Factors Leading to Public-Private Partnerships and Their Effect on Infrastructure Development: An Empirical Study from Developing Countries

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Abstract

This paper examines the determinants of Public-Private Partnerships (PPPs) in infrastructure development, focusing on the role of income levels in shaping their distribution across 128 developing countries. While PPPs have become increasingly prevalent in developing economies, existing literature has inadequately addressed the role of income levels, which influence the feasibility, attractiveness, and sustainability of PPPs in emerging markets. This study employs Poisson, Negative Binomial, and Tobit regression models, leveraging the World Bank's Private Participation in Infrastructure (PPI) panel dataset from 2000 to 2022. The results reveal that regulatory quality and prior experience with PPPs significantly determine the number and value of PPP investments in developing countries. The effect of regulatory quality and fiscal deficit on the PPP investment in Low-Income countries (LICs) is more significant than that of Lower-middle-income countries (LMICs) and Upper-middle-income countries (UMICs). This paper concludes that the impact of each determinant varies depending on a country's income status, underscoring the need for policymakers in developing countries to tailor their strategies accordingly.

Keywords: *Public-private partnerships, infrastructure, developing countries, income level, count data, censored data*

JEL Classification: H54, O18, L33

Introduction

Ensuring access to essential services for a growing population necessitates significant infrastructure investment in the face of economic challenges. Access to energy, water, sanitation facilities, telecommunications, healthcare, and education is essential for the growing population. Given the increasing demands for urbanization, industrialization (Sharma, 2012), pollution, inadequate infrastructure, and income inequality, will require extensive infrastructure investments to fulfill citizens' requirements.

Global Infrastructure Outlook (2017) estimates that worldwide infrastructure requirements must reach 94 trillion dollars between 2016 and 2040. In addition, Asia is expected to continue its dominance in the global infrastructure market in the years to come, as it currently does. Furthermore, the transportation and electricity sectors are the most significant, comprising more than two-thirds of the global investment demand. However, the Sustainable Development agenda for 2030 has reiterated the need to increase infrastructure funding to accelerate revolutionary change, particularly in low-income nations (Leigland, 2018). Decision-makers recognize that the public-private partnership (PPP) strategy is a feasible solution to address the infrastructure gap. PPPs have become more significant in many developing economies over the past 20 years as a substitute for traditional infrastructure supply. The preparation, funding, construction, and management of infrastructure development under contractual agreements increasingly depend on the PPP model for governments in developing nations (Sharma, 2012), especially those in Latin America, Africa, and Asia (Kang et al., 2019).

Although public-private partnerships are increasingly widespread in emerging economies, the literature has not effectively documented income levels in the developing world (Mofokeng et al., 2024). To fulfill the aim of investigating the key factors that significantly influence the landscape of PPPs in emerging economies, this paper will examine the key factors that affect public-private partnerships (PPP) in infrastructure development across 128 developing countries from 2000 to 2022. Panel data from the Private Participation in Infrastructure database provided by the World Bank is employed in the study to evaluate the prevalence of the PPP approach in the developing world. In analyzing the data from the prior studies, this study utilizes two distinct dependent variables: PPP occurrences and the volume of PPP investment. The literature enhanced by this paper by exploring the critical factors influencing PPP in developing economies' infrastructure expansion, considering the occurrence of projects and the level of investment. Emerging economies are the paper's primary focus due to their urgent requirement for PPP arrangements, surpassing any advanced countries. In addition, regardless of the income level of the countries, the demand for infrastructure is steadily increasing alongside economic development and rising population. Consequently, this research will identify the key factors driving PPPs in infrastructure development in developing countries, stratified by income level. The paper is organized as follows: Section 2 explains previous studies on PPP overview and determinants of establishing PPP on infrastructure. Section 3 addresses the data and empirical methodology utilized for data analysis, including the research models. Section 4 discusses the empirical results and findings, considering income level. Section 5 offers a conclusion and policy suggestions and proposes possible directions for research.

Literature Review

Solid and modern infrastructure is essential for economic development and quality of life worldwide (Kumar, 2019; Kasri & Wibowo, 2015; Banerjee et al., 2006). When properly planned, funded, and maintained, infrastructure is crucial to maintaining a high standard of living and promoting trade and commerce, which increases a country's overall wealth (Zangoueinezhad & Azar, 2014). Guo et al. (2023) emphasize that inadequate infrastructure is a significant and widespread issue in many areas, particularly emerging countries.

Due to financial limitations, governments in emerging economies need more resources to meet the demand for infrastructure (Dairu & Muhammad, 2015; Sharma, 2012). In addition, efficient resource use (Yurdakul & Kamasak, 2021), access to modern technology, and improved project layout, implementation, execution, and activities enhance efficacy and efficiency, which typically need to be improved in public sector initiatives. Consequently, public-private participation serves as an approach to bypassing the financial constraints of the public sector in infrastructure financing (Yurdakul & Kamasak, 2021). There are no accepted definitions of public-private partnerships (PPPs), which are business structures that integrate the government and private parties (Yurdakul & Kamasak, 2021). However, the definition given by the World Bank is frequently utilized. It outlines public-private partnerships as "a long-term contract between a private party (the private partner) and a government entity (the contracting authority) for providing a new or existing public asset or service under which the private partner bears significant risk and management responsibility and where payments received by the private partner are linked to performance" (The World Bank, 2019, p. 06). PPP can involve different contractual forms, such as leases, concessions, or divestiture agreements. What distinguishes these PPPs is the allocation of decision-making authority and risk, which are the key characteristics that define these partnerships (Bel et al., 2013).

