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Hazard analysis on public-private partnership projects in developing Asia

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ABSTRACT

Developing Asia's infrastructure gap results from both inadequate public resources and a lack of effective channels to mobilize private resources toward desired outcomes. The public-private partnership (PPP) mechanism has evolved to fill the infrastructure gap. However, PPP projects are often at risk of becoming distressed, or worst, being terminated because of the long-term nature of contracts and the many different stakeholders involved. This paper applies survival-time hazard analysis to estimate how project-related, macroeconomic, and institutional factors affect the hazard rate of the projects. Empirical results show that government's provision of guarantees, involvement of multilateral development banks, and existence of a dedicated PPP unit are important for a project's success. Privately initiated proposals should be regulated and undergo competitive bidding to reduce the hazard rate of the project and the corresponding burden to the government. Economic growth leads to successful project outcomes. Improved legal and institutional environment can ensure PPP success.

Keywords: *infrastructures; investment policy; public-private partnership; survival analysis*

1. Introduction

The United Nations Sustainable Development Summit in 2015 set 17 sustainable development goals, a 15-year global agenda to reduce poverty, fight inequality, and tackle climate change. The ninth sustainable development goal focuses on building better-quality, sustainable, and resilient infrastructure, with a focus on affordability and accessibility for all. Basic infrastructure such as roads, information and communication technology, sanitation, electrical power, and water are still limited in many developing countries. Developing Asia's infrastructure has improved rapidly, yet over 400 million Asians have

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no access to basic infrastructure needs and countries need to invest an estimated US$26 trillion from 2016 to 2030, or $1.7 trillion per year, to maintain the growth momentum, eradicate poverty, and respond to climate change (Asian Development Bank (ADB), 2017). Indeed, there is still a big gap between infrastructure development and the demands of economic growth in the region, and financing gaps remain the bottleneck of the region's infrastructure development.

State funds have been the major source of infrastructure financing in developing countries, but state funds still cannot meet the estimated infrastructure needs. Due to fiscal constraints, governments have been turning to the private sector to build and operate public infrastructure, leading to the use of partnerships between the public and the private sectors (Lee *et al*. 2019). Public-private partnership (PPP) is broadly defined as "a long-term contract between a private party and a government entity, for providing a public asset or services, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance" (World Bank, 2017). PPP transforms how the public and private sectors collaborate to deliver public infrastructure and services. PPP can be an innovative policy tool to improve the performance of the public sector by reducing government budgetary constraints through accessing private capital for infrastructure investments (Jamali, 2004).

In Asia and the Pacific, the use of PPPs is continuing, especially in the Republic of Korea, where PPPs are well established, with varying degrees of implementation and success in the People's Republic of China, India, Indonesia, the Philippines, and Singapore. Latin America and the Caribbean countries have used PPPs since the late 1980s, and given the diversity of countries in the region, the evolution and level of sophistication of the various PPP markets have not been uniform. Chile and Mexico are considered to have the most successful programs in the region, especially in the transport sector. Brazil, Colombia, and Peru also have an extensive track record on PPP projects (World Bank, 2017).

While PPPs provide real advantages, such as incentivized finance, capacity to innovate, and operational efficiency of infrastructure management and public service delivery, they come with considerable risks and challenges. With the long-term nature of the contracts and involvement of various stakeholders, PPP projects are often at risk of becoming distressed or eventually canceled. Since the early 1980s, there have been elevated tensions between the contractual parties, which forced the contracts to be distressed or terminated. Renegotiation phenomena are persistent in some less developed countries such as Latin America and the Caribbean countries, where projects are abandoned due to the private (or public) partners' inability to abide by contractual obligations (Ahmad *et al*., 2014). Breach of contract has become widespread and has been one of the major problems for foreign investors, compared with outright expropriations in the recent decades (Nose, 2014).

Poor governance, insufficient institutional capacity, and lack of regulatory and weak legal framework can hamper the implementation of PPPs (Maktabi, 2014). Weak institutional capacity creates uncertainties about the quality of regulations, leading to higher country risk and decreasing the incentives for private investors to participate in PPPs. Contracts can be designed to mitigate breach-of-contract risk by involving multilateral development partners in PPP contracts, as they play important roles not only by narrowing the funding gaps but also by significantly mitigating the risk of project cancellation.

Strong institutions and effective rule of law, as well as the perception of a country's level of corruption and democratic accountability, are essential for securing PPP arrangements and successful outcome of a PPP project (Hammami *et al*., 2006; Galilea and Medda, 2010). Furthermore, Moszoro *et al*. (2014) show that private investment in infrastructure is highly sensitive to freedom from corruption, quality of regulations, and the number of disputes in a sector. Developing economies, in particular, must ensure stable macroeconomic conditions and reasonable economic policies to support and reduce the uncertainties to be able to attract PPP projects (Reside Jr. and Mendoza Jr., 2010).

This paper estimates the hazard rates of PPPs in developing Asia using survival-time hazard analysis. It examines project-related factors (type of PPP, contract award method, and level of government support, for example), macroeconomic factors (growth, debt levels, and the occurrence of natural disasters), and institutional factors (whether there is a dedicated PPP unit, law and order issues, and degree of corruption, for example). The empirical results suggest policy makers should carefully assess these factors to determine the expected efficiency gains of proposed PPP projects because their success will depend just as much on well-designed contracts as on economic and political conditions and the institutional capacity.

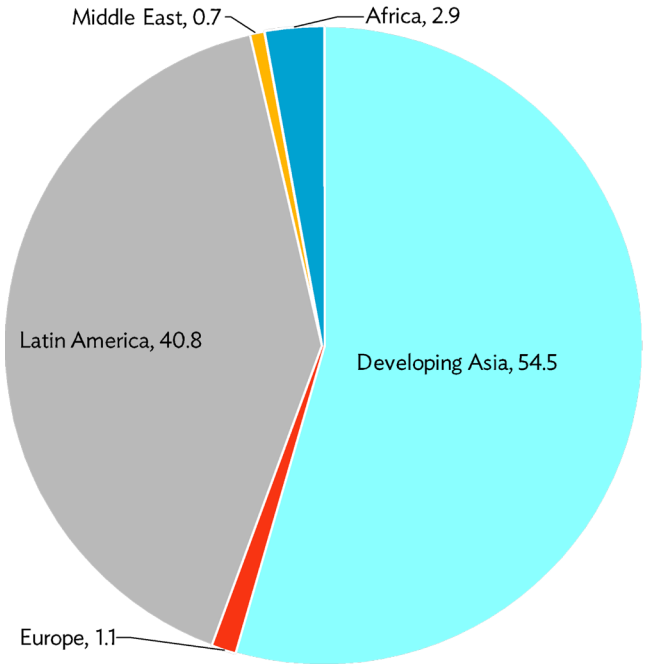
The remainder of the paper is structured as follows. Section 2 of this paper discusses the reasons for failed PPP projects in developing countries, and common risks and success factors for infrastructure PPP projects. Section 3 describes the data and analytical framework for the empirical analysis, followed by Section 4, which presents the estimation results. Lastly, Section 5 discusses the policy implications of the results.

