators such as the level of companies or countries' indebtedness; ability to pay in the short, medium, and long term; corporate or state governance quality; state institutional risk; ability to generate capital for meeting financial obligations, among other factors. Then, the indicators are allocated to statistical risk models and transformed into a data group for analysis (Iwata, 2012).

Nevertheless, the first risk assessment practices date back to the 17th century, when the Dutch India Company already issued equity securities to investors. At some point, the obligation payment was an almost mandatory capital movement, and the defaulter figure almost inexistent. For above-average risk operations, the simple preparation of a letter of recommendation offered the borrower the possibility to raise finance for his activities (Sylla, 2002).

2.3 Future Horizons in Infrastructure

Although the countries with leading economies have, in quality and proportion, more sophisticated infrastructure than the developing nations, both face challenges regarding the maintenance and expansion of the sector in the following years. In this regard, the two blocs' needs seem to be different. For developed countries, the challenge is centered not only on expansion but also replacing existing assets with more sustainable structures and responsibly integrated into the environment (Hueskes et al., 2017).

In contrast, the developing countries main challenge is focused not only on the concern with the new environmental standards in force. Obtaining new funding channels for long-term projects tends to be challenging in countries that lack institutionalism and states that offer low amounts of investment in their public budget. In addition, integration between the public and private sectors doesn't tend to provide the capacity to generate quality projects. (Hodge et al., 2017).

Although the ability to undertake and move capital flows appear to be global, the investment determinants in several sectors as infrastructure, for instance, lack local politics, the risk conditions that the project demands, and studies in the area. In turn, the zone should be divided into groups of countries with similar features, as the funding structure is different when funding for investment in the EU compared to a country in the African bloc of nations, for example (Gemson et al., 2012).

As we have seen, the sector's challenge goes through a series of analyses from the political and economic perspective as through new demands of a world more concerned with man's impacts on the environment. However, we draw attention to a common issue faced by both blocs, and this inflection point is where the concentration of efforts in new studies can benefit the advancement of socioeconomic well-being indices and the availability of funding.

3. Data and Methodology

The objective of the third chapter is to present the data and methodology that provide empirical support to the infrastructure drivers evaluation process. At first, the data panel variables and sources introduce. Following, the methodologic design and econometric tests that provide the research's empirical results explain.

3.1 Data and Sources

The research dependent variable is the fraction of Gross Fixed Capital Formation corresponding to the infrastructure (N112G Other buildings and structures) of the European Union (UE) between 1997 and 2020 years, offered by Eurostat. Thus, the objective is to understand the correlation between investment in infrastructure and the drivers following indicated.

We have classified the independent variables used in the panel into three categories: macroeconomic, institutional, and capital market variables. Also, in this model, the variables Local Stock Exchange Composite Index, Index of Economic Freedom, and Rating Index are exogenous, and others were predetermined.

Table 1 - Descriptive Variables

Variable	Unit of Measure	Acronym	Source of Data	Classification
Dependent Variable				
Gross Fixed Capital Formation - N112G Other buildings and structures	% of GDP	N112G	EuroStat	Predetermined
Independent Variables				
Central Government Debt, Total	% of GDP	DEBgov	IMF	Predetermined
Gross Fixed Capital Formation, Total	% of GDP	GFCFtot	Eurostat	Predetermined
Gross Fixed Capital Formation, Total - Government	% of GDP	GFCFgov	Eurostat	Predetermined
Gross Fixed Capital Formation, Total - Business	% of GDP	GFCFbsn	Eurostat	Predetermined
Rating Index	Credit Rating	RATind	Standard & Poor's	Exogenous
Local Stock Exchange Composite Index	Index	LSEind	Bloomberg	Exogenous
Financial Development Index	Index	FDIind	IMF	Predetermined
Domestic Credit to Private Sector	% of GDP	DCPbsn	IMF	Predetermined
Index of Economic Freedom	Index	IEFind	Heritage Foundation	Exogenous

Besides, this research is composed of three-time series: between 1997-2006, 2007-2014, and 2015-2020. The period division becomes fundamental to avoid bias which could create gaps and distortions between the analysis and reality of the infrastructure sector. Notably, during these twenty-three years, the UE went through moments of economic crisis, recovery, and interregnum

between the first two phases. Therefore, we section the work into three models named pre-crisis, between, and post-crisis periods.

Regarding macroeconomic variables bloc, they are three. The first one is the Central Government Debt, whose data contribute to understanding the government's indebtedness to GDP and whether percentages, low or high, are directly related to the State's capacity to provide or not invest in infrastructure (World Economic Outlook Database, 2022).

The second one is the global gross fixed capital formation index. The main idea for using this index is to verify if exists a connection between the total investments made in a given economy in specific infrastructure projects promotion (World Economic Outlook Database, 2022).

The third one is the gross fixed capital formation variables divided between public and private. The purpose of using these decomposed data is to understand which investment type has a more extensive correlation with infrastructure project progress (Eurostat, 2022).

As for the institutional variables bloc, we have used the Economic Freedom Index, which translates into data the efficiency level of regulatory frameworks, the size of the State, the economy's overture, and the legal system efficiency of a given country (The Heritage Foundation, 2022).

Concerning capital market variables bloc, they are four. The first is the rating assessments provided by Standard & Poor's from Sovereign Risk Indicators. The index assumption is to evaluate the capacity of the State to fulfill or not its financial obligations, offering agents a perspective on the possibility of moving forward with infrastructure projects (S&P Global, 2022).

The second one is the data composed of the Stock Index of all countries in the bloc during the period analyzed. This index allocation support understanding the importance degree of the perception of capital market volatility for capital allocation in the infrastructure market.

The third one is the data from the Financial Development Index designed by the International Monetary Fund (IMF). The index aims to aggregate information on the countries' financial system access capacity, efficiency, and depth, evaluating the financial institutions and the capital market.

The fourth one is the Domestic Credit to the private sector as a percentage of GDP. Whose objective is to verify if the local credit level is decisive for the investment in infrastructure. This indicator is important, as access to credit can influence the local companies' allocation of resources in the sector (World Bank, 2022).

It is important to recall that since this research had carried out with three different blocs of variables, intuitive conduct between them has expected. In this sense, there are some following considerations regarding the phenomenon.

The first group, the macroeconomic variable bloc, has a strong correlation, given that some data are fractions of the same variable. As is the case of gross physical capital formation and their respective divisions between public and private sector participation. Also, it is necessary to stress that the highest values are concentring among the three types of Gross Fixed Capital Formation and their dynamics with the dependent variable. As well as there is a strong negative influence between the deficit and the amount of the State's debt when placed in perspective with the advancement of the dependent variable.

For this variable group, the dynamic was present in the three panels, emphasizing the strong animation in the crisis period between 2006 and 2014 and with almost all of the statistically significant outputs. The previous evaluation is that the macroeconomic variables chosen as a factor contributed to the progress or not of the infrastructure sector, according to what they obtained.