According to Yurdakul et al. (2022), the PPP framework benefits governmental and private organizations and the entire economy. Regarding financial flows, efficiency gains by reducing life cycle costs (Dairu & Muhammad, 2015), optimizing risk allocation, and fiscal stabilization, PPP offers developing countries several benefits and opportunities (Kasri & Wibowo, 2015; Sharma, 2012). Mofokeng et al. (2024) argue that both direct and indirect ways of infrastructure investments are connected to economic growth. The direct line promotes economic expansion through increased capital stock from infrastructure investment via the direct effect of a conventional production function. However, higher project costs (Blanc-Brude & Strange, 2007) and participation costs compared to traditional techniques for public procurement, lengthy delays in the negotiation and contract transaction phases due to complex processes (Zhang, 2005) and less experience, and the absence of structured government guidelines, policies, and legal frameworks are some limitations of the PPP approach (Ismail & Harris, 2014; Rybnicek et al., 2020; Al-Hanawi et al., 2020).

Theoretical background and empirical hypothesis

There is no specific theory directly related to PPPs. However, Leibenstein (1966) created the notion of x efficiency, the cornerstone of public-private partnership. He found that public organizations can mitigate the inefficiencies covered by governmental interventions and bureaucratic structures by adapting to market forces, thus enhancing their competitiveness. Nonetheless, this strategy acquired substantial traction early in the 1980s with the rise of the New Public Management paradigm in the United Kingdom, particularly under Margaret Thatcher's leadership (Yehoue et al., 2006). The prime aim of this innovation was to implicitly integrate the operational principles of private firms into public administrations.

Several factors can influence the presence of PPPs in a country. This section discusses some key factors that may impact the development of PPPs. From these discussions, we derive hypotheses that we aim to test empirically in this study.

Fiscal restraints

Academics emphasize that PPPs are favored over conventional procurement methods when governments face budgetary constraints and high debt levels. (Kasri & Wibowo, 2015; Hyun et al., 2018; Mofokeng et al., 2024), and a significant infrastructure gap (Sharma, 2012). According to (Yehoue et al., 2006), countries without external revenue streams (such as aid, oil royalties, or income from natural resources) have gone through severe economic crises, followed by the establishment of legislative majorities that are typically more welcoming of foreign private investment. This study arrives at the following hypothesis under fiscal constraints based on these arguments:

H1: Governments facing growing fiscal burdens that tighten hard budget constraints will demonstrate greater openness to public-private investment in infrastructure projects.

H2: Countries with significant external revenue streams typically encounter softer budget constraints, potentially reducing their need to rely extensively on PPP projects for infrastructure financing and development.

Macroeconomic stability

To attract private investment, it is essential to establish stable macroeconomic conditions (Chan et al., 2010), implement suitable tariff systems, demonstrate evidence of fulfilling commercial requirements, and enact rational economic strategies (Yehoue et al., 2006). Banerjee et al. (2006) find that a higher exchange rate reduces the competitiveness of the local economy, which harms private flows. Kumar (2019) states that lower inflation will encourage private infrastructure investment. Fast-growing economies present economies of scale decreased transportation costs, and reduced product marketing expenditures since products are predominantly marketed within the host economy (Mottaleb & Kalirajan, 2010). Hence, it is worth investigating whether private infrastructure enterprises prefer nations with dependable and stable macroeconomic environments.

H3: Many private infrastructure enterprises favor nations offering reliable and stable macroeconomic environments.

Market size

Infrastructure projects frequently require time to turn a profit and typically involve enormous upfront costs with significant financial risk. Yehoue et al. (2006) argue that market circumstances affect motivations for private firms to be involved in PPP infrastructural investments. Private investors find higher GDP per capita economies more appealing because they will have more purchasing power and a greater expectation of infrastructure demand (Banerjee et al., 2006; Kumar, 2019). Nevertheless, Mottaleb & Kalirajan (2010) note that a nation with a small domestic market can still offer foreign investors economies of scale comparable to those with larger domestic markets if it is successfully integrated and open to the world market through international commerce.

H4: High GDP levels suggest a sizable market that will probably see more PPP initiatives and investments.

Financial institutions

Private sector credit allows infrastructure project funding (Mehar, 2022). Dairu & Muhammad (2015) reveal that implementing appropriate policies to encourage prolonged credit is vital for effectively executing PPP projects in Nigeria. Chan et al. (2010) and Kaur & Malik, (2020) argue that a well-established financial sector guarantees the availability of less expensive financing, which lowers the expenses related to PPP projects.

H5: The improved access to private sector credit to participants in public-private partnerships will contribute to attracting more PPP investments to the country.

Experience with PPP projects

Due to the nature of PPP infrastructure expenditure, previous project management experience is a crucial indicator of future project success (Yehoue et al., 2006). Kang et al. (2019) highlight that effective contract management and implementations are essential to successful partnerships. Sanni and Hashim (2014) identify that insufficient ability and policy guidance, delays in negotiations, and poor performance are critical obstacles that affect the effective direction and execution of PPP initiatives in the African subcontinent.

H6: Previous project management experience in infrastructure expenditures is a crucial predictor of future project success.

Existing infrastructure

Well-established infrastructure provides a foundation and support system for new projects and reduces initial investment requirements. Reinikka and Svensson (2002) discovered that low public funds discourage profitable investments in Uganda's private sector. Banerjee et al. (2006) find that economies with a significant proportion of telephone mainline and paved roads tend to attract less private infrastructure investment. Mottaleb

and Kalirajan (2010) state that inexpensive and skilled labor, dependable electricity, energy, and infrastructure can considerably affect FDI inflows by attracting foreign investments that aim to cut costs and seek efficiency.

H7: Access to well-maintained infrastructure attracts more PPP investment.

Institutional environment

The quality of the bureaucratic system significantly influences private investment (Banerjee et al., 2006; Kumar, 2019). As demonstrated by the country's regulatory framework, PPP projects must meet a minimum institutional quality standard to maximize resource use and run smoothly (Kasri & Wibowo, 2015). Moreover, Pérez-D'Oleo et al. (2015) provide compelling evidence that developing economies should continue to improve their institutional structural standards to raise the amount of money invested in PPP projects.

H8: More PPP projects are drawn to countries with better regulatory quality.

