PEKING UNIVERSITY
Institute of New Structural Economics

Working Paper Series of New Structural Economics

No. E2020006 **2020-12-04**

Can a New Model of Infrastructure Financing Mitigate Credit Rationing in Poorly Governed Countries?

Jiajun Xu*

Institute of New Structural Economics, National School of Development at Peking University

Xinshun Ru

School of Mathematics, Shandong University

Pengcheng Song

School of Economics and Finance of Xi'an Jiaotong University

* Corresponding author. Institute of New Structural Economics and National School of Development at Peking University, Beijing, 100871, P. R. China. E-mail address: jiajunxu@nsd.pku.edu.cn.

Acknowledgements: This work was supported by the National Natural Science Foundation of China - Data Center for Management Science at Peking University (2017KEY06) and the National Social Science Foundation (17BJL124). We would like to thank the China Africa Research Initiative from Johns Hopkins University to share the loan-level data of China-Africa Loan Database. We are grateful for constructive feedbacks from the editor and anonymous reviewers. The views expressed here are our own.

PEKING UNIVERSITY
Institute of New Structural Economics
Working Paper Series of New Structural Economics

Can a New Model of Infrastructure Financing Mitigate Credit Rationing in Poorly Governed Countries?

Jiajun Xu*

Institute of New Structural Economics, National School of Development at Peking University

Xinshun Ru

School of Mathematics, Shandong University

Pengcheng Song

School of Economics and Finance of Xi'an Jiaotong University

Abstract

We explore why resource-financed infrastructure—whereby developing countries pledge future resource revenues to repay infrastructure loans—mitigates credit rationing in poorly governed countries. Using a novel project-level database, we find that the loan sizes for resource-financed infrastructure are much larger than those determined by the traditional government infrastructure

* Corresponding author. Institute of New Structural Economics and National School of Development at Peking University, Beijing, 100871, P. R. China. E-mail address: jiajunxu@nsd.pku.edu.cn.

Acknowledgements: This work was supported by the National Natural Science Foundation of China - Data Center for Management Science at Peking University (2017KEY06) and the National Social Science Foundation (17BJL124). We would like to thank the China Africa Research Initiative from Johns Hopkins University to share the loan-level data of China-Africa Loan Database. We are grateful for constructive feedbacks from the editor and anonymous reviewers. The views expressed here are our own.

purchasing model especially in poorly governed countries. We use the credit rationing model to explain these empirical patterns. The traditional government infrastructure purchasing model suffers from two limitations: the borrowing government may steal infrastructure funds, or fail to make a credible commitment to using taxation to repay its sovereign infrastructure loans. The new financing model solves such problems by allocating loans directly from the lender to the contractor minimizing government corruption, and channeling resource revenues into an independent escrow account to repay infrastructure loans. Our findings highlight that this new infrastructure financing model can alleviate credit rationing in poorly governed, resource-rich countries.

Keywords: Infrastructure financing; Resource-financed infrastructure; Development banks; Public infrastructure; Credit rationing

JEL Classification: H54, G23, C61

1 Introduction

Infrastructure deficit is a significant challenge, especially in developing countries (Brueckner 1997; Della and Yermo, 2013; Mamatzakis and Tsionas, 2018; Ra and Li, 2018; Woetzel et al., 2016; World Bank, 2017; Zhang and Ji, 2018). To fill the infrastructure financing gap, the international development community has called for greater private participation in financing infrastructure in developing countries since the early 1990s (World Bank, 1994). However, a private solution to infrastructure financing is less viable than anticipated. Public infrastructure projects have positive externalities that render private investors less willing to fund them (Hashimzade and Myles, 2010). Institutional weaknesses in developing countries often cause international regulatory policy best practices to be ineffective and even counterproductive (Estache and Wren-Lewis, 2009). Privatized infrastructure sectors open the door to further corruption by shifting the burden from taxpayers to customers based on soft ex post price regulation (Martimort and Straub, 2009). Regulatory failures and price increases have led to widespread dissatisfaction with privatization (Estache, 2007).

Against this background, the China Development Bank (CDB) and the Export–Import Bank of China (China Exim Bank) have become important players in financing infrastructure in Africa, Latin America, and other developing regions since the early 2000s. Founded in 1994, the CDB and China Exim Bank accumulated total assets of RMB 16 trillion (USD 2.2 trillion) and 4.2 trillion (USD 578 billion), respectively, in 2018. To put these amounts into perspective, the CDB's total assets are larger than those of the World Bank and traditional regional development banks (namely, the Asian Development Bank, African Development Bank, Inter-

American Development Bank, and European Bank for Reconstruction and Development) combined.