Table 2 - Correlation Matrix (1997-2006)

Variables	N112G	DEBgov	GFCFtot	GFCFgov	GFCFbsn	LSEind	FDIind	DCPbsn	IEFind	RATind
N112G	1									
DEBgov	-0.666***	1								
GFCFtot	0.696***	-0.479***	1							
GFCFgov	0.380***	-0.191***	0.242***	1						
GFCFbsn	0.603***	-0.539***	0.722***	-0.044	1					
LSEind	-0.137**	0.364***	-0.182***	0.04	-0.349***	1				
FDIind	-0.522***	0.421***	-0.238***	-0.024	-0.531***	0.109*	1			
DCPbsn	-0.310***	0.152**	-0.07	-0.166***	-0.352***	-0.102*	0.616***	1		
IEFind	-0.023	-0.203***	0.169***	-0.03	-0.096	-0.158**	0.482***	0.555***	1	
RATind	0.366***	-0.170***	0.261***	0.308***	0.235***	-0.003	-0.597***	-0.360***	-0.229***	1

Note: *** p<0.01, ** p<0.05, * p<0.1

Regarding the market variables bloc, the correlations are statistically significant but with lower levels than the macroeconomic ones. The highlight is the FDIind variable, which has a robust correlation with the dependent variable in all periods and only once with the GFCFbsn variable in the pre-crisis period. Furthermore, the DCPbsn variable, as an index that provides data on local private credit, has an intrinsic link with FDIind, as the latter provides an overview of the local financial sector.

At last, in the institutional variable's bloc, we have the IEFind component, which despite having statistically significant values for almost the entire matrix in all periods, only demonstrates relevant values compared to the FDIind variable. The financial index developed by the IMF has

some elements aiming to measure the capacity for stability and efficiency of the local capital market. Thus, the correlation may be the effect of this similarity between the methodologies.

Table 3 - Correlation Matrix (2007-2014)

Variables	N112G	DEBgov	GFCFtot	GFCFgov	GFCFbsn	LSEind	FDIind	DCPbsn	IEFind	RATind
N112G	1									
DEBgov	-0.653***	1								
GFCFtot	0.675***	-0.576***	1							
GFCFgov	0.748***	-0.595***	0.551***	1						
GFCFbsn	0.671***	-0.570***	0.826***	0.394***	1					
LSEind	-0.016	0.147**	-0.079	0.078	-0.195***	1				
FDIind	-0.665***	0.435***	-0.331***	-0.476***	-0.398***	0.03	1			
DCPbsn	-0.429***	0.209***	-0.306***	-0.272***	-0.434***	-0.193***	0.551***	1		
IEFind	-0.192***	-0.347***	0.018	-0.169**	0.04	-0.286***	0.206***	0.308***	1	
RATind	0.187***	0.133*	-0.041	0.197***	-0.114*	0.304***	-0.501***	-0.163**	-0.392***	1

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 4 - Correlation Matrix (2015-2020)

Variables	N112G	DEBgov	GFCFtot	GFCFgov	GFCFbsn	LSEind	FDIind	DCPbsn	IEFind	RATind
N112G	1									
DEBgov	-0.552***	1								
GFCFtot	0.240***	-0.384***	1							
GFCFgov	0.666***	-0.410***	0.153*	1						
GFCFbsn	0.059	-0.275***	0.913***	-0.075	1					
LSEind	0.139*	0.044	-0.008	0.143*	-0.064	1				
FDIind	-0.643***	0.374***	0.004	-0.411***	0.061	0.007	1			
DCPbsn	-0.532***	0.235***	-0.288***	-0.188**	-0.260***	-0.252***	0.578***	1		
IEFind	0.187**	-0.700***	0.478***	0.142*	0.445***	-0.127	0.015	0.066	1	
RATind	0.136*	0.149*	-0.198**	0.014	-0.057	0.127	-0.534***	-0.385***	-0.357***	1

Note: *** p<0.01, ** p<0.05, * p<0.1

To correct those problems presented, we offered a set of estimates that precisely aim to eliminate this issue based on econometric models introduced in the next section.

3.2 Methods of Estimation

As already demonstrated on correlation matrices, the panel data estimates can suffer bias and correlation problems between variables. Hence, Kripfganz's bias-corrected method of moments is applied to estimate the data and to correct the sampling bias. The base of this strategy correction is the assumption that the moments mean of the model parameters function must be aligned with the moments mean of the sample with correction. The base of this strategy correction is the assumption that the moments mean of the model parameters function must be aligned with the moments mean of the sample with correction. Thus, in the standard GMM system, the averages are only aligned, which can lead to research bias problems (Kripfganz, 2022).

The main objective of the panel data structure is to provide samples of the units where it is possible to analyze the temporal variation (time series) and transversal variation (cross-section) of the selected variables during the three periods analyzed.

First, we applied the Kripfganz model One-step difference-GMM. We use one-step experimental models with first-order instrumental differences, thus estimating the relation between the dependent and independent variables data through a GMM system. The model is named because it performs the equation with just one step and offers results to combat endogeneity based on the calculation first difference between the variables (Kripfganz, 2019).

The data obtained through the Kripfganz model One-step System-GMM is the base of the second analysis. This method is an extension of the 2020 method and is also known as Dynamic Panel Data. The model in question aims at outputs from the control of the non-observable heterogeneity of the variables. In addition, there is also a decrease in the risk of endogeneity between the dependent and independent variables. In short, the model offers outputs already considering the effects of lagged variables and uses GMM estimators with first and second-order differences (Kripfganz, 2022).

We applied the Quasi-Maximum Likelihood (QML) methodology, namely, almost maximum probability, to obtain the estimates. The QML can be considered an alternative approach to panel data overview where the time horizon is not as long. The Ordinary Least Squares (OLS) or Generalized Least Squares (GLS) are usually applied to random or fixed effects because the condition in the initial observations generally gives more biased estimates due to the correlation of the lagged dependent variable and the combined error term (Kripfganz, 2016).

The QML, otherwise, adapts the unconditional likelihood function, and therefore, it can be an alternative strategy if all assumptions are duly satisfied, given the efficiency and performance of final samples, according to Kripfganz (2016). Even though these estimators are considered efficient, there is a trade-off between their efficiency and robustness. Yet, a correction to this approach used in QML is more effective when handling the endogeneity of the dependent lag variable by periods.

For Kripfganz (2022), a generic model for dynamic panel data can describe as follows:

$$y_{it} = \lambda y_{i,t-1} + x'_{it}\beta + f_i'\gamma + \varepsilon_{it} \ (1)$$

$$\varepsilon_{it} = u_i + e_{it}$$

Namely, there is a vector of variables x'_{it} in time and a vector of variables f_i' invariant in time. When bearing with the estimation of panel data, it becomes indispensable to address whether fixed or random effects are verified, and this decision runs through the interpretation of the Hausman Test.

If the random effects presence is verified, we assume that the external regressors are uncorrelated x'_{it} e f_i'. By the author's definition, the lagged dependent variable correlated with the specific error of the time-invariant variable that extends to the initial observations (y_{io}). In a likelihood approach, this correlation needs elucidation through the connecting distribution of all observances, and only the external regressors, x'_{it} e f_i' , are subjected to this likelihood approach.

The initial unconstrained observations were represented by (Bhargava & Sargan 1983), $y_{i0} = \sum_{s=0}^{T^*} x'_{is}\pi_{x,s} + f_i'\pi_f + v_{i,0}$, instead of assuming ($y_{io}$) as exogenous. According to Kripfganz (2016), in this equation, $\pi_{x,s}$, e π_f, are the new vector parameters to be estimated.