Urbanization

According to Anwar et al. (2017), 54% of people currently reside in cities; by 2050, that number will rise to 66%. The increased interest in public facilities such as social housing, healthcare, education, and infrastructure strains governments' financial resources. Duranton (2015) argues that establishing transportation infrastructure can improve urban crowding and decrease preference in large cities.

H9: Highly populated urban areas attract more infrastructure financing in PPPs.

As a result of analyzing the literature, it can be identified that most of the studies are cross-country analyses, and few are sub-national-level analyses. Moreover, the income stage analysis is yet to be investigated. Therefore, the present study fills this gap theoretically by identifying the influencing factors in developing economies comparable to the countries' gross national income per capita. Moreover, based on the nature of the dataset, the Poisson, Negative binomial, and Tobit regression are employed to bridge the methodological gap. Finally, the current study focuses on identifying income-specific trends in how PPPs are approached at each income level.

Data and methodology

Data

The study comprises 128 developing countries (please refer to Appendix 1), including 22 low-income countries, 50 economies in the high middle class, and 56 in the lower middle class. Considering the availability of data on response and predictor variables among developing countries, these countries were selected for analysis. Although developing countries adopted the PPP approach in the early 1990s, it gained popularity only after 2000. Hence, this study spanned 2000 to 2022 and utilized secondary data from the World

Bank's private participation in infrastructure (PPI) database to determine the elements influencing PPPs in developing countries.

The target for this paper was developing countries with low, lower-middle, and upper-middle-income economies based on the World Bank classification. Each country is categorized into one of four income groups based on its gross national income (GNI) per capita: low, lower-middle, upper-middle, and high. On 1 July, the World Bank fiscal year begins, and the classification is updated annually (Fantom & Serajuddin, 2016). Presently, for the fiscal year 2024 (using the World Bank Atlas approach), the classification is as follows:

- low-income category – countries with GNI per capita of $1,135 or less
- lower-middle category - have a GNI per capita between $1,136 and $4,465
- upper-middle category - countries having a GNI per capita between $4,466 and $13,845
- High-income category - countries having a GNI per capita of at least $13,846

The PPI database covers five main sectors: energy, information and communication technology, municipal solid waste, transport, water, and sewerage. These primary sectors are subdivided into thirteen sub-sectors. The energy sector is divided into the electricity and natural gas sub-sectors. Information and communication technology covers the ICT sub-sector. The municipal solid waste sector contains three sub-sectors: collection and transport, integrated municipal solid waste (MSW), and treatment or disposal. The transport sector comprises airports, e-vehicle charging stations, ports, railways, and roads. Finally, the water and sewerage sector includes treatment plants and water utilities.

The number of PPP initiatives and the volume funded in each project after 1983 are available from the PPI database (Yehoue et al., 2006). This is the largest standardized multiple-sector panel database available for developing countries. Advanced economies are not considered in this study. Data availability limits the analysis of these five infrastructure sectors in developing countries.

Empirical methodology

Variables and data sources

To measure the prevalence of PPPs among the countries, the current study utilized two dependent variables: (1) the number of public-private partnership projects and (2) the value of public-private partnership investments (as a % of the country's GDP) annually. The requirement for two dependent variables arises from the fact that the quantity and value of PPPs are not always comparable. The World Bank Private Participation in Infrastructure (PPI) database provided the data for these two variables from 2000 to 2022. A comprehensive interpretation of the predicted variables is outlined in Table 2 for better understanding and interpretation.

A statistical summary for each variable in the model is shown in Table 3. The average level of fiscal deficit, debt, fuel export, inflation, GDP growth international reserves, bank credit, internet usage, and regulatory quality implies skewed distributions driven by a few outliers.

Table 2: Description and source of variables

Determinant	Variable	Description of the variable	Data sources
PPP prevalence	Num PPP	Number of PPP projects in a year	PPI (WB)
	Value PPP	Value of PPP investment (as a % of GDP)	
Hard budget constraints	Fiscal deficit	General government net lending/borrowing (Percent of GDP)	WEO (IMF)
	Debt	General government gross debt (Percent of GDP)	
Soft budget constraints	Aid assistance	Net ODA received per capita (current US$) (logged)	WDI (WB)
	Fuel export	Fuel exports (% of merchandise exports)	
Market size	GDP	Gross Domestic Products (logged)	WDI (WB)
Macroeconomic stability	Inflation	Inflation, GDP deflator (annual %) (lagged)	WDI (WB)
	GDP growth	GDP growth (annual %) (lagged)	
Country risk	International reserves	Total reserves in months of imports	WDI (WB)
Operating environment	PPP experience	Experience in previous PPP projects (dummy)	PPI(WB)
Financial institutions	Banks credits	Domestic credit to private sector by banks (% of GDP) (lagged)	WDI
Existing infrastructure	Internet usage	individual using the internet (% of population) (lagged)	WDI
Regulatory institutions	Regulatory quality	Regulatory quality index	WGI
Urbanization	Urban population	Urban population (% of the total population) (lagged)	WDI

Source: Prepared by author

Note: PPI: Private Participation in Infrastructure Database, WB: The World Bank, WEO: World Economic Outlook, IMF: International Monetary Fund, WDI: World Development Indicators, WGI: World Governance Indicators

Table 3: Summary statistics

	count	mean	Var	sd	min	max
Number of PPP projects	2944	3.01	139.14	11.80	0.00	143.00
Value of PPP investment	2785	0.24	1.06	1.03	0.00	18.87
Fiscal deficit	2880	-2.62	34.47	5.87	-55.41	125.14
Debt	2834	54.13	1902.92	43.62	0.00	600.12
Aid assistance	2684	3.76	2.04	1.43	-2.81	8.46
Fuel export	2318	15.79	672.58	25.93	0.00	99.99
GDP	2915	10.17	0.86	0.93	7.80	13.25
Inflation	2893	9.52	2764.40	52.58	-30.20	2630.12
GDP growth	2894	3.85	28.16	5.31	-36.66	63.37
International reserves	2418	5.16	15.58	3.95	0.07	36.78
PPP experience	2944	0.40	0.24	0.49	0.00	1.00
Bank credits	2757	31.82	653.51	25.56	0.00	185.36
Internet usage	2732	24.14	608.78	24.67	0.00	97.40
Regulatory quality	2777	-0.45	0.38	0.62	-2.39	1.32
Urban population	2920	48.32	410.99	20.27	8.25	95.69
Observations	2944					

Source: Prepared by the author.

