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Policymakers' Decisions on Public-Private Partnership Use

The Role of Institutions and Fiscal Constraints

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Institutions for Development Sector

Fiscal and Municipal Management Division

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Abstract*

Using an alternative methodology to those commonly seen in the literature, we investigate the fiscal and institutional factors that influence policymakers' decisions to use public–private partnerships (PPPs) while controlling for macroeconomic factors. Prior empirical evidence (Checherita, 2009; Hammami, Ruhashyankiko, and Yehoue, 2006) has found that fiscal constraints increase PPP use. However, previous studies have not investigated the effects of institutions that are likely to influence policymakers, such as the ability of governments to formulate and implement effective policy. The relationship between fiscal constraints and institutions and their effects on the decision to use PPPs are critical to understand. PPPs can be used to avoid fiscal constraints in the short term due to their initial private sector financing, but without proper institutional controls and safeguards, this avoidance of constraints can quickly create unsustainable fiscal liabilities that will worsen the country's overall fiscal and development position. This study finds that policy-related government institutions increase the probability of countries having active PPP programs but have no effect on the level of expected expenditures on PPPs. It also finds, like previous studies, that fiscal constraints increase PPP use. The results suggest that governments understand the importance of institutional quality for PPPs, but may feel compelled to utilize their PPP units once they exist even if they do not have the institutional quality to maintain their use. This could have ramifications for the sustainability of PPP programs throughout the world.

JEL codes: E62, H54, O18, O23
Keywords: fiscal constraints, infrastructure, institutions, public–private partnerships

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1. Introduction

The macroeconomic effects that influence policymakers' decisions to use public–private partnerships (PPPs) are not well understood. We advance the literature on understanding policymakers' decision rules to use PPPs by investigating the effects of institutional capacity for governments to formulate and implement effective policy, the effects of fiscal constraints, and the effects of development constraints and demographics. We are particularly interested in the institutional and fiscal dimensions because of the potential for governments to accrue unsustainable fiscal liabilities if PPP programs are not well managed. Case studies frequently note that the unsustainable acquisition of fiscal liabilities is one of the primary outcomes of the poor institutional capacity of PPP units (Reyes-Tagle and Tejada, 2015). Previous studies (Checherita, 2009; Hammami, Ruhashyankiko, and Yehoue, 2006) have also found that fiscal constraints are a primary determinant of PPP use but have not investigated the effects of government institutional capacity to effectively formulate and implement policy in detail. This leaves an important question unanswered: do the countries using PPPs because of fiscal concerns have the institutional capacity to avoid accruing unsustainable fiscal liabilities? Answering whether PPPs are used sustainably requires jointly studying the institutional effects with the fiscal effects, which is the primary purpose of this paper.

This inquiry is like previous literature (Checherita, 2009; Hammami, Ruhashyankiko, and Yehoue, 2006) on the macroeconomic and institutional factors that influence PPP use but differs quite strongly on two dimensions. The first is in our institutional focus: Hammami, Ruhashyankiko, and Yehoue (2006) control primarily for the effects of institutions that are directly related to the risks faced by the private sector (country risk indices, consistency of legal enforcement, control of corruption), with only a minimal focus on those that define the effectiveness of government policy (control of corruption).[1] The second is in our empirical methodology, which focuses on minimizing bias from selection and country-level effects by using a cross-sectional Heckman selection model, as opposed to maximizing data availability through the use of pooled and random-effects type 1 Tobits. Our empirical framework directly correlates with how our theoretical model functions, allowing us to directly test hypotheses developed through our theoretical model. This includes examining the indirect effect of institutional quality on PPP use through other macroeconomic effects by quantifying the size of any existing selection bias. Doing so can provide an indication of whether PPPs are used sustainably based on the sign and significance of the fiscal constraint variables conditional on

[1] Corruption is a risk faced by the private sector but it is also indicative of a country's ability to formulate *and implement* effective policy since corruption will, by its very nature, make any implemented policies less effective.

the existing selection bias and the role of institutional quality in correcting for the selection bias. We can test these hypotheses in two different ways: by comparing the coefficients between our baseline OLS model and our Heckman selection model to ascertain the direction and scale of any selection bias, and by examining the direction and sign on the inverse Mills' ratio to determine how strong the indirect effect of institutional quality actually is.

Neither Checherita (2009) nor Hammami, Ruhashyankiko, and Yehoue (2006) conclusively answered the question of whether the capacity of governments to design and implement effective policy affects PPP use. They did not find that control of corruption influences the level of expenditures on PPPs, but Hammami, Ruhashyankiko, and Yehoue (2006) did find that better control of corruption increases the number of PPP projects conducted by governments. However, control of corruption is only an indirect indicator for the capacity of governments to formulate and implement effective policy. It also captures effects related to private sector risk, which are found to be consistently significant throughout both Checherita's (2009) and Hammami, Ruhashyankiko, and Yehoue's (2006) regressions. This makes it difficult to isolate the specific reasons for the inconsistency in control of corruption's statistical significance across regressions. This is especially true when control of corruption may not be significant with relation to PPP expenditures because high levels of corruption could potentially increase PPP expenditures[2] as much as low levels of corruption, as can be extrapolated from the literature (Engel, Fischer, and Galetovic, 2009; Maskin and Tirole, 2007).

However, despite minimizing potential biases from selection and country-specific effects and directly controlling for the capacity of governments to design and implement effective policy, our results confirm that government policy-related institutional quality has no effect on the level of expenditures on PPPs. This is despite the finding that the likelihood of a country having an operational PPP program during the sample timeframe (2008–2012) is strongly associated with better policy-related institutional quality. Taken together, these two results suggest that countries understand the institutional requirements of implementing PPP programs but may experience difficulties in execution. Alternatively, countries with low levels of institutional quality that do operate PPP programs may feel political obligations to use PPPs to the fullest extent possible since they have already invested in the institutional structures to do so despite not necessarily having the capacity to do so effectively. On the fiscal dimension, our results coincide with those of our predecessors in that fiscal constraints have a significant and positive effect on the level of PPP expenditures as a percentage of GDP within a country, but this applies most

[2] Through patronage or other political motivations. Some private sector entities may also find operating in countries with high levels of corruption to be less expensive or more profitable due to the costs of bribing officials potentially being smaller than the costs of meeting regulatory requirements, for example.

strongly to countries with high levels of fiscal constraints (debt). Combined with our result that institutions have no effect on a country's level of PPP expenditures, we have concerns that many countries are using PPPs to avoid fiscal constraints in the short term without the ability to effectively manage the fiscal liabilities this creates.

The structure of the paper is as follows. Section 2 analyzes the key literature surrounding the macro-fundamentals of PPP participation, in which many of the key questions that must be resolved about PPPs at the macro-scale have seen only preliminary answers. In Section 3 we establish a basic theoretical framework to show the motivating factors behind the government's choice between public investment and PPPs given the level of public debt, institutional quality, and the perception of the development constraints facing the country. Section 4 provides an overview of the data. Section 5 presents the theoretical model, and Section 6 discusses the empirical model. With the theoretical motivation for the study and an overview of the data in place, we turn to discussing the differences in our approach from the methods used by Hammami, Ruhashyankiko, and Yehoue (2006) and Checherita (2009). These differences include implementing a more explicit selection bias correction method (Heckman selection; Heckman, 1979) than that provided by the Type 1 Tobit, expanding the basic unit of time from annual frequency to five-year averages; and using primarily lagged explanatory variables to account for the delay between the medium-term macroeconomic conditions a country observes and the realization of expenditures on the project.[3] We then estimate the relationships between our potential macroeconomic determinants and PPP participation, first providing the model specifications for our OLS, probit, and Heckman Selection models with which we are conducting the analysis. Section 7 contains the results and our interpretations, and our remarks on the implications of our overall study are in Section 8.

2. Literature Review

There are two primary articles on the macroeconomic determinants of PPP use: Checherita (2009) and Hammami, Ruhashyankiko, and Yehoue (2006). Hammami, Ruhashyankiko, and Yehoue (2006), one of the first articles to explicitly look at the macroeconomic determinants of PPPs, conducts a relatively broad survey of the macroeconomic determinants due to the lack of prior research. They find, using pooled and random effects Type 1 Tobits as their primary models, that the main determinants increasing expenditures on PPPs relative to economic size

[3] The planning and bidding phases of a PPP often take two to three years. In addition, changes in a country's medium-term macroeconomic position that might promote PPP use may take years to be observed. The confluence of these two effects can create a significant delay between changes in the observed macroeconomic conditions and the actual expenditures on a PPP project.