If the original data and the rest of the observations have resulted through the same data generation process and if $|\lambda| < 1$, through the following equation:

$$y_{i0} = \lambda^m y_{i,-m} + \sum_{s=0}^{m-1} \lambda^s x'_{i,-s}\beta + \frac{1-\lambda^m}{1-\lambda} u_i + \sum_{s=0}^{m-1} \lambda^s e_{i,-s} \ (2)$$

Thus, this equation is a way to reach an optimal forecast for ($m \to \infty$), the first term ($\lambda^m y_{i,-m}$) will eventually disappear. Moreover, if the exogenous regressors are stationary, then it becomes possible to project past and unobservable occurrences of x'_{it} e f_i', through the following equation:

$$y_{i0} = \sum_{s=0}^{T^*} x'_{is}\pi_{x,s} + f_i'\pi_f + v_{i,0} \ (3)$$

Thus, this equation is a way to reach an optimal forecast for (y_{io}), restricted to the values of the exogenous variables. That said, the terms $\sum_{s=0}^{m-1} \lambda^s x'_{i,-s}\beta + \frac{1-\lambda^m}{1-\lambda} u_i + \sum_{s=0}^{m-1} \lambda^s e_{i,-s}$ the equation below:

$$y_{i0} = \sum_{s=0}^{T^*} x'_{is}\pi_{x,s} + f_i'\pi_f + v_{i,0} \ (4)$$

Then, they become the covariance between the initial observations and the specific effects of the unit, and to obtain more efficient and robust results, it could incorporate into the log-likelihood function.

Admitting only f_i', excluding x_{it}' and still considering that the process started in the infinite past, with |λ|<1, comes:

$$y_{i0} = \frac{1}{1-\lambda} f_i'\gamma + \frac{1}{1-\lambda} u_i + \sum_{s=0}^{\infty} \lambda^s e_{i,-s} \quad (5)$$

In this research, the panel data balance, and given this condition, the log-likelihood function is based on equation (1) and equation (2), for all periods $t \geq 1$ and for the initial observations $t = 0$.

The assumption of random effects does not consider any correlation between a specific unobserved unit effect, whereas exogenous regressors are prohibitive, according to Kripfganz (2016). So, it is necessary to remove the precise error to handle this condition, then the equation is present as:

$$\Delta y_{it} = \lambda \Delta y_{i,t-1} + \Delta x_{it}'\beta + \Delta e_{it} \quad (6)$$

This transformation removes the regressors f_i' regressors from the model, and the error term shows a first-order negative serial dependency.

The maximum likelihood estimate of equation (4) depends on the initial observation, while the (y_{it}), is similar to the GLS estimate. Due to the correlation between the initial observances (y_{it}), and the transformed error (e_{it}), this approach is unreliable whether the time horizon fix. Due to the situation, a feasible representation for the initial observations of the transformed model proposes as follows:

$$\Delta y_{i1} = b + \sum_{s=1}^{T*} \Delta x_{is}'\pi_s + v_{i1} \quad (7)$$

From the random effects, the same concept can be applied to restricted initial observations, as demonstrated:

$$\Delta y_{i1} = \lambda^m \Delta y_{i,1-m} + \sum_{s=0}^{m-1} \lambda^s \Delta x_{i,1-s}'\beta + \sum_{s=0}^{m-1} \lambda^s e_{i,1-s} \quad (8)$$

According to Kripfganz (2016), in balanced panel data with an interactive procedure, Log-likelihood maximizes, and usable initial values collect from consistent initial estimates.

The method choice justifies by the presence of endogeneity in the independent variables and the possibility of correlation between them. The data are suitable for the GMM as the chosen variables are exogenous, and the expectation is to have a causal effect on the dependent variable. Furthermore, the models overcome the Arellano & Bond estimations' shortcomings, bearing more flexibility to the panel estimation to offer more robustness to the models.

4. Results

The chapter four objective present the results of processed estimates according to the methods exposed in chapter three. The chapter organizes into three parts: the first one offers a general view of the descriptive variables; the second one provides an analysis from the perspective of the estimates by Kripfganz et al. (2022) and Kripfganz & Schwarz (2019) based on the interpretation of the results obtained from Difference-GMM and System-GMM methods; and the last discusses the research results with other results obtained in the current literature.

4.1 Determinants of investment in infrastructure in the European Union

The panel construction conceives from the variables set presented and their respective preliminary results following. The result below considers the contraction of the panel in its entirety of time, that is, between the periods of 1997 and 2020.

Table 5 - Summary Statistics of Panel Data

Variable	Mean	Std. Dev.	Min	Max	Obs
N112G	7.038942	2.401278	2.7	18	624
DEBgov	57.78731	35.13287	3.765	211.215	624
GFCFtot	23.15081	4.671329	9.727	54.698	624
GFCFgov	3.750914	1.0805	1.51	7.69	624
GFCFbsn	13.56066	3.965417	4.52	49.57	624
LSEind	5695.168	9498.757	36.68	63746.2	624
FDIind	0.5393359	0.2035577	0.1036279	0.9017801	624
DCPbsn	79.58649	43.28401	0.1861699	255.3103	624
IEFind	67.38348	6.861753	45.7	82.6	624
RATind	6.442308	5.409391	1	18	624

It is important to emphasize that all variables have a coefficient of variation greater than 1% with a non-standard result for the LSEind variable. Thus, the relative variability of the data is relatively high concerning the mean.

4.2 Analysis the Bias-corrected estimation of linear dynamic panel data models

The results using the method of moments estimator following Kripfganz & Breitung (2022), according to Table 3, show different statistically significant impacts of the various determinants of Gross Fixed Capital Formation - N112G. Other buildings and structures in the 1997-2006 and 2007-2014, before the global crisis, after the global crisis, during the sovereign crisis 2007-2014, and after the sovereign crisis 2015-2020.

In this way, we gathered the outputs of the models and grouped them into two fronts, namely, fixed and random effects. For both models, we split the time series into three periods: 1997-2006, 2007-2014, and 2015-2020.

For the dependent variable, L1.N112G, it is statistically significant at 1% for the fixed effects model in the pre-and post-seizure periods and statistically significant at 5% for the crisis period. Regarding the random effects model, the three outputs are statistically significant at 1%.

The results indicate that the effects of the advance of capital allocated to infrastructure projects show chaining effects within the sector itself. In other words, the impact of economic investment causes economic growth and follows a greater demand from economic agents for new infrastructure units. The new force demand can occur due to some factors as the creation of new workstations, increased productivity in existing infrastructures, and the attraction of new economic agents to a given region.

Table 6 - Panel Regression Analysis – Bias-corrected fixed-effects estimator

Variable	**1997-2006**	**2007-2014**	**2015-2020**
L1.N112G	0.5298***	0.2381**	0.3227***
	(0.0498)	(0.1104)	(0.0859)
DEBgov	- 0.00134	- 0.00505	- 0.01909***
	(0.0055)	(0.0061)	(0.0062)
GFCFtot	0.01027***	0.01021	0.038983
	(0.0395)	(0.00561)	(0.0369)
GFCFgov	0.35644***	0.57644***	0.62256***
	(0.0956)	(0.1490)	(0.1608)
GFCFbsn	0.08781***	0.38306***	- 0.02408
	(0.0983)	(0.1011)	(0.0414)
LSEind	2.01 e-07	8.10 e-06	0.00004
	(9.18e-06)	(0.00001)	(0.00003)
FDIind	0.281502	-1.774972	-5.02395***
	(0.6174)	(1.242)	(1.9187)
DCPbsn	-0.002191	0.013985**	0.0003144
	(0.0023)	(0.0079)	(0.0023)
IEFind	0.006171	- 0.002181	0.029088
	(0.0220)	(0.0257)	(0.0310)
RATind	0.012672	0.004479	0.021101
	(0.0155)	(0.0084)	(0.0194)
Constant	- 1.95319	- 0.481848	0.062077
	(1.454)	(2.443)	(2.1734)
Hausman Test	24.225***	26.174***	35.294***

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

We note a clear deceleration pattern of the coefficients in periods of crisis, which indicates possible budget restrictions, project stoppages, restrictions on financing the sector, demand reduction, and directing capital to other activities.