Table 4 (Appendix 2) displays the correlation matrix, which exhibits the correlation coefficients between the variables in the given data set. The data set shows a strong negative correlation of -0.71 between GDP and ODA received per capita, indicating that countries with a higher GDP receive less assistance from development institutions. Other variables do not appear to have significant correlations with each other.

The data analysis utilizes panel data techniques to investigate and identify the determinants affecting the outcomes of interest. Since the quantity and value of PPPs determine a country's PPP scope, it uses two distinct techniques: the count data model and the Tobit model. This section addresses the two approaches to determining the factors influencing PPPs in developing infrastructure in developing nations.

Dependent variable 1: Number of PPP projects

The first response variable is a discrete count (data non-negative) outcome variable: the number of PPP projects yearly. The Poisson regression model is commonly used to count data-dependent variables (Yehoue et al., 2006; Banerjee et al., 2006; Sharma, 2012; Kasri & Wibowo, 2015). Table 3 demonstrates the overdispersion of the number of PPP occurrences in the current data set by indicating that the variance (139.14) exceeds the mean (3.01). We used a Poisson goodness-of-fit test to assess how well the model fits the data (Please refer to Appendix 3). The Poisson goodness-of-fit test's null hypothesis states that a Poisson model with equal mean and variance can effectively represent the data. The significance of the Poisson goodness-of-fit test statistic's p-value led to rejecting the null hypothesis. This implies that the examined data exhibit characteristics inconsistent with those expected under a Poisson model. This occurred because of an issue with the current

data set. It contains numerous zeros, indicating years when countries have no PPP projects (resulting in a dependent variable value of zero). Second, the overdispersion caused by this abundance of zeros indicates a considerable variation between the mean and variance of the outcome variable. In response to the issues encountered with the Poisson model, we adopt the Negative Binomial Regression Model (NBR) as a suitable alternative (Yehoue et al., 2006; Kasri & Wibowo, 2015; Kaur & Malik, 2020).

After the negative binomial regression analysis, a post-estimation test known as the likelihood ratio (LR) test of alpha is carried out to compare NBR with the Poisson model. The negative binomial regression (NBR) method is the recommended estimation approach since a significant p-value of the LR test of alpha specifies that the distribution parameter alpha is statistically significant. Furthermore, the models' fits are compared using Akaike Information Criterion (AIC) values; models with lower AIC values have better fits and preferences (Kaur & Malik, 2020).

Equation 1 describes the formulation of the negative binomial regression (NBR) model:

$$num\_ppp_{it} = exp\,[\,\alpha + \beta_1 deficit_{it} + \beta_2 debt_{it} + \beta_3 aid_{it}\,(logged) + + \beta_4 fuel\_export_{it} + \beta_5 gdp_{it}\,(logged) + \beta_6 inlation_{it-1} + \beta_7 gdp\_growth_{it-1} + \beta_8 reserves_{it} + \beta_9 ppp\_experience_{it}\,(dummy) + \beta_{10} bank\_credit_{it-1} + \beta_{11} internet\_usage_{it-1} + \beta_{12} regulatory\_quality_{it} + \beta_{13} urban\_population_{it-1} + \eta_i + \delta_t + e_{it} + \varepsilon\,]\qquad(1)$$

Where num_ppp_{it} is the PPP investments in a country *i* and *t* from 2000 to 2022. α denotes the constant term. It is determined by the explanatory variables, which include the fiscal deficit (General government net lending/borrowing (Percent of GDP)), debt level General government gross debt (Percent of GDP), aid assistance (Net ODA received per capita (current US$) (logged)), fuel export (Fuel exports (% of merchandise exports)), logged GDP (Gross Domestic Products (logged)), lagged inflation (GDP deflator (annual %) (lagged)), lagged GDP growth (GDP growth (annual %) (lagged)), international reserves (Total reserves in months of imports), PPP experience (Experience in previous PPP projects (dummy)), lagged bank credits (Domestic credit to the private sector by banks (% of GDP) (lagged)), internet usage (Individuals using the Internet (% of the population)), regulatory quality (Regulatory quality index), and urbanization (Urban population (% of total population)) *i* and period of *t*. The η_i denotes the country-specific effect, and the δ_i represents the time-specific effect. The e_i exhibits the error term. The ε shows a gamma distribution that allows the difference of variance and mean.

Dependent variable 2: Value of PPP projects (as a % of GDP)

We employed the Tobit regression model to analyze the non-negative dollar value of investments in PPP finance, constituting our second dependent variable. In the Tobit model, the dependent variable is censored either from below, above, or both, reflecting limitations in measuring the variable (Guo et al., 2023). The Tobit model was chosen for our empirical study due to the zero-inflated nature of our PPP project data, where many countries report zero PPP projects over extended periods. The investigation and

interpretation of the findings are impacted by the available data, which establish the outcome variable's lower limit and left-censoring presence.