(PPP expenditures to GDP ratio) are fiscal constraints (higher debt-to-export ratio), demographic factors (larger population), political competition (more opposition parties in the legislature), lower inflation, and lower country risk (lower composite country risk index, better rule of law). They also find, using a zero-inflated Poisson model, that the main determinants that increase the total number of PPP projects a country conducts are fiscal constraints (higher debt-to-export ratio), larger population, more resources (higher GDP per capita), lower inflation, better control of corruption, greater respect for the rule of law, and prior experience with PPPs. They do not study the binary decision on whether to use PPPs; thus, their models are not directly comparable to our probit. However, the zero-inflated Poisson model incorporates a selection correction for the large number of zeroes in the dependent count variable (number of PPP projects). This model's results can be cautiously compared to our probit results across variables (such as control of corruption) that do not measure economic or demographic scale (such as population or real GDP per capita).

Checherita's (2009) study has a much narrower focus on two subjects that derive from her theoretical model, which is constructed to identify the optimal level of private participation in a project given market risks and irreversible investment. The first is the level of substitutability (or complementarity) between different types of investment: pure public, public–private partnership, and pure private. The second is determining the specific nature of the risks to private sector investment that have the most effect on PPP expenditures and PPP project counts. She follows Hammami, Ruhashyankiko, and Yehoue (2006) methodology of using pooled and random effects Type 1 Tobits to identify the determinants of PPP expenditures (as a percentage of GDP), but uses a slightly different methodology with her count variable. Rather than using a zero-inflated Poisson model to correct for the zeroes in the dependent variable, she aggregates her data across the entire sample to create a cross section without zeroes in the dependent variable, and fits a negative binomial model to this cross section. Constructing the dependent variable such that there are no zeros, and therefore there is no need to correct for the selection decision, means that we have no models that can be compared with Checherita's (2009) negative binomial model.

On the dimensions where Checherita's (2009) study overlaps with Hammami, Ruhashyankiko, and Yehoue's (2006) study, the results are relatively similar. Checherita (2009) finds that fiscal constraints increase expenditures on PPPs (as a percentage of GDP) but not the PPP project count. However, she finds that this effect occurs through the tax burden (government revenue-to-GDP ratio), which Hammami, Ruhashyankiko, and Yehoue (2006) did not incorporate, rather than the debt level. However, Checherita (2009) used a different

measure of debt (debt-to-GDP ratio rather than debt-to-export ratio), so it is not possible to conclusively say that the tax burden is a better measure of fiscal constraint than debt. Similarly, Checherita (2009) finds that both foreign aid and GDP increase PPP expenditures, while Hammami, Ruhashyankiko, and Yehoue (2006) do not. However, Checherita (2009) measures both in log levels, while Hammami, Ruhashyankiko, and Yehoue (2006) measure them in per capita terms.

Checherita (2009) also finds that risk to the private sector is a key determinant of both PPP expenditures and PPP project count. Where Hammami, Ruhashyankiko, and Yehoue (2006) find a broad range of impacts from risk factors, Checherita (2009) finds that only the country investment profile matters in determining expenditures on PPPs. She does not find any effects from any other economic, social, or political risk factors on expenditure. With respect to PPP project count, she finds that exchange rate uncertainty decreases the number of PPP projects conducted, while public capital finance uncertainty increases the number of PPP projects conducted.

Despite this result, Checherita (2009) finds no conclusive evidence that PPPs are substitutes for public infrastructure provision. Instead, she finds that private investment complements PPP expenditures but is a statistically weak substitute in terms of the number of projects conducted. This may be indicative of two separate effects. The first is that increased private investment may signal an economic boom period, in which case private participation in the economy will increase across the board (including in PPPs). However, this may also provide the opportunity for many of the smaller infrastructure projects to be allocated solely to the private sector, leaving PPPs to take care of the larger infrastructure projects that the private sector would not be able to undertake by itself. This would reduce the number of PPP projects, but would result in larger PPP projects overall.

Based on these results, the countries that use PPPs most extensively are large (both economically and in terms of population), fiscally constrained countries with low levels of risk to the private sector through economic or institutional concerns. Much of what happens on the policymakers' side is not studied, however, and the effects of resource and development constraints remain uncertain. We aim to address both questions in our theoretical and empirical models, with a primary focus on policymakers' decisions to use PPPs and the impacts of fiscal constraints.

3. Theoretical Model

This section constructs a model that formalizes a theory, based on the effects of institutional quality, of the reasons why previous studies have found that governments facing fiscal constraints spend more on PPPs. The model hinges on the concept that better policy-oriented institutional quality enables governments to gain more benefits from using PPPs, resulting in situations where countries with higher levels of fiscal constraints but high institutional quality spend more on PPPs than countries without fiscal constraints but with low levels of institutional quality. This purely macroeconomic approach fills a gap in the current array of theoretical models. Previous theoretical models have generally focused on the project-level decisions related to PPPs, such as optimal contracting or contract design (Checherita, 2009; Iossa and Martimort, 2015), or the timing of investment given macroeconomic conditions if investment is irreversible (Checherita, 2009). We can also show through our model how selection bias might arise in our data sample through a simple set of conditions. This allows us to develop a set of formal hypotheses against which we can directly test the findings of our empirical framework.

The motivating factor behind this model is that countries facing constraints, whether fiscal or development, will have fewer resources to allocate to infrastructure investment. However, if these same countries have high levels of institutional quality, they are better positioned to take advantage of the benefits of PPPs, and will therefore shift their investment portfolio toward PPPs. Under this concept, the primary factor in determining the extent to which a government uses PPPs is its institutional quality rather than the constraints it faces. This effect may be difficult to isolate in an empirical study that both does not effectively control for the indirect effects of institutional quality and faces a data sample in which many countries may not behave optimally with respect to the decision to use PPPs.

Our theoretical model follows a permanent income methodology constructed under the assumption that the government is a benevolent social welfare planner acting to maximize social utility by providing infrastructure demanded by its citizens while also managing its fiscal and development pressures. The procurement decision rule for this model as debt changes is built on key government-specific parameters: the interest rate r, the institutional quality parameter ϕ, and the subjective discount rate β that we interpret to be a measure of perceived development constraints such as having underdeveloped markets (financial or otherwise).

We use the simplest deterministic version of the permanent income model to guide our theoretical investigation. Following Park (1997), we define a utility function that depends on the consumption of private and public goods. Our economy is based on two agents, the consumer and the government. Consumers maximize their utility by selecting their private good

consumption each period conditional on how much of the public good the government will deliver to the consumers. The basic utility function used by Park (1997) is:

$$U(C_t, G_t) = \frac{1}{1-\gamma}\left[\alpha \frac{C_t^{1-\sigma}}{1-\sigma} + (1-\alpha)\frac{G_t^{1-\delta}}{1-\delta}\right]^{1-\gamma}$$

where α, σ, δ and γ are preference parameters. In this context, 0 < α < 1 will influence the share of private goods consumption in total consumption. The parameters σ and δ are the intertemporal elasticities of substitution between current and future private and public good consumption, while γ is the composite intertemporal elasticity of substitution; all three are bounded on the interval [0, 1]. We make two assumptions about the intertemporal elasticity of substitution for simplicity. The first is that C and G are additively separable in the utility function, which requires $\gamma = 0$. The second is that public and private consumption have the same degree of intertemporal substitution ($\sigma = \delta$); that is, public and private consumption grow at the same rate. We depart from Park (1997) by redefining $G_t^{1-\delta}$ as a composite function $G_t(g_{1t}, g_{2t})$, with the stock of G_t dependent on two types of delivery methods: PPP (g_{1t}) or traditional procurement (g_{2t}). In this sense, we can express G_t as an aggregate public good provided by the government that enters the utility function as:

$$G_t(g_{1t}, g_{2t}) = \left[g_{1t}^{1-\delta} + g_{2t}^{1-\delta}\right]$$

We assume that the agent is *a priori* indifferent to the method of procurement outside of pure considerations of utility, and that g_{1t} and g_{2t} are additively separable.

When translated into the form of a Bellman equation, the problem of the consumer is then:

$$\max_{C_t, C_{t+1}, A_{t+1}} V_t(C_t, G_t) = U(C_t, G_t) + \beta E_t V_{t+1}(C_{t+1}, G_{t+1})$$

subject to the budget constraint:

$$Y_t + \frac{A_{t+1}}{(1+r)} = C_t + T_t + A_t$$

And the government's problem is:

$$\max_{g_{1t}, g_{1t+1}, g_{2t}, g_{2t+1}, B_{t+1}} V_t(C_t, G_t) = U(C_t, G_t) + \beta E_t V_{t+1}(C_{t+1}, G_{t+1})$$

subject to the budget constraint:

$$T_t + \frac{B_{t+1}}{(1+r)} = B_t + \frac{1}{\phi} g_{1t} + g_{2t}$$

where β is the subjective discount rate, Y_t is income in period t, A_t are the assets that the consumer has, T_t is total tax revenue, and B_t is the government's debt. Though there is some disagreement on whether PPPs are more cost-efficient in the short run (Vining and Boardman, 2008), we assume that PPPs are more efficient over time given high institutional quality and incorporate ϕ as a cost multiplier on PPPs, representing the effects of institutional quality. As such, $1 < \phi$ represents higher institutional quality while $\phi < 1$ represents lower institutional quality.