Regarding the independent variable DEBgov, for the fixed effects model, it is only statistically significant for the post-crisis period at a level of 1%. For the random effects model, it is at 1% for the pre- and post-crisis periods and 5% for the crisis period. Thus, we cannot reject the hypothesis as null for both models.

It calls attention to the negative coefficients for all results. In other words, there is an acceleration of them in periods of crisis and no recovery after this time gap. We can say that, within this model, the level of indebtedness of the states negatively influences the capacity to generate new infrastructure projects. This can happen to the redirection of expenses to other sectors, the fiscal and political risk for the implementation of the project with high costs and long-term returns, and the low ability to predict the macroeconomic scenario.

Worth noting is that, after the end of the crisis, the index does not return to pre-crisis levels. This phenomenon may indicate a possible withdrawal of the state's role as a promoter of infrastructure expansion policies. In this sense, analyzing the importance of state investment in the sector is an issue we will shortly discuss in the variable that represents this presence.

For the GFCFtot variable, it was possible to observe in the fixed effects model that only the pre-crisis period was statistically significant at 1%, and the hypotheses are null for the other time gaps. Also, for the random effects model, the hypotheses is accepted for all periods, being statistically significant at 1% for pre- and post-crisis periods and 5% between 2007 and 2014.

We stress that the coefficients are positive, with more robust outputs for the random model, where a deceleration of almost half of the coefficient in the post-crisis period. Then, it was expecting the occurrence of this positive correlation because this variable represents the totality of the fractionated in the dependent variable. The increase in the gross formation of physical capital is correlated with the growth in demand for new infrastructure projects since the increase in physical capital is a generator of new jobs, increased income, and, consequently, increased demand.

However, the most significant sign of this model for this variable is the deceleration of the coefficient for the post-crisis period. This phenomenon may indicate a redirection of this variable, such as, for example, the purchase of machinery and equipment, investment in information technology, and promotion of R&D projects. Therefore, it is possible to infer that long-term project, such as large-scale infrastructure, may have been neglected after the crisis period by a search for optimal allocation and, consequently, a higher return on invested capital.

The variable, GFCFgov, is statistically significant at 1% for all periods, both for the fixed and random effects model. Thus, it is not possible to reject the hypothesis as null. We draw attention to a positive coefficient for all-time series with hardy advances in the crisis and post-crisis periods of the variable.

To this extent, it is possible to affirm, within the model, that the state has a role not only as a financier of infrastructure projects but also as a coordinator of this sector. Because it can project, offer credit with interest rates below the market, and accepts long-term payback.

Table 7 - Panel Regression Analysis – Bias-corrected random-effects estimator

Variable	1997-2006	2007-2014	2015-2020
L1.N112G	0.597039***	0.37479***	0.32606***
	(0.0371)	(0.0419)	(0.0693)
DEBgov	- 0.01059***	- 0.007198**	- 0.007491***
	(0.0018)	(0.00289)	(0.0024)
GFCFtot	0.087648***	0.080841**	0.047398**
	(0.0281)	(0.0307)	(0.0261)
GFCFgov	0.236441***	0.38686***	0.574710***
	(0.0881)	(0.0788)	(0.1046)
GFCFbsn	0.0528717	0.1085433**	- 0.048485**
	(0.0384)	(0.0484)	(0.0252)
LSEind	0.0000145	0.000010	9.78 e-07
	(3.57e-06)	(4.55e-06)	(6.53e-06)
FDIind	- 0.608588	- 2.59500***	- 0.759765
	(0.4398)	(0.5429)	(0.5388)
DCPbsn	- 0.0013225	0.000480	- 0.007097***
	(0.0014)	(0.0012)	(0.0023)
IEFind	0.0028581	- 0.07562***	- 0.006968
	(0.0089)	(0.0110)	(0.0124)
RATind	0.0065714	- 0.018626**	0.008450
	(0.0111)	(0.0079)	(0.0101)
Constant	- 0.094375	6.77285***	3.59458***
	(0.6266)	(0.9542)	(1.1747)
AR (1)	- 2.8693***	- 1.896**	- 2.1712**
AR (2)	- 2.8632***	0.5136	-0.1319
AR (3)	0.4063		

Note: We present the results of bias-corrected (BC) estimator fixed-effects using the stata command xtdpdbc, following Breitung, Kripfganz, and Hayakawa, (2021). Standard errors can be adjusted to be robust to cross-sectional dependence

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

In addition, the government plans aiming for social and economic development involve these projects' promotion. The models indicate that the state was able to promote investment in infrastructure in a period of uncertainty in the macroeconomic scenario and accelerate them. As this is a sector that has an intrinsic characteristic delay in completing project execution deadlines, it seems appropriate to be promoted by an agent that also has long-term goals.

Next, the independent variable, GFCFbsn, is statistically significant at 1% for the fixed effects model, only for the crisis periods and before the crisis, with positive coefficients. And at 5% for the random effects model in the crisis periods and post-crisis, respectively, with positive and negative coefficients. Thus, we cannot reject the null hypothesis.

At first, with the positive coefficient in the crisis period, we can infer that the private agent replaced the state as the protagonist in infrastructure investment, as there was a considerable acceleration of the coefficient between these two periods. However, the coefficient assumes negative values in the post-crisis period, which may indicate a preference for short-term investments and rejects the hypothesis that the private sector has replaced or complemented the public in fostering new frontiers of fixed asset accumulation in the infrastructure sector.

The risk associated with long-term projects can explain this slowdown, depending on the inability of agents to finance long-term projects after the crisis, the deterioration of companies' financial conditions, and the directing of capital to assets that remunerate investors in the short term.

The model indicates that the private agent lost the ability to invest in long-term projects in the sector and that the state filled the gap left by companies and consistently promoted the infrastructure area. From this result, we can infer that there is no possibility of overcoming the contemporary challenges in the area just by offering a political-economic scenario favorable to business.

The market variables could not offer robust and consistent outputs in the models for all selected indices. The LSEind is not statistically significant for the model. However, FDIind is statistically significant at 1% for the post-crisis period in fixed and crisis effects for the random model with strong negative coefficients. Thus, we cannot reject the hypotheses. On this basis, it is possible to affirm that the conditions of the local financial environment acted negatively on the expansion of infrastructure. There are hypotheses to consider in this sense, such as the possible restriction of resources for the projects, a significant increase in the cost of capital for risky activities after the financial crisis of the last decade, deterioration of the sector's institutionality, as well as the direction of resources for activities with a short-term payback.

The DCPbsn variable has signs similar to the previous one, which is statistically significant at 1%, for the random model and 5% for the fixed model, with coefficients respectively negative for the post-crisis period and slightly positive during the crisis. And we cannot reject the hypotheses.