2. Literature review

2.1. Failed public-private partnership projects in developing countries

The World Bank's Private Participation in Infrastructure database defines a canceled PPP project as one in which the private partner has quit a partnership either by selling or transferring its economic interest back to the government before fulfilling the contract terms. A distressed PPP project, also by using the World Bank's definition, is when a public sector partner or private sector operator has either requested a contract to be terminated or have requested international arbitration to settle a dispute. This chapter uses both definitions in its analysis of project failure. The stakes are high when this happens: public services can get disrupted, it discourages private investment in other PPPs, and—for a specific project—may require higher risk premiums.

The Private Participation in Infrastructure database shows that 259 PPP projects in developing countries worldwide were canceled, and 67 were distressed, out of 6,273 PPP projects from 1991 to 2015. These numbers might seem small, but it should be noted that only 216 projects were completed during the period. The fact is that the cancellation of PPP projects is a great concern, especially in developing countries facing fiscal constraints. More than half the canceled projects were in developing Asia (**Figure 1**). Globally, the canceled projects had initial investments of $76.4 billion, 4.4% of the $1.7 trillion committed investments.



PPP = public-private partnership

Notes:

1. Includes only low- and middle-income countries.

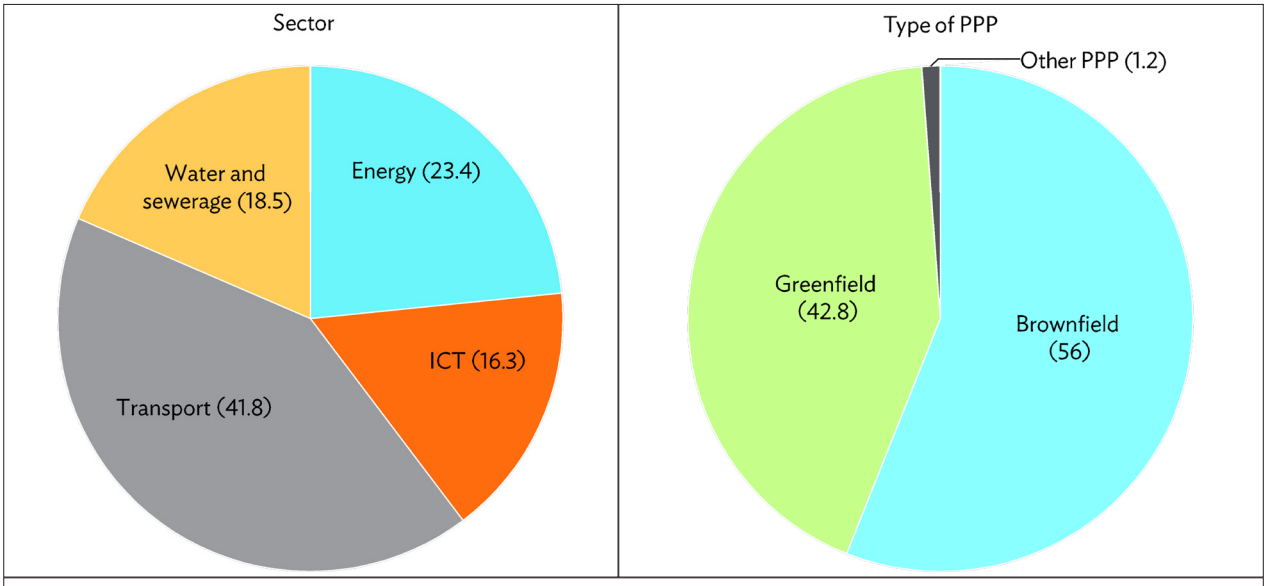
2. Excludes privatizations and merchant projects that do not include government guarantees or that operate in a liberalized environment.

3. Projects in the Private Participation in Infrastructure database must be at least 20% privately owned; state-owned enterprises are considered public.

Source: World Bank's Private Participation in Infrastructure database. https://ppi.worldbank.org/data (accessed 28 March 2017).

Figure 1. Canceled PPP projects by region, 1991–2015 (% share to total canceled projects)

For developing Asia, most failed PPPs were in the transport and the energy sectors (**Figure 2**). Within a sector, information and communication technology had the highest failure rate (25% or 14 failed projects out of 57 covered in the database in the review period).



ICT = information and communication technology, PPP = public-private partnership

Notes:

1. 'Other PPP' includes management and lease contracts and partial divestiture.

2. Includes only low- and middle-income countries.

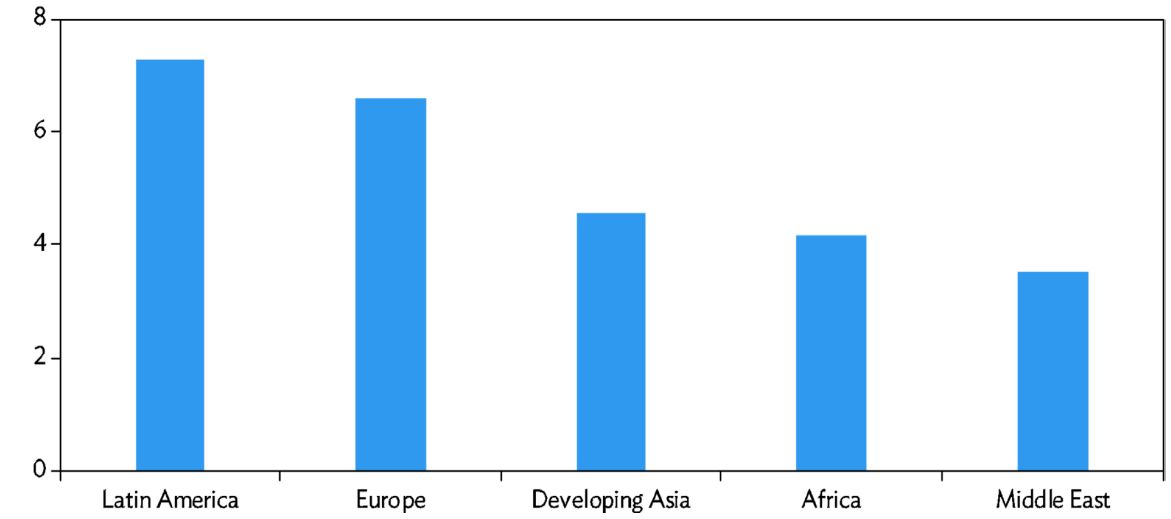
3. Excludes privatizations and merchant projects that do not include government guarantees or that operate in a liberalized environment.