Using the first order conditions of the government's optimization problem, we find the inter and intratemporal expenditure conditions on government expenditures:

$$(1)\ \frac{g_{i,t+1}}{g_{it}} = \big(\beta(1+r)\big)^{\frac{1}{\delta}}$$

$$(2)\ g_{1t} = \left(\phi^{\frac{1}{\delta}}\right) g_{2t}$$

Condition (1) shows that there is an optimal investment path for both PPPs and traditional procurement methods, while condition (2) shows that there is an optimal PPP/traditional procurement expenditure ratio primarily based on the level of institutional quality in the country. The second condition is the one we're primarily interested in. It provides a simple relationship that can define the absolute level of PPP investment if we know the level of aggregate investment—which itself is a function of the fiscal constraints faced by the government, as shown by expenditures on both procurement methods decreasing as debt increases.[4]

$$(3)\ \frac{\partial g_{1t}}{\partial B_t} = -\phi^{\frac{1}{\delta}} \frac{k}{(1+r)^2}$$

$$(4)\ \frac{\partial g_{2t}}{\partial B_t} = -\frac{k}{(1+r)^2}$$

To show how institutional quality can result in governments with higher fiscal constraints spending more on PPPs than governments without fiscal constraints, consider the following situation. Suppose that there is a continuum of governments investing in infrastructure, I, but facing a variety of fiscal constraints such that a government's normalized aggregate investment

[4] These derivatives are taken from the solutions for the level of investment using a specific procurement method. For PPPs this is:

$g_{1t} = k\left[\sum_{s=0}^{\infty} T_{t+s}(1+r)^{-s} - \frac{B_t}{(1+r)^2}\right]$, where $k = \left(1 - \frac{\theta}{1+r}\right)\left(1 + \frac{1}{\phi}^{\frac{\delta-1}{\delta}}\right)$ and $\theta = \big(\beta(1+r)\big)^{\frac{1}{\delta}}$

I is bounded to an interval $I \in [0,1]$. This interval is the result of I being a monotonically decreasing function of debt (as shown by conditions (3) and (4)), with a high debt level resulting in a government having few resources to allocate to aggregate investment and a country with zero debt being able to allocate the full 1 unit to aggregate investment in infrastructure. We can use condition (2) to determine the distribution of investment funds between PPPs and traditional procurement as a function of institutional quality such that:

$$(5)\ \frac{g_{1t}}{g_{2t}} = \phi^{\frac{1}{\delta}}$$

We also impose the following constraint on the allocation choice between PPPs and traditional procurement to represent that the government must allocate all its investment funds between these two procurement options:

$$(6)\ g_{1t} + g_{2t} = 1$$

Taken together, conditions (5) and (6) state that as ϕ increases g_{1t} must increase and g_{2t} must decrease, with $\lim_{\phi \to \infty} \phi^{\frac{1}{\delta}} \Rightarrow g_{1t} = 1$.

Now that we know the relative distribution of investment for any government given its institutional quality, we can find the government's total level of PPP investment by multiplying g_{1t} by the government's available aggregate investment I. The usefulness of this is that we can now compare PPP investment levels across governments with varying debt and institutional quality. As such, it is possible to show that a country with a very high debt level and very high institutional quality could potentially spend more on PPPs than a country with no debt but very poor institutional quality (see Figure 1 below).[5] Governments on the left of the figure have very low institutional quality and as a result allocate only 10 percent of their available investment funds to PPPs, while governments on the right have very high institutional quality and allocate 90 percent of their available investment funds to PPPs. The different lines in the gradient of the figure show the level of fiscal constraint that governments face, with the bottom of the gradient facing the largest fiscal constraints and the top of the gradient facing no fiscal constraints. Constructed visually in this way, it should be relatively easy to see the institutional quality conditions that would result in a country with high fiscal constraints and high institutional quality spending more on PPPs than a country with low fiscal constraints and low institutional quality.

To see how selection bias might develop in this framework with regards to PPP use, consider a simple situation in which barriers to entry exist such that countries only receive positive net social welfare benefits from PPPs if they have institutional quality of 0.8 or greater

[5] This figure assumes $\delta = 1$ for simplicity.

(Figure 2). Under this condition, countries will only use PPPs if they have institutional quality of 0.8 or greater, resulting in an observed distribution of PPP use that is truncated relative to the true distribution without barriers to entry (Figure 1). Attempting to conduct an empirical study based solely on the data in Figure 2 will result in biased results, especially if the underlying decision rule that creates the truncated distribution is not known, because the observed distribution is quite different from the true distribution.

Figure 1: True Distribution of PPP Use

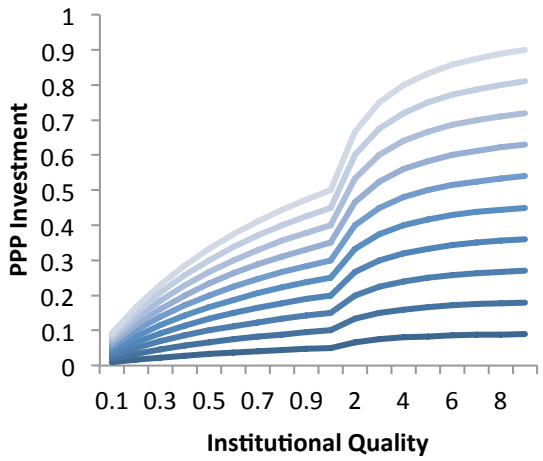
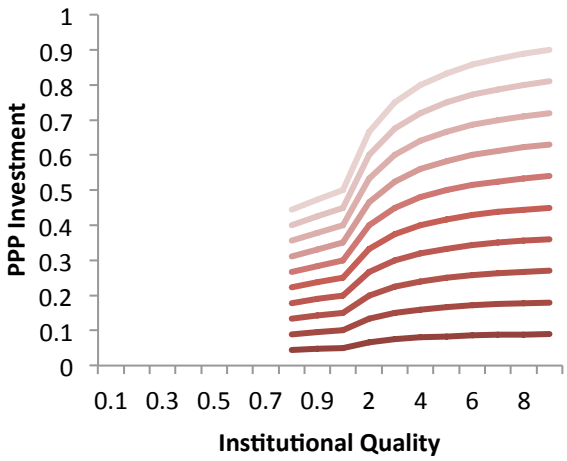


Figure 2: PPP Use with Barriers to Entry



Source: Authors' calculations.

Similar principles apply to development constraints, both in terms of the potential for countries with high institutional quality and high levels of development constraints to use more PPPs than other countries, and in terms of the potential for selection bias. Condition (1) provides an easy way to see that countries with lower β will develop infrastructure more slowly over time than others. Countries facing the constraint of a low β but with high institutional quality will therefore find significant benefits in allocating more resources to PPPs. The rate of growth of infrastructure investment spending will not match that of other countries, but the efficiency gains from using PPPs in concert with high institutional quality will mitigate some of the effects of the development constraints the country is facing.

What are the implications of these results? The first is that PPPs can be a crucial component of any infrastructure development program if used optimally. The existence of a well-behaved optimal investment ratio between PPPs and traditional procurement supports this point, while the existence of well-behaved intertemporal transition paths for both PPPs and

traditional procurement shows that PPP use can be sustainable as part of a long-term infrastructure plan.

The second implication is the importance of institutional quality to effective use of PPPs. While PPPs have a place in almost any country's infrastructure development plans in this model (assuming no barriers to entry), they see the greatest and most effective use in the countries with the highest institutional quality.

This second implication has important ramifications for those countries facing severe fiscal and development constraints, which leads to the third implication. Recall that institutional quality enters the government's budget constraint as a multiplier on the cost of PPPs, with higher institutional quality reducing the cost of PPPs. A country with high institutional quality but severe fiscal or development constraints will be able to maintain its infrastructure stock and development at a level comparable to countries with fewer constraints but lower institutional quality because of this cost adjustment.

However, the model and these implications assume optimal government behavior, and governments do not always behave optimally with respect to PPPs. It is entirely possible that countries in our sample have decided to use PPPs without optimal conditions, have implemented PPPs in a manner which is not optimal given their level of institutional quality, or do not have the capacity to enforce existing laws and frameworks (Engel, Fischer, and Galetovic, 2009). Regardless of the explanation for non-optimal PPP use, the message from the theoretical model is clear: making effective use of PPPs requires high levels of institutional quality.

3.1 Formalization of Hypotheses

We empirically test three primary hypotheses about the relationship between institutional quality, fiscal constraints, and PPP use based on the theoretical model we have constructed. We will discuss the results of similar hypotheses with respect to development and resource constraints in our results section. However, our primary focus is on institutions and fiscal constraints. Thus, we present the hypotheses here in these terms.