Since the early 2000s, Chinese policy banks have been incentivized to increase infrastructure investment in developing countries by the Chinese government's ongoing global strategy of securing commodities to fuel domestic economic growth. Since China joined the World Trade Organization in 2001, the Chinese government has strongly encouraged Chinese enterprises to go abroad. However, infrastructure deficits in developing countries have been a major impediment to direct investments by Chinese companies. For example, if no road connects a garment factory to a seaport in a low-wage developing country, a Chinese light manufacturer will not invest in a factory there because it will not deliver the goods on time to global buyers. To reduce the transaction cost of doing business in developing countries, Chinese policy banks commit to building infrastructure in an effort to incentivize more Chinese companies to go abroad.

Chinese policy banks often provide long-term infrastructure financing that exceeds the capacity of private commercial banks. One reason for this is that Chinese policy banks rely on the sovereign credit of the Chinese government to issue long-term bonds in capital markets, which enables them to better cope with the problem of maturity mismatch faced by retail-deposit-taking commercial banks (Schclarek et al., 2019). Another reason is that unlike profit-driven commercial banks, development banks have the official mission of fulfilling public policy or strategic objectives, which incentivizes them to invest in infrastructure with positive externalities and spillover effects (Xu, 2017; Xu et al., 2019).

One salient infrastructure financing model deployed by the CDB and China Exim Bank is known as resource-financed infrastructure (RFI), which is a financing model whereby a government pledges future revenues from a resource-development project to repay an existing construction loan (Halland et al. 2014, p. 13). RFI links two otherwise separate supply chains: infrastructure building and resource extraction (Lin and Wang, 2016). The size of China's overseas RFI is significant. Between 2003 and 2011, Chinese banks provided an estimated USD 132 billion in financing to African and Latin American governments and state-owned firms. Over half of this (USD 75 billion) was in the form of RFI (Bräutigam and Gallagher, 2014).

This paper explains why RFI is able to fill the infrastructure financing gap in poorly governed developing countries. Traditionally, governments in developing countries governments have often borrowed from foreign creditors to build public infrastructure and then used tax revenues to repay their loans. Yet this traditional government infrastructure purchasing model has two substantial limitations that have resulted in large infrastructure financing gaps. First, it is often corrupted by politicians who pocket loans to the government. Second, resource-rich governments often cannot make credible commitments to repay their loans. It is well documented that a weak institutional framework makes governments more likely to renege on their promises (Laffont, 2005) and that resource-rich countries are often poorly governed (van der Ploeg, 2011). As a result, resource-rich governments may pledge to use their resource revenues to repay infrastructure loans, but this effort is often frustrated by limited institutional commitment (Hamdi and Sbia, 2013). This problem may be worse during election cycles, when politicians are motivated to offer welfare to citizens to attract votes.

Using a comprehensive and hand-collected project-level data set, we discover two robust empirical patterns. First, RFI loans are much larger than conventional sovereign loans, averaging USD 1.9 billion compared with USD 188 million for non-RFI loans. Second, countries with RFI loans are more corrupt than those without. Even though conventional wisdom holds that poor country-level governance exacerbates credit rationing, RFI alleviates this problem.

Based on interviews with key stakeholders, we identify two channels through which RFI protects itself against corruption and limited commitment while mitigating credit rationing in poorly governed, resource-rich developing countries. RFI enjoys two significant advantages over the traditional government infrastructure purchasing model. First, Chinese policy banks allocate funding directly to construction companies rather than to borrowing governments, which reduces the risk of corruption. Second, the resource revenue goes directly to an independent escrow account established to service the debt of infrastructure loans rather than flowing conventionally into the coffers of resource-rich governments. In sum, these two mechanisms reassure creditors that loans will finance infrastructure and that sufficient revenues from separate resource-extraction projects will be secured to repay infrastructure loans.

Our paper makes two important contributions to the literature on infrastructure financing and credit-rationing theory. First, to the best of our knowledge, we are the first to systematically use project-level data to examine the stylized facts of RFI and employ a formal model to explain why RFI is better able to mitigate credit rationing in poorly governed countries. Despite the practical significance of RFI, little academic research has been conducted on its underlying

mechanisms. Bräutigam and Gallagher (2014) identify the aggregate size of RFI in Africa and Latin America but do not take the additional step of using project-level data to reveal the distinct features of RFI in comparison with the traditional infrastructure financing model. Halland et al. (2014) compare RFI with its parent models, such as the traditional government infrastructure purchasing model, but fail to identify and explain the empirical pattern whereby RFI tends to fund larger infrastructure projects in resource-rich developing countries afflicted with poor governance. Collier and Cust (2015) argue that the packaging of infrastructure and resource extraction provides a valuable 'commitment technology,' but do not specify the underlying mechanism. Lin and Wang (2016) highlight RFI's potential for filling the infrastructure gap but fail to apply a formal model to explain the underlying mechanisms.