The equation of the second dependent variable is as follows (2):

$$value\_ppp_{it} = exp\,[\,\alpha + \beta_1 deficit_{it} + \beta_2 debt_{it} + \beta_3 aid_{it}\,(logged) + + \beta_4 fuel\_export_{it} + \beta_5 gdp_{it}\,(logged) + \beta_6 inlation_{it-1} + \beta_7 gdp\_growth_{it-1} + \beta_8 reserves_{it} + \beta_9 ppp\_experience_{it}\,(dummy) + \beta_{10} bank\_credit_{it-1} + \beta_{11} internet\_usage_{it-1} + \beta_{12} regulatory\_quality_{it} + \beta_{13} urban\_population_{it-1} + \eta_i + \delta_t + e_{it}\,] \qquad (2)$$

In this context, value_ppp$_{it}$ is the second response variable, the value of PPP investment in the country i and time t. It depends on explanatory variables such as which include the fiscal deficit (General government net lending/borrowing (Percent of GDP)), debt level General government gross debt (Percent of GDP), aid assistance (Net ODA received per capita (current US$) (logged)), fuel export (Fuel exports (% of merchandise exports)), logged GDP (Gross Domestic Products (logged)), lagged inflation (GDP deflator (annual %) (lagged)), lagged GDP growth (GDP growth (annual %) (lagged)), international reserves (Total reserves in months of imports), PPP experience (Experience in previous PPP projects (dummy)), lagged bank credits (Domestic credit to the private sector by banks (% of GDP) (lagged)), internet usage (Individuals using the Internet (% of the population)), regulatory quality (Regulatory quality index), and urbanization (Urban population \% of total population)) i and period of t. α represents the constant term; η_i and δ_t denote fixed effects specific to the country and fixed effects specific to the time, respectively. Moreover, e_{it} denotes the error term.

Results and Discussion

The estimation outcomes for the quantity of PPP occurrences and the volume of investments across all developing nations with low, lower-middle, and upper-middle income levels are shown in Table 5.

All the Developing countries (DCs)

The results of all the DCs under the number of PPP investments are from the Negative Binomial regression (NBR) analysis, and the value of PPP investments is analyzed using the Tobit regression.

Operating environment: DCs with more significant historical PPP investments are attracting more PPP investment. The findings exhibit a positive and significant relationship between both dependent variables, indicating that if a country had a PPP experience in the preceding year, the number of PPP projects in the current year would lead to an increase of 0.581 units and the value of PPP investment by 0.399 % points at a 1% significant level. This implies that when a country has established PPP projects and attracts more PPP projects, it creates a model and a foundation that facilitates the attraction of comparable investments in the future. Hyun et al. (2018) also suggest that

due to the complexity of PPPs, it is vital for the public sector to have the expertise needed to successfully implement these projects.

Regulatory institutions: A higher level of institutional quality is linked to the private sector's increased interest in public activities. The findings demonstrate a positive and significant association between regulatory quality and both dependent variables, emphasizing that the increment of regulatory quality by one index raises the PPP projects by 0.542 units and the value of the investment by 0.901% points at the 1% significant level. This indicates that the effectiveness of PPP investments in developing nations has a significant consequence on the standards of the regulatory system. Kumar (2019) revealed that establishing a strong governance framework has become an essential factor in attracting PPPs in each country.

Hard budget constraints: Developing countries facing higher budget deficits necessitate more PPP projects. The results show that at a 5% significant level, the fiscal deficit increase of 1% point will increase the number of PPP investments by 0.0242 units. This emphasizes that the decline of the general government balance and the fiscal restraints faced by developing economies, where funding large-scale infrastructure projects is challenging, may encourage more PPP. This result corroborates with existing literature (i.e. Kasri & Wibowo, 2015).

Soft budget constraints: Aid assistance encourages more PPP projects in emerging economies. The estimate suggests that a one percentage point rise in ODA receipt increases the PPP volume by 0.2 percentage points at a 5% significant level. This implies that private investors will likely carry out more projects in countries that receive substantial foreign grants, concessional loans, technical assistance, and capacity building.

Based on these findings, we accept H6 and H8, while our analysis does not provide strong support for the other hypotheses.

Low-income countries (LICs)

The results of LICs under the number of PPP projects are derived from the Poisson regression analysis, and the value of PPP investment is analyzed using the Tobit regression.

Hard budget constraints: Low-income economies facing severe budget constraints are attracted to PPP investments. Table 5 demonstrates that fiscal deficit has a positive and significant relationship with both dependent variables, indicating that a 1%-point upsurge in budgetary deficit leads to a surge in the PPP investment by 0.360 units and the value of PPP investments by 0.399% points at a 1% and 10% significant level, respectively. A worsening budget balance limits fiscal space, and as an alternative financing approach, PPP financing infrastructure is required without immediately increasing taxes or debts in LICs. The finding is generally in line with the Kaur & Malik (2020), suggest that the governments facing higher fiscal constraints promote PPPs to finance infrastructure projects.

Country risk: The country's risk factors significantly affect the attractiveness of low-income countries as investment destinations for PPP. The results reveal that international reserves show a significant and positive relationship with both dependent variables in low-income countries, demonstrating that international reserves increase in one month of imports leads to a rise in the PPP projects by 0.384 units and the volume of investments by 1.253% points at a considerable level of 5% and 1%, respectively. It implies that higher international reserves may diminish a country's risks, offering greater assurance to investors considering PPP projects in low-income countries.