4. Projects in the Private Participation in Infrastructure database must be at least 20% privately owned; state-owned enterprises are considered public.

Source: World Bank's Private Participation in Infrastructure database. https://ppi.worldbank.org/data (accessed 28 March 2017).

Figure 2. Canceled PPP projects by sector and project type by investment, 1991–2015 (% share)

Project cancellations in developing Asia occur on average five years after financial closure, which is typically during the final stage of the project construction (**Figure 3**).



PPP = public-private partnership

Notes:

1. Duration is measured as the time difference from the financial closure year (i.e., the year in which private sponsors legally entered an agreement to invest funds or provide services) through to the year in which the project was canceled.

2. Includes only low- and middle-income countries.

Source: World Bank's Private Participation in Infrastructure database. https://ppi.worldbank.org/data (accessed 28 March 2017).

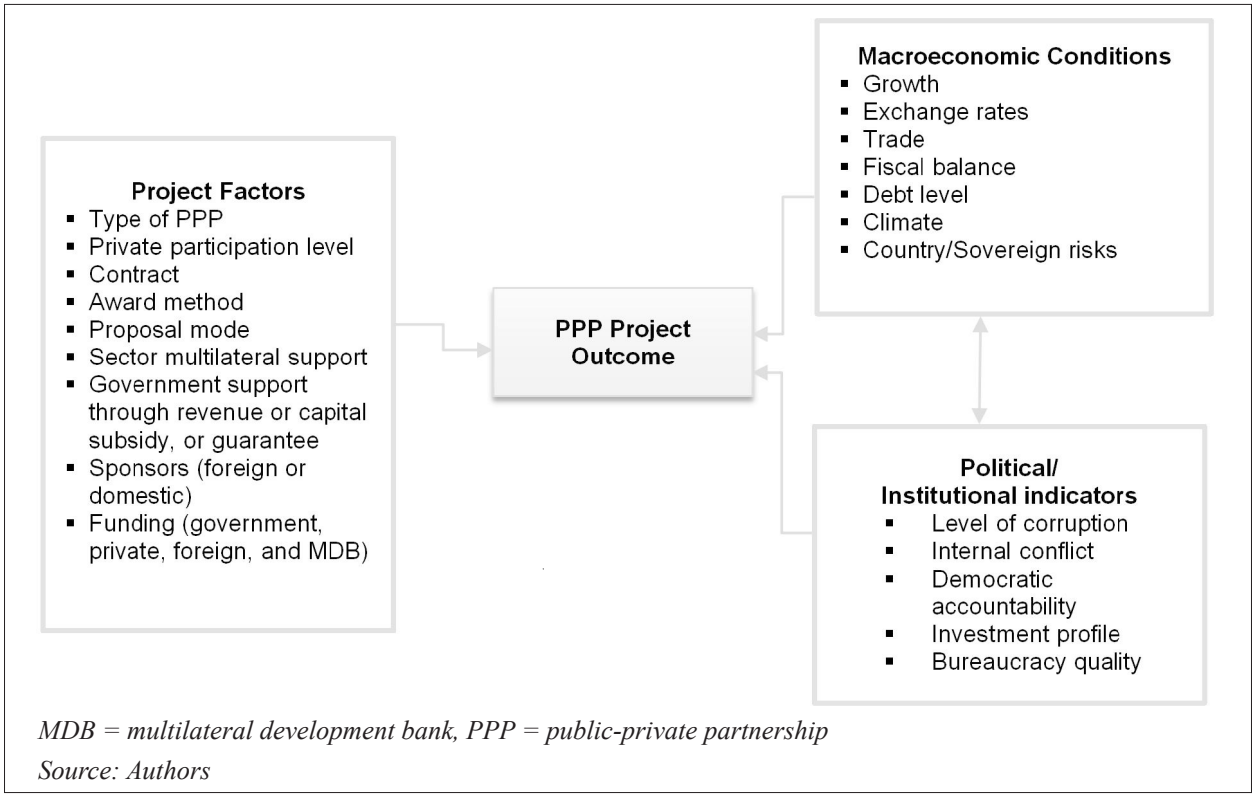
Figure 3. Mean duration of PPP project cancellations

2.2. Factors affecting public-private partnership project outcomes

The potential benefits of PPPs are many. Realizing them requires proper planning, execution, and monitoring. Well-structured PPP projects can deliver dividends over the long term, but these dividends do not materialize by themselves—they have to be drawn out. And even well-structured PPP projects can fail or require expensive restructuring because of unforeseen events or the opportunistic behavior of the contracting parties. More PPP projects will succeed if the country's macroeconomic, political, and institutional conditions, as well as project-related factors that can affect project outcomes, are considered (**Figure 4**). The figure shows the causal relationship of these factors, which can affect one or all project partners and a project's overall progress. These are not independent of each other, and their influence on project outcomes is closely interrelated.

2.3. Formation requirements for effective public-private partnerships

To guarantee a smoother PPP process, it is important to identify the key critical success factors for PPP project planning and implementation. Rockart (1982) describes the main success factors for effective PPP projects as a "few key areas of activity" where favorable results are necessary for project managers to reach their goals. Because of the complexity of PPP projects, careful preparatory work is needed; this includes a comprehensive feasibility study and thorough economic evaluations of a proposed project's potential (Jamali, 2004). Any concerns on transparency and accountability by the public sector partner need to be tackled, and private partners need to be reassured of the safety of and the returns on their investments. Sharing the same vision and trust between the parties contributes to successful PPPs.



MDB = multilateral development bank, PPP = public-private partnership

Source: Authors

Figure 4. Factors affecting PPP project outcomes

The challenge is to ensure that the interests of the stakeholders are skillfully negotiated and packaged. Governments need to maintain their involvement throughout a project's life, whether as a partner or a regulator. This is especially necessary in projects where accountability is vital, cost-shifting can be a problem, timeframes are long, and where the social aspects of a project are more important than costs (Spackman, 2002). A PPP unit is required to fill the gaps in projects caused by a lack of coordination between partners, high transaction costs, and institutional shortcomings.[1] The PPP unit should support the competent authority to get the value for money in a project's procurement and implementation phases (OECD, 2012).