This paucity of research is partly explained by a lack of transparency in the practical design and implementation of RFI, such that practice has run ahead of theory and the economics of RFI remain imperfectly understood. To close this research gap, we gained access to project-level data compiled by the China Africa Research Initiative (CARI) at Johns Hopkins University, which have enabled us to identify previously undisclosed empirical patterns in RFI contracts. Furthermore, we interviewed senior management at the CDB, China Exim Bank, and China Export and Credit Insurance Corporation (Sinosure), as well as policymakers from resource-rich developing countries who have engaged in loan negotiations with Chinese policy banks. This enabled us to understand how RFI can alleviate the financing constraints of infrastructure investments in poorly governed developing countries with abundant natural resources.

Second, our paper builds on classical credit-rationing theory in corporate finance by applying our analytical framework to sovereign infrastructure financing. As others have done previously (e.g., Bolton, 2016), we make an analogy between nations and corporations. Although highly reductive, consolidating all of a nation's agents into a single representative decision-maker has the advantage of clarifying that nation's economic objectives and constraints. We adapt the agency problem in the classical credit-rationing model (Holmstrom and Tirole, 1997; Tirole, 2006): Borrowers may deliberately reduce the success probability of an investment to enjoy private benefits. The literature identifies the deleterious effects of poor governance on long-term infrastructure financing, but seldom delineates the most relevant analytical dimensions of such country-level governance. For example, the World Bank's flagship report argues that a poor legal and institutional framework and weak contract enforcement can excessively limit the supply of long-term finance (World Bank, 2015). Del Río (2018) finds that more accountable and fair governance encourages governmental accumulation of social infrastructure, which stimulates productivity. We go beyond a general discussion of how poor governance impedes infrastructure financing by analysing two dimensions of poor governance: using infrastructure loans for private benefit and a limited commitment to honoring them.

The rest of the paper proceeds as follows. In Section 2, we compare RFI with conventional infrastructure financing models, examine its pros and cons compared with the traditional government infrastructure purchasing model, and use project-level data to identify the stylized facts of RFI. In Section 3, we present our model to explain the stylized facts of how RFI

mitigates credit rationing in poorly governed countries. Section 4 concludes with our core findings and practical implications.

2 Key Features and Stylized Facts of RFI

We begin by comparing RFI with conventional infrastructure financing models. We then analyze the potential advantages and disadvantages of RFI compared with the traditional government infrastructure purchasing model. Finally, we use a novel project-level data set to identify the stylized facts of RFI.

2.1 Compare RFI with Conventional Infrastructure Financing Model

RFI links infrastructure building to resource development, which are otherwise two separate supply chains. First, the resource-rich government and the lender simultaneously agree on both a resource-development project and an infrastructure project. Second, the government grants a resource-development and production license to a resource developer who must have a firm development timeline and a fiscal regime that can provide clear revenue flows once the resource is in production. Third, the government pledges some or all of the resource revenues to the lender in exchange for an infrastructure loan. Third, the government grants a license to a contractor to develop and build the specific types of infrastructure determined by the government. The origin of RFI can be traced to several parent models, including the traditional government infrastructure purchasing model, the project finance model, and the public–private partnership (PPP) (Soumaré, 2016; Chan et al., 2009; Voss, 2002). RFI is similar to its parents but is “a unique child” (Halland et al., 2014, pp. 15–29, 33–34).

First, RFI resembles the traditional government infrastructure purchasing model in that the borrowing government can decide what infrastructure to build with a sovereign loan facility for instant resource revenues. Yet this model runs the risk of corruption because public officials administering construction projects can be tempted to accept bribes or steal funds. RFI can mitigate this problem, as the next section will explain in greater detail.

Second, RFI, which is built on the project finance model, employs a nonrecourse clause. Thus, the private developer can shield its balance sheet from unlimited exposure to the project. RFI resembles the project finance model in that the project is invariably undertaken by a special purpose vehicle (SPV), a company established and financed for this sole purpose. The project finance model is more useful for funding telecommunications, electricity, tourism, and airport investments, where middle-class and business customers can be relied on to pay for services, whereas it is difficult if not impossible to apply the user-pay principle to public infrastructure. To address this limitation of the project finance model, RFI uses the government's future revenue streams from a separate resource development project to repay infrastructure loans instead of the revenues to be derived from the infrastructure investment itself.