Table 5: Determinants of PPP on infrastructure in developing countries

VARIABLES	DV 01: Number of PPP projects				DV 02: Value of PPP investment			
	All the DCs	LICs	LMICs	UMICs	All the DCs	LICs	LMICs	UMICs
Hard budget constraints								
Fiscal deficit	0.0242**	0.360***	0.0368**	0.00864	0.00751	0.399*	0.0336	-0.0246
	(0.0122)	(0.123)	(0.0171)	(0.0184)	(0.0170)	(0.229)	(0.0281)	(0.0179)
Debt	0.00241	0.0240	0.0117***	-0.00718*	-0.00120	0.0419	0.00199	-0.00139
	(0.00257)	(0.0193)	(0.00384)	(0.00369)	(0.00367)	(0.0386)	(0.00605)	(0.00425)
Soft budget constraints								
Aid assistance (logged)	0.0273	0.225	-0.163*	0.136**	0.198**	1.656	0.314*	0.158**
	(0.0511)	(0.813)	(0.0848)	(0.0643)	(0.0906)	(1.543)	(0.179)	(0.0798)
Fuel export	-0.00517	-0.00751	-0.00572	-0.00250	0.0126	-0.0320	0.0210*	0.00345
	(0.00512)	(0.0297)	(0.00702)	(0.00837)	(0.00782)	(0.0656)	(0.0119)	(0.00926)
Market size								
GDP (logged)	-0.166	-2.492	0.975	-1.584**	-1.026	-6.529	-1.089	-0.0578
	(0.414)	(2.472)	(0.604)	(0.705)	(0.644)	(5.968)	(1.045)	(0.770)
Macroeconomic stability								
Inflation (lagged)	0.000881	0.0198	0.00213	-0.000316	0.00261	0.0708	0.00306	0.000755
	(0.00263)	(0.0211)	(0.00357)	(0.00381)	(0.00311)	(0.0451)	(0.00530)	(0.00320)
GDP growth (lagged)	-0.00168	0.0485	0.000387	0.00292	0.00545	0.190	-0.0220	0.00983
	(0.00768)	(0.0550)	(0.0103)	(0.0112)	(0.0129)	(0.126)	(0.0210)	(0.0131)
Country risk								
International reserves	-0.0111	0.384**	-0.0402	0.0261	0.0207	1.253***	0.0126	0.00388
	(0.0179)	(0.182)	(0.0257)	(0.0282)	(0.0299)	(0.440)	(0.0477)	(0.0346)
Operating environment								
PPP experience (dummy)	0.581***		0.677***	0.511***	0.399***		0.294	0.547***
	(0.0900)		(0.128)	(0.140)	(0.127)		(0.209)	(0.135)
Financial institutions								
Bank credits (lagged)	-0.00178	0.00654	-0.00289	-0.00213	0.00212	0.0227	-0.00429	0.00386*
	(0.00152)	(0.00805)	(0.00253)	(0.00187)	(0.00236)	(0.0151)	(0.00450)	(0.00223)
Existing infrastructure								
Internet usage (lagged)	0.00265	-0.00126	-0.000436	0.00665*	0.000211	-0.0496	0.00538	0.000347
	(0.00252)	(0.0137)	(0.00385)	(0.00341)	(0.00391)	(0.0326)	(0.00679)	(0.00397)
Regulatory institutions								
Regulatory quality	0.542***	6.550***	0.698**	0.605***	0.901***	13.05***	1.347***	0.316
	(0.161)	(1.875)	(0.285)	(0.212)	(0.250)	(3.621)	(0.512)	(0.228)

Urbanization								
Urban population (lagged)	-0.00114	-0.000554	-0.00185	-0.00209	-0.00196	0.0212	-0.00333	0.00102
	(0.00187)	(0.0113)	(0.00285)	(0.00251)	(0.00304)	(0.0254)	(0.00514)	(0.00308)
Constant	2.290	7.225	-8.621	15.10**	9.153	38.30	9.165	-0.384
	(4.142)	(2,924)	(6.580)	(6.957)	(6.421)	(1,584)	(11.41)	(7.555)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,552	160	616	702	1,486	143	598	676
r2_p (pseudo-R2)	0.314	0.419	0.299	0.325	0.173	0.253	0.184	0.175
chi2_c (χ2 for comparison test)	586.2	138.5	101.8	195.5	-	-	-	-
p (p-value for the model test)	0	0	0	0	0	0	0	0
ll (log-likelihood)	-2060	-96.11	-851.4	-1032	-1455	-105.2	-648.9	-589.1
AIC	4405.967	284.2149	1864.893	2218.198	3192.771	302.4323	1457.711	1332.203
chi2 (χ2)	-	-	-	-	607.8	71.09	293.0	250.8

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

Note: Dcs: Developing countries; LICs: Low-income countries; LMICs: Lower-middle income countries; UMICs: Upper-middle income countries

Source: Prepared by the author.

According to Kasri and Wibowo (2015) and Kumar (2019), higher international reserves foster macroeconomic stability, making PPPs more likely.

Regulatory institutions: The tendency to use PPP finance for infrastructure improvement is contingent upon sound institutional frameworks. The results show that at a considerable 1% level, an increment of institutional quality by one index will lead to a rise in PPP projects by 6.550 units and the value of the investment by 13.05% points. Higher regulatory quality offers a stable and transparent legal framework, lower bureaucratic barriers and corruption, and enhanced risk management, which draws more PPP investment to the LICs.

These findings lead us to accept H1, H3, and H8, while our analysis does not offer strong support for the remaining hypotheses.

Lower-middle-income countries (LMICs)

To investigate the influences that affect the number of PPP projects in LMICs, the current study uses the NBR, and for the value of PPP investment, it uses the Tobit regression.

Regulatory institutions: Regulatory institutions are of considerable importance in attracting PPP projects in LMICs. The results revealed that regulatory quality increases by one index, raises the PPP projects by 0.698 units, and the value of investments by 1.347% points at a significant level of 5% and 1%, respectively. Robust regulations guarantee clear, transparent, and effective policies and protocols and lower risks and uncertainties, increasing the attractiveness of these countries to private investors.

Hard budget constraints: Tight budget constraints necessitate the appeal of PPP projects in LMICs. In LMI economies, the fiscal deficit rising by 1% will lead to a rise in the quantity of PPPs by 0.0368 units at a considerable level of 5%. Similarly, an increment of the debt level by 1% increases the PPP investment by 0.0117 units at a 1% considerable level. This suggests that hard budget constraints necessitate small-scale PPP projects in LMICs.

Soft budget constraints: Soft budget constraints are crucial in the prevalence of PPP in LMICs. Results reveal that ODA receipts increased by 1% points, decreasing the PPP projects by 0.163 at a significant level of 10%. The financial pressure on governments to look for alternative financing methods, such as PPPs, is lessened with significant ODA receipts to LMICs. However, the results reveal that when the aid assistance increases by 1%, the volume of PPP increases by 0.314%, which is a significant 10% level. ODA can expand basic infrastructure facilities, such as ports, highways, and railways, to facilitate the development and operation of functional facilities in subsequent PPP projects. This divergent finding may be explained by the tendency for higher ODA receipts to shift investments from many low-value projects to a select few high-value ones.