The literature identifies an array of factors essential for successful PPP projects. For build-operate-transfer projects, Tiong (1996) identifies six critical factors for winning these contracts: (i) entrepreneurship and leadership, (ii) identifying the right project, (iii) technical strength of the consortium, (iv) technical solution advantage, (v) financial package differentiation, and (vi) differentiation in guarantees. For Zhang (2005), the success factors are (i) a favorable investment environment, (ii) a project's economic viability, (iii) having a reliable concessionaire with strong technical strength, (iv) a sound financial package, and (v) appropriate risk allocation. Samii *et al*. (2002) cite resource dependency, commitment and common goals, good communication and cooperation between partners, and similar working cultures.

Shi *et al*. (2016) examine the interrelationships among 29 success factors and categorize these based on their characteristics: government's ability and characteristics, private sector characteristics,

[1] PPP unit is defined by the Organisation for Economic Co-operation and Development as an organization that has been set up with the aid of the government to carry out any of policy guidance, technical support, capacity building related to PPP projects, as well as its promotion and investment.

the public's characteristics, cooperative environment, and process characteristics.

Jamali (2004) underscores the importance of governments providing better regulatory systems for PPPs, and that these systems should include protection from expropriation, arbitration procedures, respect for contract agreements, processes for recovering of costs, and making profits proportional to project risk. Di Lodovico (1998), Pongsiri (2002), and Zouggari (2003) point to the importance of transparent and sound regulatory and legal frameworks as prerequisites for the private sector's participation in PPPs. For governments, strong frameworks help ensure that PPPs operate efficiently and optimize the use of public resources. ADB (2008) and Trebilcock and Rosenstock (2015) stress the importance of creating a PPP unit to help public partners to disseminate information on PPP projects and to advise on procurement processes to put the public partner on an equal footing with the private partner in PPP negotiations. World Bank (2007) finds that the efficiency of a PPP unit is highly correlated with the success of a country's PPP program. For example, implementing PPP projects in the Philippines markedly improved when its Public-Private Partnership Center, the government's PPP unit, was reorganized in 2010 and strengthened.

Reyes-Tagle and Garbacik (2016) find that policy makers increase the chances of countries having active PPP programs, though this has no effect on the level of government spending on PPPs. The authors note that PPPs can be an immediate remedy for fiscal constraints from initial private sector financing. But without proper institutional safeguards against corruption, unsustainable fiscal liabilities can be created, which will worsen a country's fiscal position.

2.4. Risk factors in public-private partnership project implementation

Of the 20 countries covered in the 2014 Infrascope index and survey, which ranks the readiness and capacity of PPP projects for Asia and the Pacific, only one—Australia—has a mature PPP environment (Economist Intelligence Unit, 2015). Four countries—India, Japan, the Philippines, and the Republic of Korea—were considered a developed environment for PPP. The People's Republic of China had the highest readiness and capacity ranking among emerging PPP market economies in the region such as Indonesia, Thailand, and Viet Nam. Taken overall, the survey reflects the growing importance of PPPs in Asia and the Pacific, and how some developing countries in the region are getting more experienced and adept at implementing PPPs. That said, the survey highlights a wide range of obstacles that continue to undermine PPP projects, including weak legal and regulatory frameworks, poorly prepared or structured projects, lack of capacity to carry out projects by the public and private sectors, and weak financial market. Moszoro *et al*. (2014) show that a PPP investment in infrastructure is highly sensitive to freedom from corruption, rule of law, quality of regulations, and the number of disputes in a sector. Furthermore, PPP-enabling law provisions allowing for unsolicited project proposals and for the comingling of public and private funds are particularly helpful in facilitating private investment in infrastructure (Albalate *et al*., 2015). Ismail and Harris (2014) identify the top five negative factors for getting PPPs off the ground and implementing them in Malaysia: lack of government guidelines and procedures, lengthy delays in negotiations, high user charges, project delays caused by political debate, and confusion over government objectives and evaluation criteria for projects.

The long-term nature of PPP contracts and the many different stakeholders in these partnerships can heighten project risk, making PPPs less attractive to private partners. This is widely discussed in the literature. Nijkamp *et al*. (2002) and Scharle (2002) identify the

obstacles to project success. These include long-term planning horizons, overly complex projects, lack of institutionalized competition rules for public projects, and hold-ups caused by a change in the position of public partners, technocratic implementation styles, and cultural differences. Li and Zou (2008) have grouped the risks based on a project's lifecycle, from feasibility study and project design to financing and construction, operation, and transfer. Soomro and Zhang (2013) examine failure factors at different stages for transport PPPs. For example, poor economic and financial assessments done for feasibility studies, inappropriate risk allocation between partners at the procurement stage, delayed land acquisitions at the construction stage, and lower user demand at the operation stage.

Delayed land acquisitions are a prominent barrier to PPP projects in developing Asia, particularly for the relocation of squatters and disputes between landowners and environmental groups. In the Philippines, acquiring the right-of-way for infrastructure projects must involve a court process. Right-of-way problems and high resettlement costs have delayed some infrastructure PPP projects in the Philippines, including the North Luzon Expressway Project, which can enhance transport network and accessibility between provinces and municipalities particularly in North Luzon.

De Clerck and Demeulemeester (2014) point out that complex procurement procedures for PPP projects are bottlenecks to competition and keeping bidding costs manageable. Adding to the complex procedure, several empirical studies, including Carrillo *et al*. (2008), Chen and Doloi (2008), and Riedl *et al*. (2013) acknowledge that bidding for PPPs is expensive and that governments are more selective in their choice of suppliers to limit uncertainty. Soomro and Zhang (2013) argue that improper risk allocation is equally harmful to both public and private sector partners in terms of achieving project goals.

Harris (2003) examines the reasons for the failure of electricity PPP projects and finds difficulties in enforcing and maintaining cost-recovery pricing policies and in collecting payments owed by consumers or government off-takers. Water and sewerage PPPs face similar problems. The author finds that the main reason for the cancellation of telecommunication PPP projects is because cellular services are unable to attract enough customers and because of government's changes to the market's structure.