Third, because RFI is built on the PPP model, infrastructure construction may involve the private sector. The PPP model is often viewed as a variant of the project finance model because it is usually applied when government participation is necessary to make the project finance model financially viable and bring the private sector on board. In a PPP model, both the private developer and the government can declare that they are partners in providing infrastructure services. If the user fee does not cover the cost of building, operating, and maintaining the

infrastructure, governments will provide a wide range of support to make the project financially viable. For example, the government may waive taxation, transfer land, or offer free licenses. By contrast, RFI relies on one primary source of repayment—the resource revenue pledged by the government—to repay infrastructure loans. In addition, the RFI model is distinct from the PPP model in that it does not necessarily involve the private sector as an equity investor or partner as long as the government's future revenue streams from a separate resource development project are sufficient to repay infrastructure loans. Thus, RFI is well positioned to finance public infrastructure such as clean water, public hospitals, and rural roads, where it is difficult to apply the user-pay principle.

2.2 Pros and Cons of RFI

In this section, we compare the advantages of RFI with those of the traditional government infrastructure purchasing model to illustrate the mechanisms for alleviating credit rationing. Then we examine the potential pitfalls of RFI.

The most-cited RFI deal is known as the Angola Model.[1] In 2004, China Exim Bank and Angola's Ministry of Finance signed a framework agreement in which an infrastructure loan contract and a resource extract contract were sealed at the same time. China Exim Bank agreed to loan Angola USD 2 billion with an interest rate of LIBOR+1.5%. The loan had a grace period of five years and an amortization period of 17 years and was used to finance as many as 107 infrastructure projects ranging from hospitals and schools to roads and power transmission

[1] This case study is an adaptation based on Corkin (2012), Habiyaremye (2013), Lin and Wang (2016), and Tang (2014).

networks. As collateral for the infrastructure loan, a revenue of 10,000 barrels of oil per day was placed in an escrow account and used as repayments to China Exim Bank (Tang, 2014). Linking oil revenues with building infrastructure reduced the likelihood of corruption by the Angolan government. As Professor Vincent de Andrade from the Catholic University of Angola commented, it was the first time ordinary Angolans could see their country's oil funding real projects in their lifetimes (Lin and Wang, 2016).

As illustrated in Figure 1 below, the traditional government infrastructure purchasing model potentially suffers from two limitations, which are especially acute in poorly governed countries. First, the borrowing country's government receives loans directly from the lender and then allocates funds to the contractor, which opens the door to corruption. It has been well documented that the African continent is plagued with the capital flight trap (Ajayi and Ndikumana, 2015). Ndikumana (2016) demonstrated that external borrowing fuels capital flight and that trade misinvoicing is an important channel of capital flight, especially in the case of resource-rich countries. Second, the borrowing government is unable to make a credible commitment to using taxation or the resource-development project to repay its sovereign infrastructure loans. Even though the borrowing government might commit itself to using taxation or resource revenues to repay infrastructure loans, it might renege on its promise later to indulge in short-term spending, such as offering welfare handouts to buy votes or increasing the salaries of public officials. Given the prospect of debt relief in particular, the limited commitment problem might be exacerbated (Ferry, 2019).

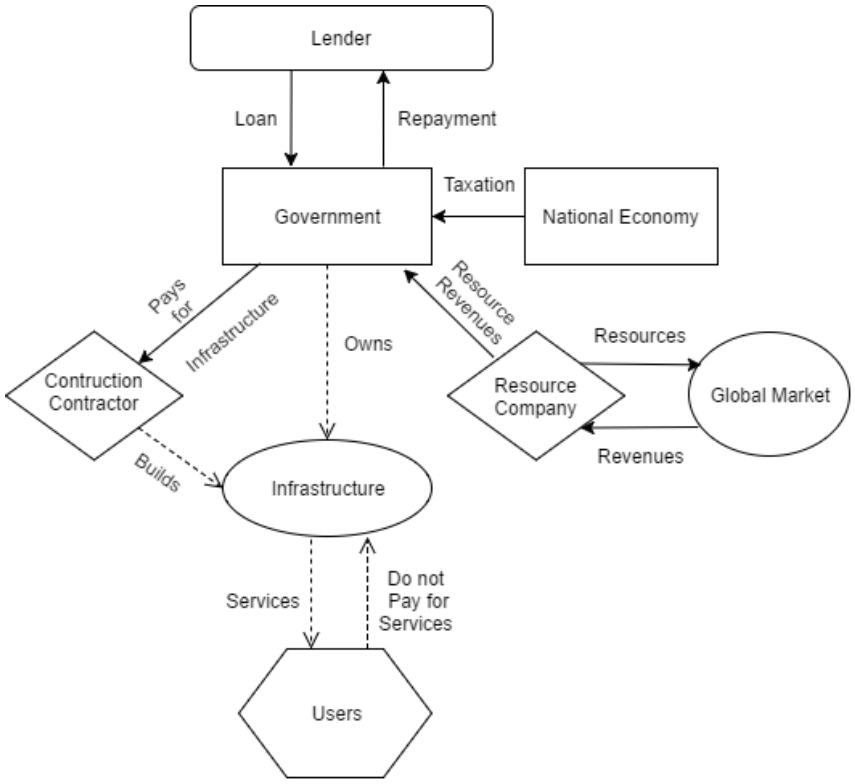

Figure 1: Mechanism of the Government Infrastructure Purchasing Model

Source: Illustrated by the authors and adapted from Halland et al. (2014), p. 21.