Thus, it is possible to attribute that in the model with greater assertiveness, in this case, the one with random effects, the ability to provide credit to the private sector in the domestic sphere offered negative returns to the dependent variable. There are possible hypotheses to be considered, such as the deterioration of companies' scores after the crisis, aversion to high-risk projects, and the inability of banking institutions to provide capital after the turbulence generated in the post-crisis macroeconomic scenario. Also, it can indicate that the ability to offer credit to the private sector does not seem to be a vector for promoting infrastructure projects in the EU.

The RATind variable was not statistically significant for the fixed effects model. Yet, it presented a negative coefficient for the random effects model with a significance of 5% in the crisis period. These results align with the consistent drop in the sovereign rating of the European bloc countries

in a given period, which had damaging chain effects for local companies and an increase in the premium on bond risk. The decrease in the bloc rating negatively affected the progress of the infrastructure sector due to the externalities caused by the volatility of the index, an increase in the interest rate for raising funds, and a decrease in the confidence of economic agents for long-term projects.

Finally, regarding the institutional variable's bloc, the IEFind, had outputs irrelevant for the fixed effects model and only statistically significant at 1% for the crisis period in the random effects model with a negative coefficient. Thus, it is possible to establish within the model and only in the period that the deterioration of institutionality may have been a negative vector for the development of the infrastructure sector. Nonetheless, at the global level, the bloc's institutional framework does not seem relevant for the economic agent's decision-making to invest in the infrastructure sector.

4.3 Trends and Perspectives from the Analysis of Estimation Results in Difference-GMM and System-GMM

The results analysis focuses on the outputs obtained by the One-Step Difference-GMM and One-Step System-GMM tests from Kripfganz. To add support and robustness to the model, commands, and corrections are applied to evaluate conditions of strictly exogenous variables. Also, to correct errors, we consider the application of the (**) command to adjust the model.

Table 8 - Panel Regression Analysis - Difference-GMM

Variable	1997-2006	2007-2014	2015-2020
L.N112G	0.763***	0.542***	0.788***
	(0.0319)	(0.0406)	(0.0499)
DEBgov	-0.00728***	0.00142	0.000181
	(0.00218)	(0.00247)	(0.00168)
GFCFtot	0.0615***	0.0657**	0.0408
	(0.0204)	(0.0297)	(0.0309)
GFCFgov	0.171***	0.449***	0.284***
	(0.0524)	(0.0960)	(0.0690)
GFCFbsn	0.0159	0.112***	-0.0275
	(0.0254)	(0.0379)	(0.0302)
FDIind	-0.818***	-1.431***	-0.0813
	(0.304)	(0.483)	(0.426)
DCPbsn	0.000812	-0.000262	-0.00250
	(0.00154)	(0.00164)	(0.00208)
Constant	0.185	-0.773	0.0337
	(0.431)	(0.684)	(0.552)
Observations	234	182	130
Number of country	26	26	26

Note: Standard errors in parentheses

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

Next, the analysis design includes the interpretation construction of each variable by observing the three periods in the two systems.

For the Difference System, the dependent variable L.N112G is statistically significant at 1% in all three periods, the lag is negative, and it is impossible to reject the hypothesis. The coefficient is positive, suggesting that the dependent variable itself in the previous period positively affects investment in infrastructure. This scenario indicates that the investment has a cumulative effect, which means the greater the investment previously, the more significant the investment in the following year. In addition, productivity gains generate long-term effects and suggest that a favorable environment for new infrastructure projects stems from the activity and economic growth generated by it.

It is important to emphasize that this coefficient reduced significantly during the crisis period, returning to the pre-crisis level from 2015 onwards. So, we can infer that the global financial crisis following the Eurozone crisis impaired the ability to generate new projects. The hypothesis is that the fiscal adjustments and the recession in a given period provided an environment of uncertainty for the productive sector, so the investments in infrastructure that lack an extensive capital contribution and long-term payback were not attractive for the private sector and state.

For the System-GMM, the dependent variable L.N112G is statistically significant at 1% in all three periods, the lag is negative, and it is impossible to reject the hypothesis. The behavior is similar to the other variable in the previous system, where there is a decrease in the effects of the prior period during the crisis. It is relevant to mention that when considering the observation of the variable in two previous periods, the lag of the period before the seizure is negative, thus suggesting that investment in infrastructure before 1997 negatively influenced investment in the sector in the same period. Budget constraints in the period before the crisis may be consequences of excessive capital expenditure in the previous period, as the lack of coordination between the different private and stated actors to leverage the projects.

The DEBgov hypothesis for the Difference-System is only statistically significant at 1% for the period before the crisis and has a negative coefficient. The results suggest a negative relationship between total government debt and infrastructure investment in the EU, where an increase in government debt is associated with a decrease in infrastructure investment capacity. The current literature points out that the increases in debt can lead to a lowering in the state's capabilities to invest in infrastructure since may occur a redirection of the state budget to other sectors.

To infer causality on this topic requires understanding the state structure budget. It turns out that the current state expenditures as civil service salaries, payment of interest on the debt, and funding for the maintenance of public education and health structures, are placed on a preferential basis. So, investments in infrastructure are targets of fiscal adjustment policies.

In addition to the results acquired, an increase in investment in infrastructure may reduce the state's indebtedness by increasing productivity gains, which consequently adds the product to a given economy and generates an increase in revenue. That said, the importance of further studies on the interactions between the variables of debt and investment in infrastructure is noticeable.

For the model evaluated by System-GMM, the hypothesis is statistically significant at 5%, also only for the pre-crisis period, with similar insufficient effects in which we can proceed with the same interpretation of the previous model.

Table 9 - Panel Regression Analysis - System-GMM

Variable	1997-2006	2007-2014	2015-2020
L.N112G	0.921***	0.480***	0.888***
	(0.0694)	(0.0664)	(0.0728)
L2.N112G	-0.154**	0.0272	0.0490
	(0.0631)	(0.0556)	(0.0718)
DEBgov	-0.00659***	0.000841	0.000283
	(0.00230)	(0.00267)	(0.00147)
GFCFtot	0.0480**	0.0447	0.0261
	(0.0212)	(0.0373)	(0.0250)
GFCFgov	0.202***	0.468***	0.151**
	(0.0550)	(0.113)	(0.0596)
GFCFbsn	0.0358	0.0938**	-0.0203
	(0.0269)	(0.0444)	(0.0246)
FDIind	-0.599*	-1.619***	0.0774
	(0.318)	(0.512)	(0.399)
DCPbsn	0.00108	-0.00133	-0.00349*
	(0.00161)	(0.00175)	(0.00197)
Constant	-0.114	0.263	-0.0806
	(0.458)	(0.833)	(0.500)
Observations	208	156	104
Number of country	26	26	26

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

Next, for the Difference System, we have the GCFTot hypothesis. This variable is statistically significant at 1% for the period before-crisis, 5% for the period between crises, and insignificant for the post-crisis.

The model indicates that resource allocation in gross physical capital formation positively influences the progress of infrastructure projects similarly in the first two periods. It occurs because due allowance of capital in physical stock positively influences the generation of new frontiers for the accumulation of fixed assets in the EU. Another hypothesis is favorable availability of physical capital implies the possibility of the supply of a more significant resource for investment in infrastructure.