Jandhyala (2016) identifies two main channels where multilateral development banks (MDBs) can lower PPP project risks. The first is through operational assistance to ensure well-reviewed project contracts, and by encouraging a greater level of supervision of a project's implementation. The second is through policy dialogue to positively influence negotiations and help resolve project disputes between client governments and their private sector partners. PPP projects in which MDBs participate are likely to face lower project risks and be less likely to run into trouble or get canceled. Applying a logit model to 2,117 infrastructure PPP projects in 45 developing countries from 1995 to 2009, Jandhyala (2016) finds that the odds of project distress with the participation of MDBs is 50% lower than for projects without their participation. Bhattacharyay (2010) finds that MDBs can help facilitate regional cooperation by providing public goods among neighboring countries.

Examples of PPP projects where MDBs are involved in cross-border PPP infrastructure investment in developing Asia are:

(i) Turkmenistan–Afghanistan–Pakistan–India gas pipeline, a 1,700-kilometer pipeline

estimated to cost around $10 billion, is planned to carry 33 billion cubic meters of gas annually from gas-rich Turkmenistan to Pakistan and India, while Afghanistan will receive transit fees. ADB has acted as the secretariat for the Turkmenistan–Afghanistan–Pakistan–India pipeline project since 2003, and numerous meetings at technical and ministerial levels have been organized since then.

(ii) The 1,075-megawatt Nam Theun 2 Hydropower Project (by the Lao People's Democratic Republic and Thailand) is one of the largest hydropower projects in the region, whereby electricity produced in the Lao People's Democratic Republic is exported to Thailand. The Multilateral Investment Guarantee Agency provided a guarantee against the risks of expropriation, breach of contract, war and civil disturbances, and currency inconvertibility, which was a prerequisite to secure the support of lenders.

Empirical evidence confirms that macroeconomic factors can determine the success or failure of PPP projects by affecting operations and profitability. Allport *et al*. (2008) cite an elevated railway PPP project in Thailand that faced severe financial problems from overly optimistic demand projections and failed to mitigate exchange rate risk. Another good example of macroeconomic risk is Kuala Lumpur's light rail transit project, which failed because rising inflation during the Asian financial crisis hit profits and the concessionaires were unable to service the loans. The rising frequency and severity of natural disasters, and the effects of climate change, need to be addressed in PPP contracts and managed as a risk in infrastructure PPP projects.

Categorizing these and other hazards is important for managing risk in PPP projects. Ng and Loosemore (2006) group them in two basic categories: general risks (those not directly associated with a project), and project-related risks. Li *et al*. (2005) classify risks into three categories: (i) macro-risks that are exogenous to a project but still have project impacts (for example, socioeconomic and political conditions); (ii) meso-risks, which occur within the boundaries of a project (for example, risks related to project demand, usage, design, and construction); and (iii) micro-risks from the inherent differences between the public and private sector partners. Salzmann and Mohamed (1999) group risks into four categories: host country risks, investor risks, project risks, and project organization risks. Tah *et al*. (1993) categorize project risks based on factors that affect contractors and then structure them into internal and external risks.

3. Data and analytical framework

This section discusses the variables used to proxy risk factors and determine the probability of a project failing. The World Bank's Private Participation in Infrastructure database is the primary data source for this analysis.[2] The database does not contain all infrastructure projects with private investment, but it has the widest coverage of private investments in developing countries with project-related information. This study excludes full *divestitures* and *merchant* projects, whereby a private sponsor builds new infrastructure in a liberalized market but gets no revenue or payment guarantees from the government. Based on these criteria, 6,273 PPP projects are considered,

[2] The database contains information on private investment in over 6,000 infrastructure projects in 139 low- and middle-income countries in the energy, telecommunications, transport, and water and sewerage sectors.

including 2,819 PPP projects in developing Asia.

Each project contains the following information: host country, sector of investment, type and degree of private participation, project modality, duration, status, and financing. The project data are complemented with the host country's macroeconomic, socioeconomic, and political characteristics. The descriptive statistics are in **Appendix Table A1**. Although the Private Participation in Infrastructure database tracks infrastructure investments from 1960 to 2016, this study uses projects from 1990 to 2015 to maximize compatibility with non-project data.

The dependent variable is the survival time or duration of PPP infrastructure projects. All projects are grouped into two statuses: survivors (active projects) and failures (declared in distress or canceled). The duration of failures is measured as the number of years from financial closure year—that is, the year in which private sponsors entered into an agreement to invest funds or provide services—up to the year the project was canceled or declared in distress.

The duration of survivors is measured by the number of years from financial closure year up to the end of the measurement period in 2015. Because the duration of survivors has not been completed and is unknown up to the end of the sample period, the duration of survivors is treated as a right-censored observation. Of the 2,819 PPP projects considered in developing Asia, 95% were active, 4% were canceled, and 1% were distressed. Canceled and distressed projects in developing Asia have an average duration of 4.5 years.

Independent variables include project- and country-specific variables. Control variables for projects include type of projects, project origination, method of awarding contracts, level of government awarding contract, direct and indirect government support, level of private participation, and MDB support. For countries, variables include per capita gross domestic product (GDP) growth, terms of trade, trade as percent of GDP, debt ratio, political risk, presence of PPP units, and whether there were natural disasters in the study period. These macroeconomic variables provide a measure of a country's ability to withstand internal and external shocks, which can create unexpected situations that can force PPP parties to renege on contractual obligations.

To assess the political stability of the countries included in this study, the PRS Group's International Country Risk Guide's political risk rating data are applied.[3] The data are annual averages for the duration of the project of the two variables of the guide's political risk rating: firstly, law and order and secondly, corruption. The law component measures the strength and impartiality of a country's legal system; the order component assesses observance of the law. The corruption variable is an assessment of corruption in the political system. For both variables, the lower the score, the higher the risk, and vice versa.