RFI mitigates credit rationing in the traditional government infrastructure purchasing model through two innovative mechanisms (see Figure 2 below).[2] First, in an infrastructure building project, loans are disbursed directly from the lender to the contractor instead of the borrowing government. During construction, the contractor first submits work-done invoices to the lender. After the invoices are verified by the borrowing government, the lender will disburse the funds to the contractor directly. Doing so prevents the borrower from accessing the funds physically because the only way to draw down on the credit is through the work-done invoices submitted by the contractor. This *monitoring technology* helps reduce corruption in the borrowing

[2] Interviews with policy makers from resource-rich countries and bank management from China's policy banks, April 2020.

government, which might otherwise steal or misuse the infrastructure loan. Second, resource revenues used for repayments are channeled to an independent escrow account to avoid possible corrupt use or misallocation of the proceeds by the borrowing government. An SPV is established to extract resources and sell the commodity to the global market, and then resource revenues are channeled via the SPV to the escrow account directly, without passing through the hands of officials in the borrowing government. This *commitment technology* mitigates the risk of limited commitment by assuring the lender of a sufficient and reliable source of repayment (Collier and Cust, 2015).

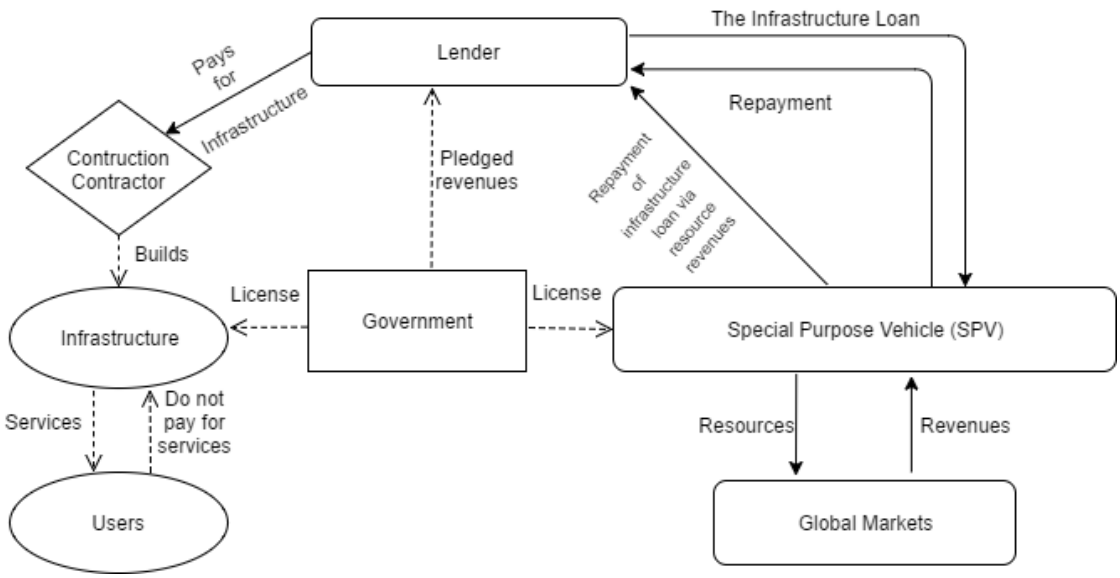

Figure 2: Mechanisms of RFI

Source: Illustrated by the authors and adapted from Halland et al. (2014), p. 32.

It is worth noting that these two mechanisms are not feasible in the traditional government infrastructure purchasing model, which is by no means a project finance model where SPVs are

used to distinguish the activities of the borrowing country from those of the project so that loans and revenues for repayments are kept away from the borrowing government's daily business. In addition, the monitoring technology could be feasible in the conventional project finance model or PPP model, but the commitment technology is new and has not yet been implemented before.

Despite the aforementioned advantages, RFI is not free from pitfalls. First, because of its monopoly position in an opaque manner, the price of infrastructure might be unduly high, especially when the loan is tied to the purchase of Chinese equipment (Halland et al., 2014). Second, RFI could suffer from political risks because of political changes or instability, and such risks may be severe given its long-term investment horizon. However, such limitations are not inherent to RFI. For example, in the traditional government infrastructure purchasing model, concessional lending could be tied to the purchase of goods and services from donor countries (Halland et al., 2014). Few infrastructure financing models are immune from political risks, especially if infrastructure projects are implemented in politically unstable developing countries.