Furthermore, the increase in gross physical capital formation generates an increase in demand for new infrastructure as economic agents demand new distribution channels for goods and capital. In addition, the infrastructure channel improvement constitutes a positive vector of increased productivity. The advancement of these channels can reduce the cost of transport, for instance, and the capital previously allocated for this cost becomes a possible probability of investment in the production chain.

Another issue is that the increase in gross physical capital formation can leverage new infrastructure projects to the point where, with product growth, interest rates can take an implicit downward trend, and the cost of raising capital decreases, thus making investment in infrastructure more attractive.

For the models evaluated by System-GMM, the hypothesis is statistically significant at 5% only for the period before the crisis, with a positive result similar to the previous model, with inferences and interpretations explained above.

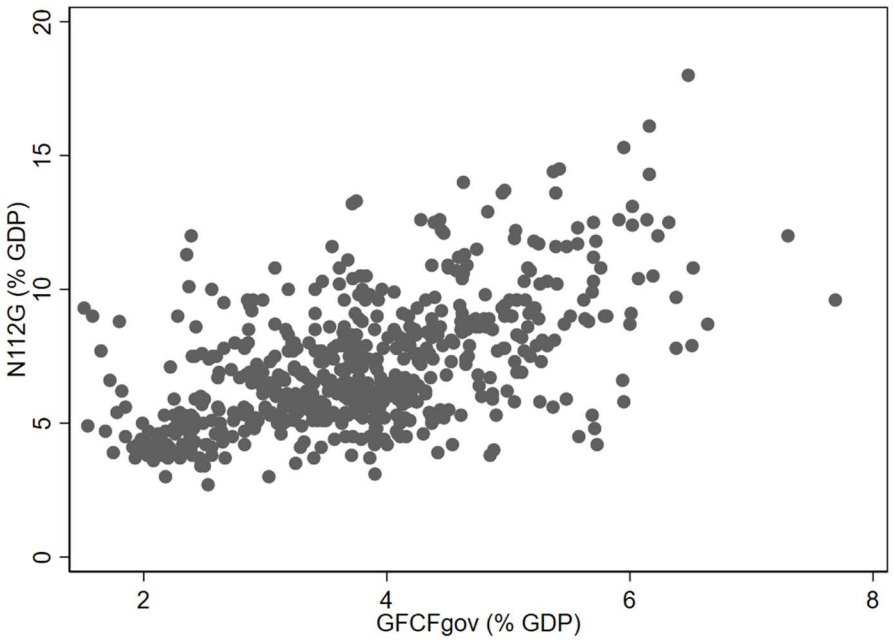

Figure 1. Relationship between "Gross Fixed Capital Formation - N112G Other buildings and structures (% GDP)" and "Gross Fixed Capital Formation, Total – Government (%GDP)" from 1997 to 2020. Source: Eurostat

Next, the variable with the highest degree of GFCFgov model robustness, which is statistically significant at 1% for all periods in both tests. Except for the post-crisis period in System-GMM, with positive coefficients for all the phases.

In both tests, verify the same tendency of the coefficient accelerates in periods of crisis and slows down in the aftermath. The hypothesis is that the poorly dimension state's investment capacity in the face of the fiscal adjustments that the region states promoted.

Yet, it is possible to state that direct investment by the state in fixed assets has positive effects on infrastructure projects. The capability to afford new urban and rural infrastructure is intrinsic to the state's ability to provide the capital for the project and turn itself into an almost inseparable promoter of the advancement of these assets.

The state investment in infrastructure in the previous period engendered chaining effects in the economy, increasing productivity and generating new opportunities for the sector. In this way, the prior period investments in infrastructure offer long-term effects and create another pattern of institutionalism that private investors do not have the capacity for.

Therefore, the state policies that promote the allocation of capital in infrastructure projects have the capacity not only to leverage investment in the sector but also constitute a hardy vector for generating an increase in the product in a given economy.

Next, the GFCFbsn hypothesis that it is only significant in the crisis period for both models. For, Difference-GMM is statistically significant at 1% and 5% for the other model, and both have a positive coefficient. The results lead us to assume that in this specific period, the gross formation of physical capital on the side of private agents became a positive vector for new infrastructure units increment. This phenomenon may occur due to the state's reduced role in contracting new infrastructure projects in a given period since the state's capital had momentary limitations in allocating resources in the sector.

The FDIind hypothesis provides statistically significant data at 1% in the Difference-GMM only in the periods before and between seizures. Both coefficients are negative with a hardy advance in the inter-crisis period. The crisis period reflects strongly on new infrastructure frontiers advancement in regions with a developed capital market, as is the case of the EU. With the advance of financialization and its repercussions in the real economy, from the 1980s onwards, crises related to inconsistencies in the financial market, such as the one in 2008, hampered fundraising and the consequent advancement of the sector.

Thus, since the financial crisis of the 2000s and early 2010s heavily impacted the European bloc, the local capital market level of maturation negatively influenced investment in new infrastructure. In crisis periods, investors usually allocate their resources to short-term income assets, making the sector unfeasible. Besides, there is a significant reduction in long-term credit for projects, an increase in the cost of financing, and a reduction in demand as an inherent reflection of the recession.

For the System-GMM, the hypothesis was statistically significant at 10% and 1% for the periods before and between seizures, respectively. For the post-crisis period, is reject the thesis. In this modeling, the results have negative coefficients and interaction patterns similar to the previous system, which makes the same analysis valid.

Finally, we have the DCPbsn hypothesis, which was statistically significant only in the post-crisis period for the System-GMM, exhibiting a negative coefficient. So, we can infer that the credit availability to the private sector in the EU did not leverage new infrastructure projects. After crisis periods, some trends for the private credit sector may emerge, such as temporary credit restrictions for incoming projects due to the uncertainty of the economic scenario, low score of agents that raise credit after the effects of the crisis, as well as uncertainties of regulatory nature.

To conclude, this last point requires a more careful reflection, bearing in mind that, after a period of crisis, states tend to promote more effective regulation of the financial sector, and the uncertainty leads to a contraction of activities and the availability of credit for long-term projects.

4.4 Exploring Research Insights: Comparative Analysis and Contrast with Current Literature

Concerning the dependent variable results, L.N112G, as mentioned above, the effect of this variable over time is positively cumulative. This result is consistent with some fragments of the current literature arguing that the infrastructure motivation entails a set of negative consequences and makes new projects in the sector unfeasible. When there is no investment in this sector's assets, economic agents perceive that risk outweighs profit-making opportunities over time. Otherwise, when there is an investment, the chaining effects, as we demonstrate in this research, are consistent with the results obtained, considering that the capital contribution in the area indicates at a value that there is a possibility of estimating future profits in infrastructure projects (Fraga & Resende, 2022).

The state indebtedness index, DEBgov, proved to be statistically viable only for the end of the crisis period. The main period feature is the state's efforts to mitigate the crisis consequences by correcting inconsistencies in the financial sector to the detriment of resource allocations to productive activities. In this instance, we emphasize the incapability of the private sector to replace the public sector. Although there is a consensus that from the 1980s onwards, the attempt to dismiss the state in obligations such as investment seems to be gradually constant throughout the economy, mostly from strategies such as public-private partnerships (Opara & House, 2019).