3.1. Survival-time maximum likelihood estimation

PPP projects are at risk from socio-macroeconomic and project-based factors. Following Nose's (2014) contract framework, the hazard model is applied to determine the probability of a project failing over the duration of the contract. The contract duration is denoted as A_i, measured by the number of years from the financial closure year (t_0) through the year that the project was canceled or

[3] The International Country Risk Guide's rating has 22 variables in three risk categories (political, financial, and economic) for 140 countries during 1984–2016. For this study, only political risk rating data were used (PRS Group, 2012).

declared in distress

$$A_i = t_1 - t_0 \tag{1}$$

The active projects were still ongoing in 2015 and classified as right-censored, since their duration was not completed up to that point in time (the censoring time is denoted as c, which is the same for all contracts). If the duration is not censored, the density of A_i is simply $f(A_i \mid x_i;\theta)$ and the probability of A_i is censored if $(A_i^* \geq c \mid x_i)$, and therefore the maximum likelihood estimation of θ can be obtained by maximizing the following log-likelihood function:

$$L = \sum_{i=1}^{N} \{ d_i \log [f(A_i \mid x_i;\theta)] + (1 - d_i) \log [P(A_i^* \geq c \mid x_i)] \} \tag{2}$$

where d_i is a censoring indicator. The covariates of project i in sector j, country c, are represented by $x_i = [X_{1,i}, X_{2,c}, \varkappa, D_j]$. The $X_{1,i}$ are project-specific characteristics, including direct and indirect government support, procurement type, multilateral development bank involvement, share of private investment in the contract, proposal mode, and type of PPP.

Macroeconomic conditions, $X_{2,c}$, include indicators that may affect PPP project operations, such as growth, trade openness, terms of trade, and political and institutional factors, including corruption and investment profile of a country. The impact of natural disasters on projects is also included, as some empirical findings recognize the adverse impacts of natural disasters on the growth of countries at different levels of economic development (Alano and Lee, 2016), which can cause an increase in political conflict (Miguel *et al*., 2004). The regional fixed effects, $\varkappa$, and a vector of dummies for sectoral affiliations, D_j, need to be included in the likelihood function.

The hazard function λ can be estimated with the above maximum likelihood estimation, $\hat{\theta}$, following a Weibull distribution:[4]

$$\lambda(A_i;x_i) = exp(x_i^{'}\beta)\alpha A_i^{\alpha-1} \tag{3}$$

where α is the measure of duration dependence.

4. Empirical results

Using hazard regression analysis, **Table 1** shows the baseline survival model of PPP projects with project variables and macroeconomic indicators for developing Asia. Based on the empirical results, when more than 80% of PPPs are financed by the private sector, the hazard rate of a project decreases, albeit not significantly. Local government PPP contracts significantly reduce failure rates because they can best determine the kind of infrastructure projects that will benefit their constituents and the local economy.

PPP projects are typically initiated through a solicited or unsolicited proposal, and each follows a different process, which often leads to different levels of involvement between parties

[4] We ran several models using survival regression and found Weibull and Cox proportional hazard model yielding very similar results (See **Appendix Table A2**). When the shape parameter is unknown, the semiparametric Cox proportional hazard model is preferred over the Weibull model. However, Adejumo and Ahmadu (2016) observe that as the sample size increases, the mean squared errors of the maximum likelihood estimates of proportional hazard function of both the Weibull and Cox proportional hazard models are approximately the same. Model selection tests conducted revealed that the Weibull distribution is more parsimonious than other models, achieving both a higher log-likelihood and a lower Akaike Information Criterion score.

Table 1. Parametric hazard regression for developing Asia

Variables	Coefficients	Hazard Ratio
Private participation (private share >80%)	–0.368	0.692
	(0.770)	(0.533)
Local government contract	–4.224 ***	0.015 ***
	(0.920)	(0.014)
Solicited proposal	–2.760 ***	0.063 ***
	(0.720)	(0.046)
Unsolicited proposal through competitive bidding	–1.888 ***	0.151 ***
	(0.666)	(0.101)
Multilateral development bank participation	–1.888 **	0.151 **
	(0.784)	(0.119)
Foreign sponsor	–0.799 *	0.450 *
	(0.467)	(0.210)
Base = No government support		
Direct government support	–0.314	0.731
	(0.422)	(0.308)
Indirect government support	–3.218 ***	0.040 ***
	(1.122)	(0.045)
Type of PPP (brownfield as base)		
Greenfield	–3.086 ***	0.046 ***
	(0.746)	(0.034)
Management and contract lease, and partial divestiture	–1.274	0.280
	(0.808)	(0.226)
GDP per capita compounded growth rate	–0.414 **	0.661 **
	(0.190)	(0.126)
Terms of trade interaction with G3 growth rate	0.002	1.002
	(0.005)	(0.005)
% trade to GDP interaction with G3 growth rate	0.002	1.002
	(0.003)	(0.003)
Debt-to-GDP ratio	–0.0948 ***	0.910 ***
	(0.027)	(0.024)
Natural disaster occurrence	4.894 ***	133.500 ***
	(0.996)	(132.900)
Law and order	–4.124 **	0.016 **
	(1.742)	(0.028)
Corruption	–7.235 ***	0.001 ***
	(2.439)	(0.002)
Base = No PPP unit		
With 1 PPP unit	–4.459 ***	0.012 ***
	(1.671)	(0.019)
More than 1 PPP unit	–4.824 ***	0.008 ***
	(1.537)	(0.012)
/ln_p	1.337	
	(0.144)	
p	3.807	
	(0.548)	
1/p	0.263	
	(0.038)	
Observations	1,201	

GDP = gross domestic product, PPP = public-private partnership

*Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. G3 economies include the United States, Japan, and the euro area.*

Source: Authors' calculations

(AECOM Consult, 2007). Solicited PPP projects, initiated by the public sector, have significantly contributed to the success of the PPP projects because they are in sync with the government's development plans. Unsolicited proposals tend to gain less government support because they often do not meet the priority investment requirements of national infrastructure plans (Yun *et al*., 2015). For governments handling unsolicited proposals, one option is through a competitive bidding process in which no bidder has a predefined advantage (World Bank, 2002). In line with this, the interaction term between unsolicited projects and competitive schemes has a negative and significant effect on the hazard rate.

The results show that the involvement of MDBs can significantly increase the success of projects in developing Asia. These institutions can play an important role in reducing funding gaps for infrastructure and, as earlier noted, can facilitate regional cooperation for the provision of public goods among neighboring countries. Furthermore, PPP projects with foreign sponsors can reduce project failures, a result consistent with the findings of Reside Jr. (2009).

The results suggest that direct government subsidies and indirect support through guarantees can help PPP projects become more viable. Governments can bear some project risks by providing capital and revenue subsidies or in-kind contributions, such as land; favorable government policies to investment; or incentives, such as loan guarantees for sub-sovereign and non-sovereign borrowing. The results confirm that the presence of at least one PPP unit can reduce a project's hazard rate.

The model also included different types of PPPs, for example, whether an infrastructure was built or upgraded. Compared with brownfield projects, greenfield projects have a negative and significant elasticity with the hazard rate. This differs from the findings of the World Bank (2016) that show greenfield projects are the most susceptible to renegotiations, largely because of their complexity and the risks they can carry, and that greenfield projects are more prone to improper selection criteria and procurement procedures. The results of our study can be explained by greenfield projects having greater design flexibility to meet project requirements, and requiring less maintenance.