2.3 Stylized Facts of RFI

Chinese policy banks and borrowing governments do not disclose project-level data, which makes it difficult to discern empirical patterns of RFI in comparison with the traditional sovereign infrastructure purchasing model. To fill the data gap, CARI at John Hopkins University has made systematic efforts to collect reliable data on the scope, nature, and modalities of China's loan financing. The methodology is rigorous, standardized, and

systematic, relying heavily on process tracing to track projects from initial reports to completion through multiple sources in multiple languages. Its scholars also use in-country contacts and field visits as opportunities to update and verify information on Chinese loans (Bräutigam and Hwang, 2019). The data set contains information regarding financers, borrowers, amounts, sectors, loan status, and finance type (concessional loans, commercial loans, export buyers' credit, etc.) at the project level. For our research purposes, the data set has systematically identified whether each project has been secured by resource revenues.[3]

To rigorously construct the sample, we have taken the following three steps to identify infrastructure projects, RFI infrastructure projects, and RFI loans that may apply to several projects.

First, we distinguish infrastructure from non-infrastructure projects by relying on the information on sector, purpose, and contract type. "Infrastructure" here is an umbrella term that includes both social and economic infrastructure. Social infrastructure refers to key public-service projects such as schools, hospitals, and public housing. Economic infrastructure refers to hubs such as airports and seaports that also connect citizens and firms to economic opportunities and networks such as telecommunications, transport, and electricity production and transmission. The CARI database contains 19 sectors. After deleting projects in non-infrastructure sectors such as budget and food, we further deleted stand-alone projects whose contract type is purchase[4]—that is, purchasing equipment—or unknown despite their falling

[3] For this reason, we used the project-level data from CARI instead of AidData compiled by the William and Mary's Global Research Institute.

[4] We identified projects whose contract type is "mixed: construction & purchase" or "purchase" in a bundled loan as "infrastructure projects" because African countries may lack intermediate goods or equipment to make infrastructure projects feasible. In other words, such purchases can be an integral part of infrastructure projects.

into the category of infrastructure-like sectors such as transport, power, and water. Finally, we conducted case-by-case screening of the "multisector" or "unallocated" sector codes based on information about the project purpose. In total, we have identified 837 infrastructure projects out of a total of 1,103.

Second, we distinguish RFI projects secured by resources or commodities from those not involving resource revenues for repayments. In the CARI database, there is a variable called "resource security." We classify projects with resource security as "RFI projects" and those without resource security as "non-RFI projects." Resources range from natural resources such as oil, copper, platinum, and diamonds to agricultural commodities such as cocoa and tobacco.[5] In total, we have identified 288 RFI projects and 549 non-RFI projects. In addition, there are two projects whose repayments are secured by the cash flow from the projects themselves, such as toll fees or electricity off-taker, whose loan amounts are USD 161 million and 3 million, respectively—much smaller than the average RFI loan (USD 1.9 billion). This modest size implies that the project finance model has been of limited use in Chinese infrastructure financing in Africa and justifies our focus on the comparison between RFI and the traditional government infrastructure purchasing model; thus, we deleted these two projects from our sample construction.

Third, we bundle projects into loans because RFI is often characterized as bundling a few infrastructure projects into one loan, as exemplified in the Angola Model. In the CARI database, for projects that have several phases or loans that have several tranches of disbursement, each

[5] For the purpose of accuracy, we did not include 14 loans where resource security is marred by questions in our analysis.

phase and each tranche receives an independent project ID (Bräutigam and Hwang, 2019). Because RFI has often taken the bundled approach—that is, one infrastructure loan is implemented in several phases used to finance a wide range of infrastructure projects—we aggregated multiphase projects into one RFI loan. In total, we identified 17 RFI loans and 527 non-RFI loans. On average, each RFI loan has 17 projects or tranches, whereas few non-RFI loans take the bundled approach.[6] In total, we identified eight African countries that have signed RFI loans with China, namely Angola, the Democratic Republic of Congo, Equatorial Guinea, Ghana, South Sudan, Sudan, the Republic of Congo, and Zimbabwe. See Appendix I for the list of bundled RFI loans containing information on country, loan amount, sector, and types of resource security.

After completing the sample construction, we analyzed the size of RFI loans compared with that of non-RFI loans. First, we compared the average sizes of RFI loans and non-RFI loans. Table 1 below shows the basic descriptive statistics on the mean, maximum, and minimum of the loan amount in both RFI and non-RFI loans. Compared with the traditional model whose first loan was signed in 1999, the RFI model is relatively new, dating from 2004. The average RFI loan is USD 1.9 billion whereas the average conventional infrastructure loan is merely USD 188 million.

[6] Only 25 non-RFI projects are bundled into three loans.