For GCFTot, the model brought noteworthy results and aggregate value to current research. The panel brings us data indicating positive externalities for the sector when is a more extensive investment in the area. The advance in gross fixed capital formation positively impacts investment in infrastructure, as there are chaining effects of economic growth, and greater expectations of profit in the sector, which attracts more funding and the creation of new projects (Greene & Villanueva, 1991).

The sample result and the modification between GFCFgov and investment in infrastructure were positive and added value to previous research. Among the most relevant variables to explain the progress in infrastructure projects it figures the government's gross fixed capital formation. The results indicate that the determination of investment in infrastructure is an action coordinated by

the state. Even with the advance of liberal policies after 1980, private capital cannot overcome state investments.

Regarding financing, we focused on the origin and the investor's characteristics and desires. As a rule, investors seek the optimal return on their stock of capital in the shortest possible time. Such demand makes raising funds from private agents for long-term projects challenging. In addition, public investment has shown over time as something that accelerates productivity factors and creates new frontiers for economic development (Aschauer, 1989).

The variables aiming to understand the importance of the private sector in promoting infrastructure projects seem to have low relevance. The GFCFbsn variable had positive effects only in periods of crisis, suggesting that, at a given moment, it replaced or complemented a public capital gap in the sector. However, according to the current literature, private investment only has significant amounts in developing countries, operating in search of infrastructure maintenance to the detriment of working new frontiers of fixed asset authority. In brief, private investment is risk averse inherent in the sector.

Although there are theoretical currents that aim to prove the hypothesis of replacing the state or complementing it by raising funds, the model of this research indicates that the private sector variable, such as FDIind, and DCPbsn, unable to leverage the sector. Therefore, the study diverges from the positions that say that private investment appears as an alternative to the lack of public stock. (Page et al., 2008), and unlike the current literature, the macroeconomic effects of both sources, public and private, are not similar. (Quiggin, 1996).

This research aimed to evaluate the importance of institutional variables for the sector. However, institutional variables were not significant. Although the political risk is relevant in the economic agent's decision-making, the model could not capture it due to the insignificance of the variable within the panel. Thus, contrary to the literature, the state is not capable of promoting investment in the sector according to our model (Chowdhury et al., 2009).

5. Conclusion

This research objective was to analyze the importance of macroeconomic, institutional, and capital market drivers concerning the promotion and advancement of infrastructure projects in the European Union, except for Malta, which determines investment in the sector.

To understand the importance of this set of variables for the development of the sector, we collected data that resulted in a final sample of three panels (1997-2006, 2007-2014, and 2015), a dependent variable (Gross Fixed Capital Formation - N112G Other buildings and structures) and nine dependent variables, divided into three blocs macroeconomic, capital market, and institutional. They are Total Central Government Debt, Total Gross Fixed Capital Formation, Total Gross Fixed Capital Formation – Government, Total Gross Fixed Capital Formation – Business, Rating Index, Local Stock Exchange Composite Index, Financial Development Index, Domestic Credit to Private Sector, and Index of Economic Freedom with a total of 6864 observations.

The methodology applied includes the Quasi-Maximum Likelihood (QML) with a subsequent comparison with the classic GMM model. In this sense, the research achieves the following results.

The institutional variable proved to be of little relevance in all the analyzed periods, and it was not possible to determine that, for example, the European bloc set of rules and laws is relevant for incrementing new physical units in the infrastructure sector.

Regarding the capital market, the first expectation was that the study would align with the most recent research highlighting the role of the private sector in developing local infrastructure. However, the private capital role did not prove to be robust throughout the three panels, and in the crisis period of the last decade, it did not play a substitute or complementary agent role for the state capital. Unlike proved to be risk averse, and the private capital fixed gross capital formation shifted to activities with less risk, such as investment in machinery in general.

However, the most relevant research result was the positive correlation of state investment as a promoter of new frontiers regarding the bloc's infrastructure expansion. Draws the attention that even in the crisis period, state capital promoted the sector's progress and could consolidate its role as a guarantor of investment in long-term projects. Thus, it is possible to state that, for this model, the set of macroeconomic variables overlaps the others, emphasizing the state's gross fixed capital formation.

Finally, this research contributes to a deeper understanding of the infrastructure drivers in the European bloc by gathering a set of information about the infrastructure sector and revealing the importance of directing public capital to an area that can generate substantial chaining effects in a given region based on boosting economic growth, improving social indices and consequently strengthening the competitiveness of the bloc's countries.

References

Andrés, L. A., Guasch, J. L., Haven, T., & Foster, V. (2008). The Impact of Private Sector Participation in Infrastructure: Lights, Shadows, and the Road Ahead. Washington, DC: World Bank. Retrieved from http://hdl.handle.net/10986/6545

Aschauer, D. A. (1989). Is public expenditure productive? Journal of Monetary Economics, 23(2), 177-200. https://doi.org/10.1016/0304-3932(89)90047-0

Barber, B. M., & Odean, T. (2013). Chapter 22 - The Behavior of Individual Investors. In G. M. Constantinides, M. Harris, & R. M. Stulz (Eds.), Handbook of the Economics of Finance (Vol. 2, Part B, pp. 1533-1570). Elsevier. https://doi.org/10.1016/B978-0-44-459406-8.00022-6

Bhargava, A., & Sargan, J. D. (1983). Estimating Dynamic Random Effects Models from Panel Data Covering Short Time Periods. Econometrica, 51(6), 1635–1659. https://doi.org/10.2307/1912110

Bogart, D. (2020). Infrastructure and institutions: Lessons from history. Regional Science and Urban Economics, 103626. https://doi.org/10.1016/j.regsciurbeco.2020.103626

Boyer, R. (2000). Is a finance-led growth regime a viable alternative to Fordism? A preliminary analysis. Review of International Political Economy, 7(1), 61-92. https://doi.org/10.1080/096922900111015

Breitung, J., Kripfganz, S., & Hayakawa, K. (2022). Bias-corrected method of moments estimators for dynamic panel data models. Econometrics and Statistics, 24, 116-132. https://doi.org/10.1016/j.ecosta.2021.07.001

Chowdhury, A., Orr, R., & Settel, D. (2009). Multilaterals and Infrastructure Funds: A New Era. The Journal of Structured Finance, 14, 68-74. doi:10.3905/JSF.2009.14.4.068

Coate, S., & Morris, S. (1995). On the form of transfers in special interests. Journal of Political Economy, 103(6), 1210-1235. https://doi.org/10.1086/601468

Crescenzi, R., & Rodríguez-Pose, A. (2012). Infrastructure and regional growth in the European Union. Papers in Regional Science, 91(3), 487-615. doi: 10.1111/j.1435-5957.2012.00439.x

Demirel, H. C., Leendertse, W., & Volker, L. (2021). Mechanisms for protecting returns on private investments in public infrastructure projects. International Journal of Project Management, Advance online publication. https://doi.org/10.1016/j.ijproman.202

Donaldson, D. (2018). Railroads of the Raj: Estimating the impact of transportation infrastructure. American Economic Review, 108(4-5), 899-934. https://doi.org/10.1257/aer.20101199

Eurostat. (2022). Gross domestic product at market prices by main expenditure aggregates [Data file]. Retrieved from https://ec.europa.eu/eurostat/databrowser/view/NAMA_10_AN6__custom_5102851/default/table?lang=en