Theoretical approaches and the literature emphasize the relevance of fiscal, macroeconomic, and political factors in deciding whether to contract out. Intuitively, these factors can affect a project's operation and outcomes. The results confirm several claims in the literature that robust economic growth leads to good project outcomes because the demand for output rises. The average growth of real GDP per capita during the contract period has a negative and significant coefficient for the hazard rate; hence, economic development is also significant for project success. For country competitiveness, the positive impacts from terms-of-trade growth and trade as a percentage of GDP have no significant impact on the viability of PPP projects. Another factor for project failure is the occurrence of natural disasters in a country during the contract period.

Fiscal factors that influence PPP outcomes have been investigated by Checherita (2009) and Hammami *et al*. (2006), among others. Similar to these studies, our results show that a higher debt-to-GDP ratio has a negative elasticity with a project's hazard rate and can significantly contribute to project success. For institutional and political factors, indicators for law and order and the level of corruption support the notion that more transparency and less corruption can significantly reduce a project's hazard rate.

Table 2. Parametric hazard regression between developing Asian and other developing regions

Item	Developing Asia		Other Developing Regions	
Variables	**Coefficients**	**Hazard Ratio**	**Coefficients**	**Hazard Ratio**
Private participation (private share >80%)	–0.368 (0.770)	0.692 (0.533)	1.136 * (0.658)	3.113 * (2.048)
Local government contract	–4.224 *** (0.920)	0.015 *** (0.014)	0.024 (0.467)	1.024 (0.478)
Solicited proposal	–2.760 *** (0.720)	0.063 *** (0.046)	–3.042 ** (1.395)	0.048 ** (0.067)
Unsolicited proposal through competitive bidding	–1.888 *** (0.666)	0.151 *** (0.101)	–0.581 (0.506)	0.560 (0.283)
MDB participation	–1.888 ** (0.784)	0.151 ** (0.119)	0.376 (0.450)	1.456 (0.655)
Foreign sponsor	–0.799 * (0.467)	0.450 * (0.210)	0.597 (0.492)	1.816 (0.893)
Base = No government support				
Direct government support	–0.314 (0.422)	0.731 (0.308)	–1.06 (0.655)	0.346 (0.227)
Indirect government support	–3.218 *** (1.122)	0.040 *** (0.045)	–0.449 (0.890)	0.638 (0.568)
Type of PPP (Brownfield as base)				
Greenfield	–3.086 *** (0.746)	0.046 *** (0.034)	–1.633 *** (0.477)	0.195 *** (0.093)
Management and contract lease and partial divestiture	–1.274 (0.808)	0.280 (0.226)	–2.006 ** (0.812)	0.135 ** (0.109)
GDP per capita compounded growth rate	–0.414 ** (0.190)	0.661 ** (0.126)	0.097 (0.107)	1.102 (0.118)
Terms of trade interaction with G3 growth rate	0.002 (0.005)	1.002 (0.005)	0.011 *** (0.003)	1.011 *** (0.003)
% trade to GDP interaction with G3 growth rate	0.002 (0.003)	1.002 (0.003)	–0.00352 * (0.002)	0.996 * (0.002)
Debt-to-GDP ratio	–0.0948 *** (0.027)	0.910 *** (0.024)	–0.0322 *** (0.012)	0.968 *** (0.011)
Natural disaster occurrence	4.894 *** (0.996)	133.500 *** (132.900)	2.139 *** (0.571)	8.489 *** (4.850)
Law and order	–4.124 ** (1.742)	0.016 ** (0.028)	1.773 ** (0.779)	5.887 ** (4.587)
Corruption	–7.235 *** (2.439)	0.001 *** (0.002)	–7.916 *** (1.308)	0.000 *** -
Base = No PPP unit				
With 1 PPP unit	–4.459 *** (1.671)	0.012 *** (0.019)	1.161 ** (0.483)	3.193 ** (1.543)
More than 1 PPP unit	–4.824 *** (1.537)	0.008 *** (0.012)	–2.161 ** (0.884)	0.115 ** (0.102)

Table 2 (continued).

Item	Developing Asia		Other Developing Regions	
Variables	**Coefficients**	**Hazard Ratio**	**Coefficients**	**Hazard Ratio**
/ln_p	1.337 (0.144)		1.050 (0.141)	
P	3.807 (0.548)		2.858 (0.403)	
1/p	0.263 (0.038)		0.350 (0.049)	
Observations	1,201		854	

GDP = gross domestic product, MDB = multilateral development bank, PPP = public-private partnership
*Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Other developing regions include Latin America and the Caribbean, sub-Saharan Africa, the Middle East and North Africa, and European countries. G3 economies include the United States, Japan, and the euro area.*
Source: Authors' calculations

Table 2 shows the hazard ratios between developing Asia and other developing regions.[5] A significant difference between these developing regions and developing Asia is that as the private sector's share in investment appears to get larger (above 80%), the hazard rate significantly increases, suggesting that a proper mix with public investments will help reduce risks. The participation of MDBs in PPP projects in project preparation may not significantly influence project success.

5. Policy implications

There is a big gap between the pace at which infrastructure is being built and upgraded in developing Asia and the demands for more and better infrastructure that the region's strong economic growth is creating. And insufficient finance remains a bottleneck to developing infrastructure across the region. The public sector should continue taking the lead in developing sustainable and resilient infrastructure to support economic development and human well-being. But PPPs can bring real advantages to the provision of infrastructure through additional funding, more efficient management, and better public services. These partnerships, however, face considerable risks and challenges. Lack of project preparation, competitive systematic project awarding method, poor governance, misaligned priorities, the underrepresentation of the public sector in decision making, and lack of coordination and cooperation between partners are just some of the common risks PPPs face.

The increased use of PPPs for infrastructure since the middle of the 1990s has been accompanied by a rise in contractual disputes between the public and private sector partners. The renegotiation and termination of PPP contracts impede infrastructure development, disrupt public services, discourage private investments, and increase risk premiums. This paper has looked at the various ways that MDBs can contribute to infrastructure development at the national and regional levels and

[5] Other developing regions include Latin America and the Caribbean, sub-Saharan Africa, the Middle East and North Africa, and developing European countries.

reduce PPP project risks. Since the involvement of multilateral partners in PPP contracts provides insurance to reduce dispute risk, MDBs have an important function to play in reducing funding gaps and facilitating regional cooperation for the provision of regional public goods among neighboring countries. While MDBs can support the infrastructure build-out and play a critical role in mitigating risks in infrastructure PPP projects in Asia, the public sector should remain on top of the whole PPP process.