Table 1: Descriptive Statistics of RFI Loans and non-RFI Loans (million USD)

	Size of RFI loans	Size of non-RFI loans
Mean	1947.78	188.60
Max	15546.34	4100.00
Min	110	0.50

Second, we conducted the t-test to see whether the difference in the loan amount was statistically significant. Table 2 shows that the difference in the average loan size between RFI loans and non-RFI loans was statistically significant at the 5% level.

Table 2: t-Test of the Average RFI and non-RFI Loan Amounts (million USD)

	RFI loans	non-RFI loans
Mean	1947.78	188.60
Observations	17	527
Difference	1759.18** (2.03)	

Note: *t* statistics in parentheses

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

Finally, we identified eight countries that have received both RFI and non-RFI loans (called "RFI countries") and then calculated the difference in the average loan size between RFI and non-RFI loans. Controlling for country-level factors, we found that RFI loans are significantly larger than non-RFI loans on average, which is statistically significant at the 5% level (see Table 3 below). This pattern is consistent across all eight countries and implies that RFI loans may help resolve credit rationing.

Table 3: t-Test of the Average Size of RFI and non-RFI Loans in RFI Countries (USD million)

	RFI loans	non-RFI loans of RFI countries
Mean	1947.78	181.12
Observations	17	137
Difference	1766.66** (2.03)	

Note: *t* statistics in parentheses

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

We then compared the characteristics of countries with RFI loans with those without RFI loans, with a special focus on the governance indicator. For our research purposes, we selected the control of corruption from the Worldwide Governance Indicators. This governance indicator ranges from -2.5 to 2.5. The smaller the indicator, the poorer the governance. As governance at

the country level can change over time, we have collected the governance indicator of each country (eight RFI countries and 38 non-RFI countries) in the year when the loan contract was signed. Using the t-test, we discovered that countries with RFI loans suffer from poorer governance than those without RFI loans. This result is statistically significant at the 1% level, as indicated in Table 4 below. In short, countries with RFI loans suffer from poorer governance.

Table 4: t-Test of Governance in RFI and non-RFI Countries

	RFI countries	non-RFI countries
Mean	-1.1	-0.57
Observations	17	374
Difference	-0.53*** (-3.93)	

Note: *t* statistics in parentheses

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

To sum up, using a project-level database we are able to identify robust empirical patterns indicating that RFI loans are significantly larger than their non-RFI counterparts, and that countries with RFI loans are afflicted with poorer governance than those without. These results imply that RFI is relatively immune from the negative impact of poor country-level governance

upon the loan size. In the next section, we will use the formal model to explain why RFI alleviates credit rationing even in poorly governed countries.

3 The Model

In this section, we use the formal model with rigor and precision to explain why countries with poorer governance suffer from more severe credit rationing, why RFI mitigates credit rationing even in poorly governed countries, and under what conditions the disadvantages of RFI may outweigh its advantages.

3.1 The Traditional Government Infrastructure Purchasing Model

In this subsection, we use the credit rationing model to explain why poor country-level governance results in the short supply of infrastructure financing in the traditional government infrastructure purchasing model. Our model has two players, the foreign lender ("lender") and the borrowing country's government ("borrower"). Both parties are risk-neutral and make decisions based on expected payoffs. The borrowing country's government receives a loan to build infrastructure from the foreign lender and then uses taxation to repay this sovereign loan. We assume that the foreign lender faces a participation constraint because it must maintain its financial sustainability. This assumption holds water when applied to the case of development banks. Unlike aid agencies that rely primarily on regular budgetary transfers from governments, development banks often rely on bond issuance to raise funds from capital markets, meaning they must ensure that their investment projects are financially viable to repay bond investors.[7]

[7] Unlike the conventional credit rationing model in corporate finance, we do not consider the initial wealth of borrowing countries. In the corporate world, there is a huge variation in initial wealth among entrepreneurs. Yet

As in the classical credit rationing model (Holmstrom and Tirole, 1997; Tirole, 2006), the foreign lender is considered to be the principal, whereas the borrowing country's government is viewed as the agent with private information. The borrower can choose to behave or misbehave. The private information of the borrowing government amounts to whether it is behaving or misbehaving and whether it obtains private benefits. The project may succeed and generate revenues or fail and produce nothing.

The timing of the model is summarized as follows: at the time T_0, financial contracts are signed and investment decisions are made. The lender invests I, and the borrower begins the infrastructure project. During the project cycle, the lender allocates funds, and the borrower chooses either to behave or misbehave in implementing the project. The project may suffer from the moral hazard problem. At T_1, the amortization period of the infrastructure loan is due, and payoffs are set.