The first hypothesis is that institutional quality affects the level of expenditures on PPPs as a percentage of GDP. We test this hypothesis through the statistical significance and sign on the institutional quality instrument in the Heckman first stage, and the inverse Mills ratio in the second stage. If countries are using PPPs optimally, then we expect that countries with higher institutional quality would not only select in to using PPPs more frequently, but would also use them more extensively (conditional on the control for selection bias) relative to economic size

compared to countries with lower institutional quality. Similarly, if countries typically use PPPs for political patronage (Maskin and Tirole, 2007), we would expect countries with low institutional quality to select in to using PPPs more frequently, as well as use PPPs more extensively. If we fail to reject the null hypothesis in the first stage, this means that institutional quality has no effect on the decision to select in to using PPPs. If we fail to reject the null hypothesis in the second stage, it means that there is no selection bias in the data and institutional quality has no effect on PPP expenditures. That is, some countries use PPPs optimally and others do not, but there is no statistically discernible relationship between the selection process and country expenditures on PPPs.

The second hypothesis we test is that fiscal constraints have a direct effect on PPP expenditures. A positive and significant coefficient shows that countries frequently use PPPs to avoid fiscal constraints, while a negative and significant coefficient shows that countries avoid using PPPs in the presence of fiscal constraints. Because previous research has shown that fiscal constraints do promote PPP, use we expect to find that fiscal constraints increase expenditures using PPPs.

Our third hypothesis is that the effect of fiscal constraints on PPP use is conditional on institutional quality. We can test this hypothesis by statistically testing the differences of the individual coefficients in our baseline OLS model and our Heckman selection model. A statistically significant difference between these coefficients will indicate that bias from countries self-selecting into PPPs is noticeable with respect to the effect of fiscal constraints on PPPs. If Heckman selection produces a statistically larger coefficient, it means that countries selecting into using PPPs use them more extensively in response to fiscal constraints than would otherwise be detected. Determining whether this is optimal behavior requires relating this to the sign of the first stage institutional quality instrument and the inverse Mills ratio. Note that testing this hypothesis requires rejecting the null hypotheses of both of the above hypotheses. If we fail to reject the null hypothesis of the first hypothesis, then the Heckman selection coefficients approximate to the OLS coefficients. If we fail to reject the null hypothesis of the second hypothesis, then there is little point in testing for statistical differences between two coefficients that are statistically equivalent to zero.

4. Data

Our data selection follows from the concepts provided by the theoretical model, focusing on fiscal constraints, institutional quality, and development constraints. We also include demographic factors to account for the differences in the levels of infrastructure demand across

countries. The dependent variable, expected PPP investment,[6] is averaged across the 2008-2012 period, while the independent variables are averaged across the 2003-2007 period in keeping with our empirical structure of lagging all independent variables one time period. Our sample is 95 countries, 46 of which are PPP users and 49 of which do not use PPPs.[7] The table below provides the means and standard deviations of our variables for the full data sample as well as a restricted sample that includes only countries with a debt-to-GDP ratio less than 90 percent, which we use in our empirical framework to determine if there are any differences in the behaviors of highly indebted countries.

Table 1. Regression Variables and Summary Statistics

	Unrestricted sample mean (standard deviation)		Debt-to-GDP ratio < 90% mean (standard deviation)	
	PPP users	Non-PPP users	PPP users	Non-PPP users
PPP-GDP ratio *(Dependent Variable)*	0.36% (0.36)	-	0.33% (0.34%)	-
Debt-to-GDP Ratio	50.7% (28.1%)	68.7% (42.8%)	43.6% (19.6%)	50.0% (23.1%)
Tax burden (Revenue-to-GDP ratio)	26.2% (7.72%)	26.7% (8.47%)	26.2% (7.70%)	26.6% (8.77%)
ODA[8]-GDP ratio	3.42% (4.77%)	7.44% (8.64%)	2.91% (3.77%)	6.09% (6.82%)
Public investment-GDP ratio	5.13% (2.33%)	6.73% (2.95%)	5.22% (2.36%)	6.58% (2.75%)
CAB[9]-GDP ratio	-1.30% (6.04%)	-4.94% (9.15%)	-1.38% (6.30%)	-3.48% (9.50%)
Log GDP per capita	6.95 (1.37)	6.82 (1.56)	7.01 (1.41)	6.85 (1.41)
Growth trajectory	1.09% (1.86%)	1.26% (2.02%)	1.14% (1.29%)	1.33% (2.06%)
Population growth	1.45% (1.13%)	1.86% (1.19%)	1.35% (1.10%)	1.68% (1.13%)
Urbanization	52.8% (20.0%)	44.8% (20.0%)	52.8% (20.0%)	45.9% (20.0%)
Regulatory quality (Index, -2.5 to 2.5)	-0.25 (0.58)	-0.44 (0.72)	-0.17 (0.55)	-0.38 (0.72)
Sample size	46	49	41	38

Source: Authors' calculations.

[6] Public-private partnerships are defined as Greenfield public-private investment projects. There are four specific types of PPPs: Build, Lease, Transfer (BLT); Build, Operate, Transfer (BOT); Build, Rehabilitate, Operate, Transfer (BROT); Build, Own, Operate (BOO).

[7] We exclude as outliers Cambodia and Togo (PPP expenditures), Guinea-Bissau and São Tomé and Príncipe (debt-GDP ratio), Azerbaijan and Equatorial Guinea (growth trajectory), and China (public investment). Each of these countries is more than three standard deviations from the mean. We maintain Argentina in the dataset; it is barely over the three-standard-deviation threshold for the growth trajectory variable, but is a consistent and important PPP user and we are interested in how Latin America behaves.

[8] Official development assistance.

[9] Current account balance.

It is important to understand what the dependent variable, expected PPP investment, represents. No data exist for annual PPP investment outlays by project; the reported number is the expected investment outlay by the private sector for the project's construction. PPP projects typically move through numerous phases over the project life cycle, generally starting with the procurement or planning phase (which includes analysis and evaluation, bidding, negotiations, etc.), then the construction phase, and finally the operations phase. The important point represented in the data is the transition from the procurement or planning phase to the construction phase. Once negotiations have finished and a contract has been signed, the project is said to have reached financial closure, ending the procurement phase and moving the project into the construction phase. The investment value reported is the agreed upon projection of investment expenditures at financial closure. This value is not updated in the database over time as funds are disbursed, expenditures are made, or financing requirements are adjusted. As such, these values represent *perceptions* of the level of investment needed to carry out the project at financial closure and may not accurately represent actual expenditures (Flyvberg et al., 2002).

The ideal measure of fiscal constraint is one that accurately captures the difficulty in increasing revenues or decreasing expenditures without causing severely adverse economic effects, but such measures are difficult to find for large country sets across time. As such, we use measures that capture different perceptions of fiscal constraints: the ratio of general government gross debt to GDP, and the tax burden, which is the ratio of government revenue to GDP. The debt-to-GDP ratio is a highly visible measure and can act as a quick heuristic for assessing the level of fiscal constraints that a country may be facing. Though the terms of debt repayment may vary greatly across countries with similar debt levels, it is relatively easy to expect that a country with high debt is facing more fiscal constraints than a country with low debt. Additionally, theory and empirical literature have frequently returned to the question of whether particularly high debt-GDP ratios have broader macroeconomic effects such as lowering the growth rate or creating other non-linearities, even if only in agents' perceptions. Common thresholds for these effects are above 60 percent of GDP for "indebted" countries and above 90 percent of GDP for heavily indebted countries (Giavazzi, Japelli, and Pagano, 2000). We describe in Section 6.2: Debt Censoring, how we set up our test for whether heavily indebted countries behave differently than countries with lower debt levels.

The tax burden is likely to be a more direct, though less visible, representation of fiscal constraints. While a large country with better institutional quality may have an easier time raising

an additional 1 percent of GDP in taxes, the measurement of government revenue as a percentage of GDP gives a relatively direct approximation of how much of the country's income is used to support the government. A large country with high institutional quality but a tax burden of 40 percent of GDP could easily increase taxes to 41 percent of GDP, but it would probably consider such an action to be poor policy because of the significant drain such a high tax burden places on the economy. More to the point, a country maintaining a tax burden of 40 percent of GDP over an extended period is likely doing so because of a very high level of recurring expenditures, such as social programs. These programs are unlikely to be flexible, and may be very popular, placing the government in a situation where they are constrained to maintain expenditures on these continuous programs with little capacity for discretionary spending. As such, the salient component of interpreting the tax burden variable is not whether a country can easily raise more taxes, but is instead the implication of having a particularly high tax rate on being able to maintain enough fiscal flexibility through discretionary spending. In this respect, a country with a high tax burden is likely to face more constraints to discretionary spending than those with a low tax burden, though a country's institutional quality will necessarily have a part in determining the thresholds at which countries begin to seriously face fiscal constraints on the revenue side.