In addition, external financial streams play a crucial role in the intention to invest in a high volume of PPP investments. The study reveals that at a 10% significant level, an increment of natural resource export by 1% increases the PPP investment by 0.0120% points.

Operating environment: A country's previous PPP successes foster an atmosphere favorable to new PPP investments. LMICs with experience with PPP projects the year prior led to an increase in the present year PPP projects by 0.677 units at a significance level of 1%, indicating that LMICs with prior PPP experience are more attractive to project investors.

These findings lead us to accept H8, while our analysis fails to provide strong support for the other hypotheses.

Upper-middle-income countries (UMICs)

To determine what factors, influence the quantity of PPP projects in UMICs, this study uses the NBR, and for the value of PPP investment, it uses the Tobit regression.

Soft budget constraints: In UMICs, an increase in aid assistance from governments and official development agencies results in a rise in PPP initiatives. The results reveal that an increase in ODA assistance by 1% point raises the PPP quantity by 0.136 units and the volume of PPP investment by 0.158% at a 5% significant level, indicating that higher-aid-receiving UMICs appeal to more PPP projects.

Previous PPP experience: UMICs with prior PPP experience will draw more projects into their economies. Previous experience with PPP projects increases the PPP quantity by 0.511 units and the volume of PPP projects by 0.547% at a significance level of 1%.

A favorable PPP environment includes a better regulatory framework, expedited approval procedures, and improved project management capabilities, increasing the country's attractiveness to new PPP initiatives.

Hard budget constraints: The limited fiscal space hinders infrastructure financing through the PPP approach in UMICs. The debt level increases by 1% and the PPP investment decreases by 0.00718 units at a substantial level of 10%, indicating that even though upper-middle-income countries suffer considerable debt, they do not tend to use the PPP approach for infrastructure financing. This finding is similar to existing studies. (Hyun et al., 2018).

Market size: Higher GDP levels in UMICs may influence PPP investment to decline. According to the study, GDP, serving as a proxy for market size, is negatively and significantly correlated to the number of PPP occurrences at a 5% significant level, suggesting that wealthier developing countries may decrease the PPP approach when financing infrastructure.

Regulatory institutions: Countries with more robust regulatory structures are more attractive destinations for PPP projects than their counterparts with less stringent regulations. The analysis shows a significant positive relationship between regulatory quality and the quantity of PPP projects, with statistical significance observed at the 1% level.

Existing infrastructure: PPP investors may prefer a country with greater Internet accessibility. This study indicates that the relationship between Internet usage and the quantity of PPP activities in UMICs is positive and statistically significant at a level of 10%, implying that UMI economies with higher Internet usage attract more PPP investment to the country.

Financial institutions: The evolution of the financial industry enables large-scale investment in infrastructure through the PPP approach. The estimation indicates a positive and statistically significant correlation between bank credit to the private sector and the volume of PPP in these countries at a substantial level of 10%, indicating that banks' credit boost to the private party raises the PPP volume. As highlighted by Kaur and Malik (2020), and Hyun et al. (2018) domestic financial development and access to funds are key factors in drawing private investments. These findings lead us to accept H2 and H6, while our analysis does not provide strong support for the remaining hypotheses.

Conclusion, policy implications, and further research

Conclusion

This paper aims to identify determinants of PPP in infrastructure development in 128 developing economies, categorized by income level. The analysis employs the Poisson, NB, and Tobit regression and draws on World Bank PPI panel data from 2000 and 2022.

The results highlight that regulatory quality and previous PPP experience are critical drivers for the number and value of PPP investments in DCs. Additionally, the fiscal deficit is a crucial determinant of the number of PPP initiatives, and the size of the PPP finance determines ODA receipts. Regulatory quality, international reserves, and fiscal deficits are critical determinants for the prevalence of PPP in LICs.

The effect of regulatory quality on the PPP investment in LICs is more significant than that of LMICs and UMICs. Similarly, the effect of the fiscal deficit on the PPP approach is higher in LICs than in LMICs and DCs. Regulatory quality is vital for the quantity and volume of PPP investments in LMICs. Hard budget constraints and previous PPP experience positive effects, and aid assistance negatively affects the PPP quantity in LMICs. Additionally, soft budget constraints are crucial for the prevalence of the large volume of PPP projects. Aid assistance and previous PPP experience are critical for the quantity and volume of PPP investment in UMICs. In addition, regulatory institutions and existing infrastructure (Internet penetration) are positive factors, and debt and market size (GDP) are negative determinants of PPP establishment in UMICs. Moreover, bank credits to the private sector are also crucial for the PPP volume in UMICs.

Policy Implications

The empirical findings lead to the following policy considerations. First, DCs should strengthen their regulatory frameworks including clear guidelines on risk sharing, dispute handling, and project life cycle management to raise the standard of institutional conditions. Governments should endeavor to provide a robust framework that supports PPPs, including rules ensuring the public disclosure of regulations unique to PPP projects. It includes implementing transparency measures for project selection, bidding process, and financial disclosure. This would promote transparency and strengthen investor trust.

Secondly, a dedicated PPP Unit, along with accessible resources for the public, will aid in successfully implementing most PPP initiatives in developing economies. The specialized PPP regulatory body is responsible for monitoring and supporting PPP projects, ensuring they meet performance targets. This may apply to all developing economies, regardless of their income level. Thirdly, development organizations are pivotal in the PPP scenario. Proficiency, collateral, loans, equity finance, and risk management provided by global and regional development organizations are decisive for attaining PPPs and can be utilized to promote PPP development.

Governments in LICs must limit excessive volatility and implement adequate safety measures to sustain macroeconomic stability. During external shocks, LICs with more flexible exchange rate regimes typically incur more minor losses of international reserves. Increased exchange rate flexibility can mitigate the need for international reserve drawdowns foster a more stable macroeconomic environment and reduce the country's risk, which is favorable for PPP investments by absorbing external pressures. It is essential to strengthen the institutional capacity of the government sector in LMICs to implement PPPs and to enhance the legislative and regulatory frameworks governing PPP

procedures. UMI nations can partner with bilateral or multilateral development banks to access concessional funding, credit enhancement tools, or technical assistance for developing and implementing PPP projects.