Fleta-Asín, J., & Muñoz, F. (2023). When bigger is better: Investment volume drivers in infrastructure public-private partnership projects. Socio-Economic Planning Sciences, 86, 101473. https://doi.org/10.1016/j.seps.2022.101473

Fraga, J. S., & Resende, M. F. (2022). Infrastructure, conventions and private investment: An empirical investigation. Structural Change and Economic Dynamics, 61, 351-361. https://doi.org/10.1016/j.strueco.2022.03.006

Gamble, A. (2019). Why is neo-liberalism so resilient? Critical Sociology, 45(7-8), 983-994. https://doi.org/10.1177/0896920519832648

Gemson, J., Gautami, K. V., & Rajan, A. T. (2012). Impact of private equity investments in infrastructure projects. Utilities Policy, 21, 59-65. https://doi.org/10.1016/j.jup.2011.12.001

von Grafenstein, L., & Gao, H. O. (2021). Infrastructure policy and public health: Evidence from OECD countries. Science of the Total Environment, 750, 141157. https://doi.org/10.1016/j.scitotenv.2020.141157

Global Infrastructure Hub. (2020). Global infrastructure outlook. https://outlook.gihub.org/

Greene, J., & Villanueva, D. (1991). Private Investment in Developing Countries: An Empirical Analysis. Staff Papers (International Monetary Fund), 38(1), 33–58. https://doi.org/10.2307/3867034

Grimsey, D., & Lewis, M. (2002). Evaluating the risks of public–private partnerships for infrastructure projects. International Journal of Project Management, 20(2), 107–118. https://doi.org/10.1016/s0263-7863(00)00040-5

Hodge, G., Greve, C., & Boardman, A. (2017). Public-private partnerships: The way they were and what they can become. Australian Journal of Public Administration, 76(3), 273-282. doi:10.1111/1467-8500.12260

Hoff, K., & Stiglitz, J. E. (2005). The creation of the rule of law and the legitimacy of property rights: The political and economic consequences of a corrupt privatization (English) (Policy,

Research Working Paper No. WPS 3779). Washington, D.C.: World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/107361468339867931/The-creation-of-the-rule-of-law-and-the-legitimacy-of-property-rights-the-political-and-economic-consequences-of-a-corrupt-privatization

Hueskes, M., Verhoest, K., & Block, T. (2017). Governing public–private partnerships for sustainability: An analysis of procurement and governance practices of PPP infrastructure projects. International Journal of Project Management, 35(6), 1184-1195. https://doi.org/10.1016/j.ijproman.2017.02.020

International Monetary Fund. (2022). International Financial Statistics. Retrieved from https://data.imf.org/?sk=F8032E80-B36C-43B1-AC26-493C5B1CD33B&sId=1480712464593&ref=mondato-insight

Kripfganz, Sebastian. (2016). Quasi–maximum Likelihood Estimation of Linear Dynamic Short-T panel-data Models. The Stata Journal: Promoting communications on statistics and Stata. 16. 1013-1038. https://doi.org/10.1177/1536867X1601600411

Kripfganz, S., & Schwarz, C. (2019). Estimation of linear dynamic panel data models with time-invariant regressors. Journal of Applied Econometrics, 34, 526-546. https://doi.org/10.1002/jae.2681

Kripfganz, S., & Breitung, J. (2022). Bias-corrected estimation of linear dynamic panel data models. Paper presented at the London Stata Conference 2022, Stata Users Group. Retrieved from https://ideas.repec.org/p/boc/lsug22/05.html

Kumari, A., & Sharma, A. K. (2017). Infrastructure financing and development: A bibliometric review. International Journal of Critical Infrastructure Protection, 16, 49-65. https://doi.org/10.1016/j.ijcip.2016.12.002

Levine, R., & Zervos, S. (1998). Stock Markets, Banks, and Economic Growth. The American Economic Review, 88(3), 537–558. http://www.jstor.org/stable/116848

Li, S., Cai, J., & Cai, H. (2019). Infrastructure privatization analysis: A public-private duopoly game. Transport Policy, 83, 80-87. https://doi.org/10.1016/j.tranpol.2018.11.006

Matsukawa, T., & Habeck, O. (2007). Review of Risk Mitigation Instruments for Infrastructure: Financing and Recent Trends and Developments. World Bank Publications. https://openknowledge.worldbank.org/handle/10986/11521?locale-attribute=en

Mor, N., & Sehrawat, S. (2006). Sources of Infrastructure Finance. Working Paper, Centre for

Development Finance, Institute for Financial Management and Research. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2597915

Nijkamp, P., & Rienstra, S. (1995). Private sector involvement in financing and operating transport infrastructure. The Annals of Regional Science, 29(2), 221-235. https://doi.org/10.1007/BF01581808

Opara, M., & Rouse, P. (2019). The perceived efficacy of public-private partnerships: A study from Canada. Critical Perspectives on Accounting, 58, 77-99. https://doi.org/10.1016/j.cpa.2018.04.004

Page, S. N., Fetterman, R., Ankner, W., & Jones, C. (2008). The Risks and Rewards of Private Equity in Infrastructure. Public Works Management & Policy, 13(2), 100-113. doi:10.1177/1087724X08326311

Percoco, M. (2014). Quality of institutions and private participation in transport infrastructure investment: Evidence from developing countries. Transportation Research Part A: Policy and Practice, 70, 50-58. https://doi.org/10.1016/j.tra.2014.10.004

Quiggin, J. (1996). Private sector involvement in infrastructure projects. Australian Economic Review, 29(1), 51-64. doi:10.1111/j.1467-8462.1996.tb00915.x

Ra, S., & Li, Z. (2018). Closing the financing gap in Asian infrastructure. Asian Development Bank. https://doi.org/10.22617/WPS189402-2

Rajan, R. G., & Zingales, L. (1998). Financial dependence and growth. National Bureau of Economic Research. Working Paper No. 5758. https://doi.org/10.3386/w5758

S&P Global. (n.d.). ESG & Sustainable Finance Disclosure Dataset. Retrieved from https://disclosure.spglobal.com/sri/

Sader, F. (2000). Attracting Foreign Direct Investment into Infrastructure: Why is it so Difficult? World Bank Publications. https://elibrary.worldbank.org/doi/abs/10.1596/0-8213-4602-4

Sylla, R. (2002). A historical primer on the business of credit ratings. In R. M. Levich, G. Majnoni, & C. W. Wihlborg (Eds.), The future of the financial system (pp. 75–98). Springer. https://doi.org/10.1007/978-1-4615-0999-8_2

The Heritage Foundation. (n.d.). About The Heritage Foundation. Retrieved from https://www.heritage.org/index/about

Thobani, M. (1999). Private infrastructure, public risk. Finance and Development, 36(1), 50–53. https://openknowledge.worldbank.org/handle/10986/11521?locale-attribute=en

Wooldridge, J. M. (2002). Econometric Analysis of Cross Section and Panel Data. MIT Press.

World Bank. (2022). Domestic credit to private sector (% of GDP). Retrieved from https://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS?end=2020&start=1990

World Economic Outlook Database [2022]. Retrieved from https://www.imf.org/en/Publications/WEO/weo-database/2022/October

Zhang, S., Chan, A., Feng, Y., Duan, H., & Ke, Y. (2016). Critical review on PPP research – A search from Chinese and international journals. International Journal of Project Management, 34(4), 597-612. https://doi.org/10.1016/j.ijproman.2015.11.004