Institutional quality can be measured across several dimensions. The World Bank's World Governance Indicators provides six different measures: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. Not surprisingly, these measures are highly correlated with each other.[10] Because these variables are highly correlated, we include only the indicator we feel is most important for effective implementation and use of PPPs: regulatory quality. There is justification for using the government effectiveness indicator as well, but the success or failure of PPPs relative to traditional procurement methods hinges on public–private interactions. The regulatory quality indicator measures governments' capacity to formulate and implement private sector-oriented policies in an optimal manner.

We use this variable as our instrument to control for selection bias in the data. Although higher regulatory quality is likely to increase expected PPP investment, the converse is also true: lower regulatory quality in a PPP-using country may also increase expected PPP investment, as suggested by Engel, Fischer, and Galetovic (2009), Maskin and Tirole (2007), and the insignificant coefficient on the control of corruption variable in Hammami,

[10] Regulatory Quality, Government Effectiveness, Rule of Law, and Control of Corruption all have correlations of .8 or above with each other in our final data set.

Ruhashyankiko, and Yehoue (2006). This effect does not appear in our theoretical model because our theoretical model assumes that governments behave optimally, producing perfectly sustainable infrastructure investment choices. Given this, optimal behavior is independent of institutional quality in the model, while these two factors are likely to be strongly linked. As an example, the initial implementation of the PPP institutional framework in Honduras was flawed, with perverse incentives promoting the fiscally unsustainable approval of too many PPPs (Reyes-Tagle and Tejada, 2015).[11] Because Honduras approved a fiscally unsustainable level of PPPs in the early years of the program, it spent more on PPPs than it would have, had institutional quality been higher.

Although our previous two variable concepts represent our main avenues of inquiry, there is a third set of important variables identified by the theoretical model: development constraints. These include the current account balance, GDP per capita, the trajectory of the business cycle, public investment in infrastructure,[12] and official development assistance (ODA). A large current account deficit must be financed with foreign exchange; a poor or deteriorating current account may make private partnerships with foreign firms unappealing. Low GDP per capita and being in the recessionary component of the business cycle could make PPPs more appealing to mitigate lost infrastructure investment relative to wealthier countries (GDP per capita) or relative to the expansionary component of the business cycle. Like GDP per capita, lower levels of public infrastructure expenditures relative to other countries could prompt additional investment using PPPs to help make up the infrastructure investment deficit. Our last variable representing these constraints, ODA, represents the effects of a country's respective levels of development; countries receiving more ODA likely require more help to develop and modernize their infrastructure, with Sub-Saharan African countries receiving an exceptionally large amount of ODA relative to their GDP.

Finally, we include demographic factors. Though not incorporated in the theoretical model, urbanization helps to control for market density and potential economies of scale in infrastructure development, while the population growth rate controls for the trajectory of future demand for infrastructure. We expect that high levels of urbanization will make PPPs more appealing for the private sector due to the presence of large, dense markets requiring less capital outlays to reach consumers. Additionally, because of infrastructure's long life cycle, planners must consider changes in the population over decades, making the population growth

[11] The PPP framework was later reformed to correct many of the initial problems.
[12] Represented by gross public fixed capital formation (GPUFCF).

rate a decent means of projecting future demand for infrastructure. A high population growth rate will necessarily entail more investment now to meet future demand.

The primary data source for the dependent variable, expected PPP investment, is the World Bank's Private Participation in Infrastructure database. General government debt, government revenues, GPUFCF, the current account balance, and GDP are taken or constructed from the IMF's World Economic Outlook. ODA, urbanization, and population growth are taken from the World Bank's World Development Indicators. Regulatory quality is taken from the World Bank's World Governance Indicators. PPP expenditures, debt, revenues, ODA, GPUFCF, and the current account balance are measured as percentages of GDP to provide easy benchmarking of thresholds—whether a country surpasses a "very highly indebted" threshold of a debt-to-GDP ratio greater than 90 percent, for example—and easily interpretable results.

4.1 Institutional Quality Outliers

As described in the literature, nonlinearities may exist in the relationship between institutional quality and expected PPP investment. There may also be indirect effects in the relationships between institutional quality and our other independent variables. As a test of whether these nonlinearities exist, we exclude a small set of countries with particularly low institutional quality that may function under different market and/or economic principles than normal and may introduce noise into our results. We remove Chad, Sudan, and Uzbekistan—the only countries from Transparency International's 2007 list of the 10 most corrupt countries[13] in our dataset—from some of our regression specifications to see whether this concern is valid. An important point here is that none of these countries participates in PPPs, and as such any bias they impose on the empirical study will appear only in the probit and Heckman first stage. Despite this, understanding nonlinearities at the lower end of the institutional quality spectrum may provide useful insight into the proper adoption and application of PPPs.

5. Empirical Theory

This study proposes several extensions to the empirical strategies used by Checherita (2009) and Hammami, Ruhashyankiko, and Yehoue (2006). To summarize the strategies of our predecessors along the dimensions in which we make innovations, Checherita (2009) and Hammami, Ruhashyankiko, and Yehoue (2006) assume primarily contemporaneous relationships between the dependent and explanatory variables; use annual data; and use

[13] http://www.transparency.org/research/cpi/cpi_2007. Last Accessed 2/1/2016.

pooled and random effects Tobit models to correct for selection bias when the dependent variable is expected PPP investment.

The key concepts that underpin this study's methodology are as follows. We lag all our explanatory variables because our dependent variable reflects the joint *expectation* of the public and private sectors about how much the infrastructure project will cost at the end of the planning phase. This means that only the fiscal, institutional, and macroeconomic conditions that exist during or before a project's planning phase will influence the dependent variable. We are also primarily interested in capturing the medium-term conditions that exist during or before the planning phase, so we transform our data into five-year averages. This provides us with a balance between providing enough time to observe medium-term dynamics, allowing us to use a simpler lag structure, and smoothing the lumpy dependent variable. Finally, over half of our dataset does not use PPPs, creating the potential for selection bias in any regression that uses expected PPP investment as a dependent variable. We utilize Heckman selection as a more explicit control for this bias than that provided by the Type 1 Tobit. Heckman selection can be thought of as more than simply a bias correction method; the significance and sign on the inverse Mills ratio, and the differences in coefficients between the baseline OLS and the Heckman selection models can provide important information on the indirect effects of institutional quality on the basis for expected investment using PPPs. Table 2 provides a summary of the concepts that underpin our empirical theory, and how we implement the concept within our framework.

Table 2. Empirical Concepts and Implementation

Concept	**Implementation**
Observed dependent variable outcomes post-date project planning, and the determinants of project development, by years.	All explanatory variables are lagged one time block.
Projects are long-term; short-term economic volatility is just noise	Data are in five-year averages.
Sample selection bias; countries make endogenous choice to use PPPs instead of public investment	Heckman selection (also known as "Heckit" or "type 2 Tobit").

Source: Authors' description.

This study's questions are primarily concerned with the underlying economic and institutional factors that cause governments to decide whether to participate in PPPs, and at what expenditure level to participate. Both factors are determined before or during the investment planning phase. To investigate this, we lag all our independent variables due to the observed outcomes that comprise our dependent variable—expected PPP investment—being

visible only once the planning phase has concluded. However, the multi-year nature of the planning phase and long-term nature of PPP projects necessitate a data structure that can capture medium-term effects without the noise of short-term fluctuations.

To best study the medium-term effects that we believe will have the largest effect on PPP planning, we aggregate our data to five year averages. This data structure allows us to strike a balance between capturing policymakers' perceptions of the medium-term economic outlook before and during the PPP planning phase (which usually takes two to three years) without adopting a complicated lag structure, and smoothing out the "lumpiness" in the dependent variable. On this first point, we believe that policymakers' perceptions are most informed by the economic conditions of the past two to three years, so a five-year average will capture the average of policymakers' perceptions from the beginning of the PPP planning phase (which includes the two to three years before planning begins) to the end of the planning phase two to three years later. On the second point, the values for expected PPP investment in the dataset are associated with the years in which they were committed, not the years in which the investment was spent. A project worth $4 million, committed in 1993 but scheduled to be spent in $1 million increments every year between 1993 and 1996, would be recorded as having a $4 million investment in 1993 and no investment in 1994–1996. By averaging these expected investment commitments across many years, we remove the lumpiness from the dependent variable and provide a more accurate perception of a country's average level of PPP investment over time.

Our last consideration is our method for correcting for selection bias, which might have a large effect on our results because half the countries in the sample do not participate in PPPs. Selection bias arises from not knowing the decision rule that a country has for participating in PPPs; a country may wish to engage in some level of PPP participation, but the associated costs or political factors could make it unfeasible. The level of preferred investment and the barriers to participating are completely unobserved; thus, removing the nonparticipating countries (or including them without correcting for their decision rules) biases the data without knowing how it is biased. Full-information maximum likelihood (FIML) Heckman selection is our preferred method for correcting for selection bias in the dependent variable (PPP investment). Heckman selection is a less restrictive correction method than the Type 1 Tobit (Vella, 1998), although it is sensitive to the quality of the instrument used to control for the endogenous choice in the agent's decision.