Governments can bear some PPP project risks by providing capital and revenue subsidies. Direct government subsidies and indirect support through guarantees can help PPP projects become more viable. Solicited projects have made a significant contribution to infrastructure development in developing Asia. Unsolicited projects remain a concern because of their higher failure rates than solicited projects, but the failure rates can be brought down by making the projects undergo more competitive bidding processes. New infrastructure projects, the so-called greenfield projects, are at a lower risk of cancellation than are projects that improve and expand existing assets, the so-called brownfield projects, because greenfield agreements allow governments to divest themselves of design, construction, and market risks.

The results of our empirical analysis confirm the literature, showing that robust economic growth leads to good PPP project outcomes, as demand for output rises. For fiscal and institutional factors, higher debt-to-GDP ratios have a negative elasticity with the hazard rate of projects. Strong legal systems and a low level of corruption reduce the hazard rate. PPP projects in developing Asia will increasingly be affected by the rising frequency and ferocity of natural disasters and the impact of climate change.

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Appendix

Table A1. Descriptive statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
MDB participation	0.06	0.24	0.00	1.00
Solicited proposal	0.30	0.46	0.00	1.00
Interaction of unsolicited proposals and competitive schemes	0.32	0.47	0.00	1.00
Direct government support	0.15	0.36	0.00	1.00
Indirect government support	0.13	0.34	0.00	1.00
Direct and indirect government support	0.00	0.04	0.00	1.00
Greenfield projects	0.67	0.47	0.00	1.00
Management, contract lease, and partial divestitures	0.08	0.28	0.00	1.00
Private participation dummy (private participation >80% = 1; 0 otherwise)	0.75	0.43	0.00	1.00
Local government contract	0.68	0.47	0.00	1.00
Foreign sponsor	0.66	0.47	0.00	1.00
GDP per capita compounded growth rate	6.28	2.21	−2.58	19.02
Terms of trade compounded growth rate interacted with G3 compounded growth rate	49.96	104.77	–140.52	439.01
% of trade to GDP compounded growth rate interacted with G3 compounded growth rate	–58.58	131.62	–612.55	103.55
Debt-to-GDP ratio	46.55	20.54	5.87	89.41
Natural disaster occurrence ratio	1.11	0.30	0.14	2.00
Law and order	1.18	0.80	0.06	4.05
Corruption	0.68	0.44	0.05	2.15

GDP = gross domestic product, MDB = multilateral development bank

Note: G3 economies include the United States, Japan, and the euro area

Source: Authors' calculations

Table A2. Robustness checking

	Weibull Distribution Model		Cox Proportional Hazard Model	
Variables	**Coefficients**	**Hazard Ratio**	**Coefficients**	**Hazard Ratio**
Private participation (private share >80%)	-0.368	0.692	0.097	1.102
	(0.770)	(0.533)	(0.810)	(0.893)
Local government contract	–4.224 ***	0.015 ***	–3.903 ***	0.0202 ***
	(0.920)	(0.014)	(0.835)	(0.0168)
Solicited proposal	–2.760 ***	0.063 ***	–2.715 ***	0.0662 ***
	(0.720)	(0.046)	(0.755)	(0.0500)
Unsolicited proposal through competitive bidding	–1.888 ***	0.151 ***	–2.109 ***	0.121 ***
	(0.666)	(0.101)	(0.699)	(0.0848)
Multilateral development bank participation	–1.888 **	0.151 **	–1.822 **	0.162 **
	(0.784)	(0.119)	(0.864)	(0.140)
Foreign sponsor	–0.799 *	0.45 *	–0.751	0.472
	(0.467)	(0.210)	(0.478)	(0.226)
Base = No government support				
Direct government support	–0.314	0.731	–0.144	0.866
	(0.422)	(0.308)	(0.429)	(0.372)
Indirect government support	–3.218 ***	0.04 ***	–3.207 ***	0.0405 ***
	(1.122)	(0.045)	(1.186)	(0.0480)
Type of PPP (brownfield as base)				
Greenfield	–3.086 ***	0.046 ***	–3.11 ***	0.0446 ***
	(0.746)	(0.034)	(0.775)	(0.0346)
Management and contract lease, and partial divestiture	–1.274	0.28	–1.126	0.324
	(0.808)	(0.226)	(0.765)	(0.248)
GDP per capita compounded growth rate	–0.414 **	0.661 **	–0.326 *	0.722
	(0.190)	(0.126)	(0.194)	(0.140)
Terms of trade interaction with G3 growth rate	0.002	1.002	–0.00286	0.997
	(0.005)	(0.005)	(0.00459)	(0.00458)
% trade to GDP interaction with G3 growth rate	0.002	1.002	0.00124	1.001
	(0.003)	(0.003)	(0.00279)	(0.00279)
Debt-to-GDP ratio	–0.0948 ***	0.91 ***	–0.0927 ***	0.911
	(0.027)	(0.024)	(0.0261)	(0.0238)
Natural disaster occurrence	4.894 ***	133.500 ***	2.324 ***	10.220
	(0.996)	(132.900)	(0.870)	(8.887)
Law and order	–4.124 **	0.016 **	–4.002 **	0.0183
	(1.742)	(0.028)	(1.572)	(0.0287)
Corruption	–7.235 ***	0.001 ***	–6.707 ***	0.00122
	(2.439)	(0.002)	(2.411)	(0.00295)
Base = No PPP unit				
With 1 PPP unit	–4.459 ***	0.012 ***	–3.489 **	0.0305
	(1.671)	(0.019)	(1.651)	(0.0504)

Table A2 (continued).

	Weibull Distribution Model		Cox Proportional Hazard Model	
Variables	**Coefficients**	**Hazard Ratio**	**Coefficients**	**Hazard Ratio**
More than 1 PPP unit	–4.824 ***	0.008 ***	–3.745 **	0.0236
	(1.537)	(0.012)	(1.531)	(0.0362)
/ln_p	1.337			
	(0.144)			
p	3.807			
	(0.548)			
1/p	0.263			
	(0.038)			
Observations	1,201		1,201	

GDP = gross domestic product, PPP = public-private partnership

*Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. G3 economies include the United States, Japan, and the euro area.*

Source: Authors' calculations