Further research

Expanding the sample to include advanced countries can offer broader observations applicable to all economies. Consequently, including advanced economies allows for a comparative analysis between emerging and advanced economies, highlighting how economic conditions influence PPP outcomes. In addition, each region's unique economic and political circumstances may influence PPPs' formation, implementation, and success. In recent history, Latin America and the Caribbean have attracted substantial PPP investment, whereas Sub-Saharan Africa remains a less popular destination for such investments. Hence, analyzing different regions separately can uncover a variety of conclusions related to the determinants of PPPs in infrastructure. In the past three decades, PPP investment in transport, energy, and solid waste management sectors dramatically increased. Thus, understanding these nuances is essential for designing effective policies and strategies. Further research is needed to examine the sector-level factors that impact PPP income levels.

In conclusion, despite limitations, this paper provides evidence for the key factors essential to successfully establishing PPP infrastructure finance techniques in developing nations.

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Appendix 1

World Bank Group country classifications by income level for FY24

East Asia and the Pacific	Europe and Central Asia	Latin America and the Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa
Low-income countries (GNI per capita of $1,135 or less in 2022)					
Not available	Not available	Not available	Sriyan Republic, Yemen Republic	Afghanistan	Burkina Faso, Burundi, Central African Republic, Chad, Congo Dem Rep, Ethiopia, Gambia The, Guinea Bissau, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leon, Sudan, Togo, Uganda
Lower-middle-income (GNI per capita between $1,136 and $4,465 in 2022)					
Cambodia, Kiribati, Lao PDR, Mongolia, Myanmar, Papua Niugini, Philippines, Samoa, Solomon Island, Timor Leste, Vanuatu, Vietnam	Kyrgyz Republic, Tajikistan, Ukraine, Uzbekistan	Bolivia, Haiti, Honduras, Nicaragua	Algeria, Djibouti, Egypt, Arab Republic, Iran, Jordan, Lebanon, Morocco, Tunisia	Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka	Angola, Benin, Cabo Verde, Cameroon, Comoros, Congo Republic, Cote Ivory, Eswatini, Ghana, Guinea, Kenya, Lesotho, Mauritania, Nigeria, Sao Tome and Principe, Senegal, Tanzania, Zambia, Zimbabwe

Upper-middle-income (GNI per capita between $4,466 and $13,845 in 2022)					
China, Fiji, Indonesia, Malaysia, Palau, Thailand, Tonga	Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Georgia, Kazakhstan, Kosovo, Moldova, Montenegro, North Macedonia, Russian Federation, Serbia, Turkey	Argentina, Beliz, Brazil, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Jameica, Mexico, Paraguay, Peru, St Lucia, St. Vincent, Suriname	Iraq, West Bank, Gaza	Maldives	Botswana, Gabon, Mauritius, Namibia, South Africa,

Source: (*World Bank Country and Lending Groups – World Bank Data Help Desk*, n.d.)

Appendix 2

Correlation matrix

	Number of PPP projects	Value of PPP investment	Fiscal deficit	Debt	Aid assistance	Fuel export	GDP	Inflation	GDP growth	International reserves	PPP experience	Bank credits	Internet usage	Regulatory quality	Urban population
Number of PPP projects	1														
Value of PPP investment	0.0537**	1													
Fiscal deficit	-0.0378*	-0.0171	1												
Debt	-0.00890	0.00666	-0.129***	1											
Aid assistance	-0.370***	0.0429*	0.0303	0.0412*	1										
Fuel export	-0.0415*	-0.0314	0.140***	-0.124***	-0.312***	1									
GDP	0.451***	-0.0301	-0.0662***	-0.198***	-0.710***	0.305***	1								
Inflation	-0.00795	-0.0153	0.00137	0.0191	0.0222	-0.00592	-0.0228	1							
GDP growth	0.0172	0.00685	0.0883***	0.00497	-0.0528**	0.0345	-0.00365	-0.0533**	1						
International reserves	0.273***	-0.0135	0.0339	-0.0979***	-0.173***	0.196***	0.328***	0.00953	-0.0590**	1					
PPP experience	0.276***	0.0568**	-0.0211	-0.0955***	-0.308***	0.0751***	0.464***	-0.0276	0.0186	0.129***	1				
Bank credits	0.00998	0.0104	-0.00346	-0.0563**	0.0300	0.0330	0.0673***	-0.0780***	-0.0858***	0.0583**	0.00393	1			
Internet usage	-0.00467	-0.0247	-0.0970***	-0.0449*	0.0899***	-0.00855	0.154***	-0.0335	-0.193***	0.120***	-0.0216	0.490***	1		
Regulatory quality	0.114***	0.0152	-0.0285	-0.0772***	0.0790***	-0.319***	0.0630***	0.0295	-0.0161	0.0134	0.199***	0.0158	0.0397*	1	
Urban population	0.0151	-0.0208	0.0121	-0.0219	0.00717	0.0437*	0.0530**	-0.0000947	-0.111***	0.0490*	0.00222	0.217***	0.457***	0.0120	1

Note: * p<0.10, ** p<.05, *** p<0.01
Source: Prepared by the author

Appendix 3

Poisson goodness of fit test

Income status		DCs	LICs	LMICs	UMICs
Deviance goodness-of-fit	=	2527.472	82.783	883.3704	1123.633
Prob > chi2(1410)	=	0	0.9877	0	0
Pearson goodness-of-fit	=	3304.715	111.2498	1073.197	1429.164
Prob > chi2(1410)	=	0	0.5554	0	0
The selected method based on Poisson-goodness-of-fit		NBREG	Poisson	NBREG	NBREG

Note: H0: Data follow the Poisson distribution.
Source: prepared by author.