The utility of Heckman selection is not simply as a correction for selection bias. As stated previously, we are interested in the indirect effect of institutional quality on expected PPP

investment and the statistical significance and sign of the inverse Mills ratio can provide useful information about the optimality of PPP use. If the inverse Mills ratio is positive and significant, the indication is that, on average, countries use PPPs in an optimal way because the bias is toward the countries with higher institutional quality. If the inverse Mills ratio is negative and significant, the indication is that, on average, countries have significant room for improvement in their use of PPPs because the bias is toward countries with lower institutional quality. If the inverse Mills ratio is insignificant, then there is a relatively even split between countries that use PPPs optimally and countries that do not, as determined by institutional quality.

6. Empirical Methodology

We estimate three separate models using a cross-sectional methodology: a simple OLS model as a base line, a Heckman selection model to account for selection bias, and a probit as both a check against the Heckman first-stage estimation and an investigation into the country-level choice of whether to use PPPs. We study the effects of macroeconomic, institutional quality, and demographic conditions between 2002 and 2007 on expected PPP investment between 2008 and 2012, setting the transition from the independent variables to the dependent variable between 2007 and 2008 to isolate the effects of the global financial crisis to one period and prevent any confounding spillover effects from the crisis. This raises the issue that the global financial crisis invariably affected PPP expenditures in the period following 2008, and thus could produce biased results between the relationship of the exogenous variables prior to 2008 and their outcomes. However, this is a tradeoff that we must make to avoid both the East Asian Financial Crisis of 1997[14] and the Argentine crisis of 1998 while also ensuring maximum data availability. Once countries lacking data and outliers are removed from our sample, 95 observations are available, whereas using the pre-crisis period (1998–2002 for the independent variables, 2003–2007 for the dependent variable) provides half the sample size. The OLS and Heckman second stage use the same basic specification:

(1) $$PPPGDP = \alpha + \beta_1 L5.GrossDebtGDP + \beta_2 L5.TaxBurden + \beta_3 L5.ODAGDP + \beta_4 L5.PubInvestGDP + \beta_5 L5.CABGDP + \beta_6 L5.lgdppercapita + \beta_7 L5.GrowthTrajectory + \beta_8 L5.PopGrowth + \beta_9 L5.Urbanization + \beta D + \varepsilon$$

[14] The East Asia and the Pacific region was the most prolific user of PPPs before 1997, and one of the least prolific users after 1997. The East Asian crisis had a significant long-term effect on PPP use within the region. Any time structure that includes this crisis and its aftereffects will likely have severely biased results because of this, especially with the limited data availability.

while the probit and Heckman first stage use the following specification:[15]

(2) $pppindic =$

$$\alpha + \beta_1 L5.GrossDebtGDP + \beta_2 L5.TaxBurden + \beta_3 L5.ODAGDP + \beta_4 L5.PubInvestGDP + \beta_5 L5.CABGDP + \beta_6 L5.lgdppercapita + \beta_7 L5.GrowthTrajectory + \beta_8 L5.PopGrowth + \beta_9 L5.Urbanization + \beta_{10} L5.RegulatoryQuality + \beta D + \varepsilon$$

All variables are five-year averages. Variables with the L5 prefix are averaged across 2003–2007 rather than 2008–2012. The variables are defined as follows:

- $PPPGDP$: PPP expenditures as a ratio of GDP.
- $pppindic$: An indicator variable with a value of 1 if the country participated in at least one PPP between 2008 and 2012, and zero otherwise.
- $L5.GrossDebtGDP$: General government gross debt as a percentage of GDP.
- $L5.TaxBurden$: Total government revenue as a percentage of GDP. Our proxy for the country's tax burden.
- $L5.ODAGDP$: Net official development assistance as a percentage of GDP.
- $L5.PubInvestGDP$: Gross public fixed capital formation as a percentage of GDP. Our proxy for public investment.
- $L5.CABGDP$: Current account balance as a percentage of GDP.
- $L5.lgdppercapita$: The natural log of GDP per capita.
- $L5.GrowthTrajectory$: The percent deviation of the annual growth rate from the five-year moving average of growth. Our proxy for the direction of the business cycle.
- $L5.PopGrowth$: Annual population growth rate.
- $L5.Urbanization$: The percentage of a country's population living in urban areas.
- $L5.RegulatoryQuality$: World Development Indicators Regulatory Quality.
- *D* is the vector of the six regional indicator variables. The six indicators are:
    - EAP: East-Asian Pacific
    - EAC: Europe and Central Asia
    - LAC: Latin America and the Caribbean
    - MENA: Middle East and North Africa
    - SAR: South Asia
    - SSA: Sub-Saharan Africa

[15] Note that the South Asian region (SAR) is perfectly predicted by the probit and as such is omitted from the probit. The probit and Heckman selection models do not perfectly share samples, but we decided against the alternatives of removing the SAR region from the Heckman selection regressions or using the asis command in Stata, which forces the inclusion of perfectly predicted variables in the probit regression but may also introduce numerical instability.

6.1 Africa Interactions

We include interaction terms between $L5.ODAGDP$ and the Sub-Saharan Africa dummy and $L5.PubInvest$ and the Sub-Saharan Africa dummy in supplementary specifications. This is to account for the significantly larger amount of ODA that many Sub-Saharan African countries receive as a percentage of GDP, and the potential for the sign on the interaction between ODA and SSA to have implications on the complementarity or substitutability between public investment and PPPs, both for the region and the rest of the world. For example, if ODA is found to produce less PPP expenditure per dollar of assistance in Sub-Saharan Africa than the rest of the world, then it is possible that the PPP investment that would have otherwise been made as a result of receiving ODA was instead targeted at public investment, producing a complementary effect. Additionally, Africa's infrastructure gap is so large (Calderón and Servén, 2008) that African countries may not have the luxury of being able to choose between PPPs and traditional procurement. They may be in a situation where they must use whatever methods are available to develop infrastructure as rapidly as possible, producing a complementary effect for traditional procurement methods and PPPs specifically in Africa.

6.2 Debt Censoring

We run two regressions for every specification, one with the full data sample and one with only those countries with a debt-to-GDP ratio below 90 percent, to test whether there are nonlinearities in the effects of the debt-to-GDP ratio on the PPP-to-GDP ratio at higher levels. This may seem like an unusual method, but the practical effect is essentially the same as running a regression in which every independent variable is interacted with a dummy variable that is 1 if the debt-to-GDP level is below 90 percent and 0 otherwise. The reason we use this empirical approach is because estimation using FIML with Heckman selection is difficult and non-convergence of the estimator is relatively common across specifications. Doubling the number of variables in the regression relative to the specifications referenced above produces a model that is too complex for FIML to estimate. By dividing these into separate estimations, we can produce a comparable effect while also retaining convergence of the estimator.

As a practical note, we censor those countries with a debt-to-GDP ratio above 90 percent rather than the other way around because there are only 16 countries in the sample with a debt-to-GDP ratio above 90 percent and their data is quite noisy. We therefore must understand any nonlinear effects at very high debt levels by comparing the differences in the estimations of the full sample and the restricted sample.

7. Results

In this paper, we presented three hypotheses derived from our theoretical model, which we would directly test with our empirical framework. We will present the outcomes of our hypothesis tests first in concert with the second stage Heckman selection results upon which they are based, then present the results of our probit. We will follow with a comprehensive interpretation of the results to present a picture of the average PPP using country, then discuss the implications of not finding selection bias in the dataset (our first hypothesis).

We were not able to reject the null hypothesis of our first hypothesis that selection bias exists in our dataset. By extension, this means that we were also not able to reject the null hypothesis of our third hypothesis, that institutional quality has indirect effects on PPP expenditures through the explanatory variables in the second stage of our Heckman selection model. Failing to reject the null hypothesis of no selection bias means the second stage coefficients approximate to the OLS coefficients.[16] We were, however, able to reject the null hypothesis of our second hypothesis, finding that fiscal constraints increase expenditures on PPPs as a percentage of GDP. This result corresponds with previous research by Checherita (2009) and Hammami, Ruhashyankiko, and Yehoue (2006). In a similar vein to the second hypothesis, we found that development constraints (represented by higher levels of ODA) and market concentration (higher urbanization) also increase expenditures on PPPs. The result on development constraints has support from Checherita (2009) but was not found to be significant by Hammami, Ruhashyankiko, and Yehoue (2006). The result on market concentration has a slight parallel in Hammami, Ruhashyankiko, and Yehoue (2006) result that population increases PPP expenditures, but market concentration can happen even in small states making it a much more nuanced measure of ability to respond to demand efficiently rather than simply a measure of aggregate demand.

We also found that interacting the Africa dummy variable with public investment and foreign aid illuminates interesting relationships with PPP expenditures in least developed countries. Interacting the Africa dummy with public investment shows that public investment and PPPs are complements in Africa, with no statistically significant relationship in the rest of the world. Interacting the Africa dummy with ODA shows that ODA produces much less PPP investment per percent of GDP than in the rest of the world. This explains why the coefficient on ODA has relatively weak significance for the entire sample without the Africa interaction: African countries receive outsized ODA receipts as percentages of GDP compared to the rest of the world, weakening the aggregate observed effect unless the interaction is controlled for.

[16] For this reason, we do not report the results of the OLS regressions.

Despite being unable to reject the null hypothesis of no selection bias in the dataset, we find that institutional quality is a key determinant of the choice to use PPPs. This result has weak support from Hammami, Ruhashyankiko, and Yehoue (2006), who find that control of corruption is significant and positive in their zero-inflated Poisson model,[17] but has no comparable analogue in Checherita's (2009) study. We also find that lower per capita GDP, which we consider a resource constraint, increases the probability that a country has an active PPP program. This result is not supported in either Hammami et al.'s (2006) or Checherita's (2009) studies, but this discrepancy has to do with scale. We are considering only the binary decision of countries to use PPPs in our probit, whereas the count variables that Hammami et al. (2006) and Checherita (2009) study will necessarily increase with economic size simply due to larger economies needing more infrastructure projects. The final result from our probit is that public investment and PPPs appear to be substitutes in the decision to use PPPs. That is, countries with lower historical levels of public investment are less likely to be using PPPs.

Due to the sizeable infrastructure gaps around the world (Andrés et al., 2014; Calderón and Servén, 2008) we argue that the primary explanation of this substitution effect is that countries are unable to meet demand for infrastructure through purely public means rather than an active choice between pure public and public–private investment. Once again, the interaction with the Africa dummy produces an interesting result, weakening the statistical effect of public investment when it is included. This, however, appears to be a result of redundancy: the PPP selection decision for Africa conditional on public investment is similar enough to the rest of the world (though it is not necessarily collinear) that including the interaction term weakens the overall fit of public investment within the model.

According to the results we have presented, the average country that maintains an active PPP program is one that has higher than average institutional quality, but is also experiencing persistent long-term resource and infrastructure constraints relative to other similar countries. Public–private partnerships provide a means by which countries can close the infrastructure gap even when facing a variety of constraints. Doing so effectively requires excellent planning, management, legal frameworks, and political systems; hence, institutional quality is a key determinant of the decision to select into PPPs.

Once countries have selected into PPPs, matters change very little, but these small changes can be particularly important. We still see that countries facing constraints—fiscal

[17] This only provides weak support because the zero-inflated Poisson model includes both the selection decision and the scale decision, and these are not disaggregated in the results; the significance could easily be a result of the scale decision. Additionally, we believe that control of corruption is an indirect indicator of government capacity to formulate and implement effective policy, while our control variable, regulatory quality, is a direct indicator.

constraints (high debt-to-GDP ratio) and development constraints (large ODA receipts)—use PPPs more extensively. However, institutional quality is no longer key to PPP-related decisions. The crux of this change lies in the concept of selection bias representing optimal PPP use.

Our theoretical model provided a simple illustration of how selection bias could occur with respect to PPPs, by creating a simple barrier to entry that causes countries with low institutional quality to not opt in to using PPPs. However, the barriers to entry are not so clear cut in reality. PPP-using countries have higher institutional quality on average, but this does not mean that all PPP-using countries have high institutional quality, or even sufficient institutional capacity to maintain an active PPP program. Many countries with poor institutional quality have selected in to using PPPs and may not understand the necessities of managing a PPP program (Reyes-Tagle and Tejada, 2015). The decision to opt in to PPPs requires excellent capacity to create and implement institutional frameworks and subsequently to evaluate and oversee complex projects. These are critical institutional facets that are likely to be missing in countries with low institutional quality. Thus, countries with low institutional quality may not actually know that they are not receiving net social welfare benefits from using PPP programs. A second option is that the political costs of shutting down an existing institutional structure—which was itself probably costly to develop and implement—may not be feasible for the government. Under such conditions, the government may continue to use PPPs due to political expediency even if they *do* know that PPPs are not providing net social welfare benefits. A third option is that even though PPP programs in countries with poor institutional quality may not provide net social benefit relative to doing nothing, they may still be a better option than pure public investment, resulting in a situation where the government picks the best from a set of bad options rather than doing nothing.

These situations—and many other similar ones—leave governments especially vulnerable to the risks incurred by inadequate management of PPP programs. All PPP-using governments should take active steps to improve their institutional structures to mitigate the risks of PPPs while maximizing their benefits. Many governments have recognized that institutional quality is an important precondition for unlocking the benefits of PPP programs in the face of many types of constraints, but it is unclear whether this understanding has been able to translate to the operational implementation of PPPs.

8. Conclusions

This study contributes to the existing literature on the determinants of the choice to use PPPs and the intensity of PPP use in two primary ways. The first is an in-depth investigation into the

optimality of PPP use around the world, and the interactions with institutional quality. The second is an examination of the effects of fiscal and development constraints on both the decision to use PPPs and the intensity of PPP use.

We developed a theoretical model to explore how the interaction of institutional quality, fiscal constraints, and development constraints produces situations in which constrained countries with high institutional quality make more extensive use of PPPs than countries with few constraints but low institutional quality. We used the insights derived from this model to guide our empirical investigation through three primary hypotheses, with one caveat: the theoretical model assumes optimal government behavior, whereas the real world does not guarantee optimality.

Our empirical investigation accounted for the potential non-optimality of government behaviors by testing for the indirect effects of institutional quality on the intensity of PPP use using a Heckman selection model. Heckman selection is generally considered a correction for selection bias—which was a potential problem in our dataset—but we extended our interpretation of the correction mechanism to provide economic intuition of whether governments use PPPs optimally on average. Our findings suggest that there is a wide range of government behavior, with some behaving optimally and others behaving otherwise, but the average distribution of behavior does not trend in either direction. However, we did find that fiscal and development constraints play important roles in determining the intensity of investment using PPPs, and that institutional quality very much informs the decision rule of whether to use PPPs. This indicates to us that, as suggested by our theoretical model, PPPs can be a useful component of comprehensive infrastructure development projects. The difficulty appears to be in the optimal implementation of the projects themselves, which raises many concerns about the sustainability of PPP programs when their use is so often linked to the avoidance of fiscal constraints. It is the responsibility of governments to ensure that the necessary institutional capacity is in place to effectively manage and oversee their PPP programs. The potential benefits of PPPs may be great, but the risks are not to be taken lightly.

The future of governments using PPPs is not, however, bleak. The continued research and dissemination of knowledge about PPPs and the existence of effective institutions for development means that resources for governments to improve their approaches to PPPs are becoming ever easier to access and use. Consider the case of Honduras again (Reyes-Tagle and Tejada, 2015), where the institutions related to PPPs had an initially problematic implementation. These institutions have undergone several successful reforms in recent years, in part because of increasing ease of access to information about the proper functioning of PPP

institutions. Any government wishing to make effective use of PPPs must establish effective institutions as the baseline for their development, but the resources available to governments today place this goal within their reach, provided there is political will and the determination to implement them effectively.

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Appendix 1. Control for Institutional Quality

Table A1.1. Probit with Control for Institutional Quality

Probit	Unrestricted		Debt-to-GDP <90%	
	Uses PPPs?	*Margins*	**Uses PPPs?**	*Margins*
L5.GrossDebtGDP	-0.000696	-0.000202	0.00484	0.00140
	(0.00573)	(0.00166)	(0.00974)	(0.00280)
L5.TaxBurden	0.0141	0.00410	0.0170	0.00490
	(0.0209)	(0.00605)	(0.0217)	(0.00623)
L5.ODAGDP	-0.0558	-0.0162	-0.0824	-0.0238
	(0.0398)	(0.0111)	(0.0591)	(0.0162)
L5.PubInvestGDP	**-0.160****	**-0.0464*****	**-0.166****	**-0.0479****
	(0.0648)	(0.0178)	(0.0766)	(0.0212)
L5.CABGDP	0.0334	0.00969	0.0213	0.00616
	(0.0250)	(0.00708)	(0.0280)	(0.00806)
L5.lgdppercapita	**-0.513****	**-0.149****	**-0.497***	**-0.143****
	(0.219)	(0.0585)	(0.258)	(0.0682)
L5.GrowthTrajectory	-0.0854	-0.0248	-0.100	-0.0289
	(0.0838)	(0.0239)	(0.0989)	(0.0281)
L5.PopGrowth	0.111	0.0322	0.381	0.110
	(0.211)	(0.0612)	(0.268)	(0.0750)
L5.Urbanization	0.0106	0.00306	0.00712	0.00206
	(0.00977)	(0.00279)	(0.0112)	(0.00320)
ECA	0.250	0.0726	0.621	0.179
	(0.813)	(0.234)	(0.901)	(0.255)
LAC	-0.686	-0.199	-0.846	-0.244
	(0.592)	(0.170)	(0.609)	(0.172)
MENA	0.0995	0.0289	0.439	0.127
	(0.651)	(0.189)	(0.754)	(0.218)
o.SAR	-	-	-	-
SSA	-0.562	-0.163	-0.809	-0.234
	(0.635)	(0.183)	(0.680)	(0.194)
L5.RegulatoryQuality_5	**0.727****	**0.211****	**1.038*****	**0.300*****
	(0.353)	(0.0951)	(0.382)	(0.0935)
Constant	**4.504****		**4.078***	
	(1.816)		(2.251)	
Observations	89	89	74	74

Source: Authors' estimations.
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A1.2. Heckman Selection with Control for Institutional Quality

Heckman Selection	Unrestricted		Debt-GDP <90%	
	PPP-GDP Ratio	*First Stage*	**PPP-GDP Ratio**	*First Stage*
L5.GrossDebtGDP	**0.00372****	-0.000464	0.00249	0.00352
	(0.00173)	(0.00574)	(0.00311)	(0.00954)
L5.TaxBurden	-0.0110	0.0146	-0.0141	0.0155
	(0.0117)	(0.0200)	(0.0110)	(0.0205)
L5.ODAGDP	**0.0299***	-0.0594	**0.0508****	-0.0794
	(0.0174)	(0.0422)	(0.0222)	(0.0611)
L5.PubInvestGDP	0.0302	**-0.155****	0.0161	**-0.167****
	(0.0223)	(0.0651)	(0.0205)	(0.0774)
L5.CABGDP	-0.00426	0.0325	0.00124	0.0202
	(0.00872)	(0.0255)	(0.00923)	(0.0289)
L5.lgdppercapita	-0.0325	**-0.532****	-0.0346	**-0.502***
	(0.0453)	(0.239)	(0.0514)	(0.278)
L5.GrowthTrajectory	-0.0358	-0.0854	-0.0143	-0.0911
	(0.0348)	(0.0841)	(0.0506)	(0.0958)
L5.PopGrowth	-0.0179	0.125	-0.0591	0.375
	(0.0798)	(0.215)	(0.0875)	(0.257)
L5.Urbanization	**0.0102*****	0.0113	**0.00972*****	0.00766
	(0.00324)	(0.00973)	(0.00317)	(0.0108)
ECA	0.166	0.381	0.117	0.720
	(0.214)	(0.875)	(0.167)	(0.947)
LAC	0.0817	-0.673	0.0903	-0.838
	(0.122)	(0.567)	(0.121)	(0.587)
MENA	0.0253	0.120	0.0763	0.441
	(0.189)	(0.637)	(0.203)	(0.727)
SAR	**0.390****	**7.680*****	**0.333***	**7.464*****
	(0.186)	(0.727)	(0.189)	(0.886)
SSA	0.0757	-0.504	0.0285	-0.746
	(0.169)	(0.624)	(0.165)	(0.670)
Inverse Mills' Ratio	-0.477		-0.504	
	(0.361)		(0.360)	
L5.RegulatoryQuality		**0.771****		**1.073*****
		(0.351)		(0.374)
Constant	-0.102	**4.501****	0.159	**4.134***
	(0.455)	(1.866)	(0.523)	(2.262)
Observations	92	92	77	77

Source: Authors' estimations.
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Appendix 2. Control for Institutional Quality and Africa Interactions

Table A2.1. Probit with Control for Institutional Quality and Africa Interactions

Probit	Unrestricted		Debt-to-GDP <90%	
	Uses PPPs?	*Margins*	**Uses PPPs?**	*Margins*
L5.GrossDebtGDP	-0.00147	-0.000427	0.00237	0.000681
	(0.00575)	(0.00167)	(0.00969)	(0.00279)
L5.TaxBurden	0.0175	0.00507	0.0165	0.00474
	(0.0220)	(0.00630)	(0.0224)	(0.00638)
L5.ODAGDP	-0.0677	-0.0196	-0.0546	-0.0157
	(0.0980)	(0.0279)	(0.109)	(0.0309)
L5.ODAGDPxAfrica	0.0140	0.00406	-0.0217	-0.00624
	(0.0937)	(0.0270)	(0.104)	(0.0300)
L5.PubInvestGDP	-0.113	-0.0328	**-0.140***	**-0.0404***
	(0.0747)	(0.0217)	(0.0784)	(0.0228)
L5.PubInvestGDP xAfrica	-0.130	-0.0375	-0.0958	-0.0276
	(0.147)	(0.0410)	(0.183)	(0.0515)
L5.CABGDP	0.0301	0.00872	0.0220	0.00633
	(0.0246)	(0.00696)	(0.0283)	(0.00808)
L5.lgdppercapita	**-0.493****	**-0.143****	**-0.465***	**-0.134***
	(0.228)	(0.0611)	(0.269)	(0.0721)
L5.GrowthTrajectory	-0.0815	-0.0236	-0.0875	-0.0252
	(0.0856)	(0.0244)	(0.101)	(0.0289)
L5.PopGrowth	0.142	0.0412	0.396	0.114
	(0.214)	(0.0616)	(0.269)	(0.0758)
L5.Urbanization	0.0110	0.00318	0.00555	0.00160
	(0.0103)	(0.00293)	(0.0118)	(0.00337)
ECA	0.314	0.0907	0.611	0.176
	(0.804)	(0.230)	(0.894)	(0.252)
LAC	-0.654	-0.189	-0.834	-0.240
	(0.567)	(0.163)	(0.593)	(0.168)
MENA	0.0809	0.0234	0.375	0.108
	(0.643)	(0.186)	(0.743)	(0.214)
o.SAR	-	-	-	-
SSA	0.173	0.0500	-0.243	-0.0701
	(0.988)	(0.285)	(1.061)	(0.307)
L5.RegulatoryQuality	**0.723****	**0.209****	**1.040*****	**0.300*****
	(0.342)	(0.0906)	(0.373)	(0.0910)
Constant	**3.975****		**3.843***	
	(1.841)		(2.263)	
Observations	89	89	74	74

Source: Authors' estimations.
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A2.2. Heckman Selection with Control for Institutional Quality and Africa Interaction

Heckman Selection	Unrestricted		Debt-to-GDP <90%	
	PPP-GDP Ratio	*First Stage*	**PPP-GDP Ratio**	*First Stage*
L5.GrossDebtGDP	**0.00439*** **	-0.00111	0.00301	0.00119
	(0.00133)	(0.00580)	(0.00299)	(0.00941)
L5.TaxBurden	-0.0149	0.0174	-0.0155	0.0159
	(0.0111)	(0.0208)	(0.0101)	(0.0209)
L5.ODAGDP	**0.0702** **	-0.0602	**0.0769** **	-0.0453
	(0.0324)	(0.0976)	(0.0343)	(0.106)
L5.ODAGDPxAfrica	**-0.0507***	0.00384	-0.0489	-0.0291
	(0.0288)	(0.0946)	(0.0341)	(0.102)
L5.PubInvestGDP	-0.00267	-0.122	-0.00498	**-0.157***
	(0.0216)	(0.0762)	(0.0218)	(0.0844)
L5. PubInvestGDP xAfrica	**0.0942*** **	-0.114	**0.0818** **	-0.0815
	(0.0339)	(0.146)	(0.0333)	(0.183)
L5.CABGDP	-0.00251	0.0314	0.00291	0.0207
	(0.00738)	(0.0253)	(0.00796)	(0.0293)
L5.lgdppercapita	-0.00270	**-0.514** **	-0.0278	-0.477
	(0.0512)	(0.250)	(0.0544)	(0.291)
L5.GrowthTrajectory	-0.0348	-0.0850	0.0133	-0.0789
	(0.0304)	(0.0855)	(0.0515)	(0.0992)
L5.PopGrowth	0.00523	0.151	-0.0417	0.390
	(0.0725)	(0.218)	(0.0848)	(0.264)
L5.Urbanization	**0.00971*** **	0.0113	**0.00927*** **	0.00616
	(0.00356)	(0.00983)	(0.00356)	(0.0111)
ECA	0.136	0.452	0.0993	0.665
	(0.188)	(0.893)	(0.155)	(0.938)
LAC	-0.00491	-0.646	0.0219	-0.855
	(0.116)	(0.550)	(0.125)	(0.577)
MENA	-0.0146	0.0813	0.0697	0.347
	(0.146)	(0.633)	(0.171)	(0.738)
SAR	0.242	**7.679*** **	0.225	**7.196*** **
	(0.200)	(0.866)	(0.203)	(0.851)
SSA	**-0.351** **	0.131	-0.256	-0.291
	(0.160)	(0.958)	(0.184)	(1.044)
Inverse Mills' Ratio	-0.386		-0.478	
	(0.196)		(0.208)	
L5.RegulatoryQuality		**0.763** **		**1.049*** **
		(0.342)		(0.368)
Constant	-0.0820	**4.100** **	0.192	**4.014***
	(0.447)	(1.904)	(0.496)	(2.296)
Observations	92	92	77	77

Source: Authors' estimations.
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.