Let p_H be the probability of success when the borrower behaves. Misbehaving results in a lower probability of success p_L and the private benefit $B > 0$. R_b and R_l are revenues distributed to the borrower and lender, respectively; $R_b + R_l = R(I)$. Here $\mathrm{R}(I)$ is the total revenue generated from the public infrastructure. To discourage the borrower from misbehaving, the following "incentive compatibility constraint" is satisfied; that is, the expected revenue of the borrower when behaving must be greater than the expected revenue when misbehaving, plus private benefits:

developing country governments are often fiscally constrained, and low-income countries especially. However, the borrowing government can deploy the sovereign guarantee to incentivize the foreign lender to provide loans, and it can levy taxation to repay loans.

$$p_H R_b \geq p_L R_b + B. \quad (1)$$

Therefore, the incentive compatibility constraint is as follows:

$$R_b \geq \frac{B}{p_H - p_L}. \quad (2)$$

Consequently, the lender's payoff faces an upper limit and is negatively affected by the size of any private benefit harvested by the borrower:

$$R_l = R(I) - R_b \leq R(I) - \frac{B}{p_H - p_L}. \quad (3)$$

As far as the participation constraint of the lender is concerned, the expected payoff of the lender must exceed the investment plus interest with a given interest rate:

$$(1 + \mathrm{r})\mathrm{I} \leq p_H R_l. \quad (4)$$

To simplify the analysis without altering the main result of our model, we assume $r = 0$, assuming that lenders behave competitively in the credit market. Hence, the necessary condition for arranging financing is

$$\frac{R(I)}{I} \geq \frac{1}{p_H} + \frac{1}{p_H - p_L} * \frac{B}{I}. \quad (5)$$

A key feature of the credit rationing model is that lenders face an agency problem because the borrower may mismanage the project. Regarding the traditional infrastructure purchasing model, two salient agency problems stand out. One problem is corruption; that is, government officials in the borrowing country may misuse infrastructure loans and line their own pockets. The other problem is limited commitment; that is, the borrowing country's government may divert taxation to meet short-term consumption instead of repaying infrastructure loans as promised. The foreign creditor is not willing to lend money unless these problems are sufficiently mitigated or avoided. Thus, the risk of limited commitment plus corruption would result in credit rationing. Below we will analyze how these two problems affect the size of private benefits and the likelihood of earmarking taxation for repayment, which in turn decreases the size of the infrastructure loan.

The more severe problem of corruption would increase the likelihood that the borrowing country's government misused a larger proportion of the infrastructure loan for private benefit. Let $b = \frac{B}{I}$ represent the ratio of investment taken by the borrowing country's government as a private benefit. We assume that the private benefit is larger when the corruption—a key dimension of governance in the borrowing country—is more severe. In other words, a well-governed country is less likely to take the investment as a private benefit. Let g denote the governance quality of the borrowing country. The higher g is, the better the governance of the borrowing country. Suppose the following general relationship between governance g and private benefit:[8]

[8] The more general form is $b=f(g)$ where f is a decreasing function. However, a specific relationship between governance g and the private benefit ratio b enables us to evaluate numerically the upper limit of the investment size, as shown in Table 5.

$$\mathrm{b} = \begin{cases} \underline{b}, & g \geq g_u \\ (-\alpha * g + c)^{q_1} - e, & g_u < g < g_l, \\ \bar{b}, & g \leq g_l \end{cases} \quad (6)$$

Here the upper and lower thresholds of governance quality are denoted by g_u and g_l, respectively. If the governance of the borrowing country is better than the upper threshold, g_u, it has little room for corruption ($b = \underline{b}$). By contrast, if the governance is poorer than the lower threshold, the borrowing government may steal a sizeable proportion of infrastructure funds ($b = \bar{b}$). Thus, $\underline{b} \leq \mathrm{b} \leq \bar{b}$, and b is continuous.[9] When the quality of governance falls between the upper and lower thresholds, the borrower's likelihood of gaining private benefits by is negative vis-à-vis the country-level governance, as reflected by $-\alpha < 0$.

We denote agency cost as *AC*, which is defined as the loss if the agent misbehaves or the loss arising from corruption during the infrastructure project.

$$AC = \frac{1}{p_H} + \frac{1}{p_H - p_L} * b = \frac{1}{p_H} + \frac{1}{p_H - p_L}((-\alpha * g + c)^{q_1} - e). \quad (7)$$

Now we shift to analyzing how the limited commitment problem may affect the use of taxation to repay the infrastructure loan. In the traditional government infrastructure purchasing model, the rate of return on public infrastructure, $r(I)$, is derived from taxation and depends on the extent to which the infrastructure stimulates the economy and generates more tax revenue, as well as on the borrowing government's efficiency at tax collection. It is well documented

[9] By adjusting the parameters, b can easily be continuous.

that it takes time for public infrastructure to generate economic progress and boost the taxation base (Naoyuki et al., 2019) and that infrastructure can promote long-term economic development only when its investments surpass a certain threshold and create network externalities (Agénor, 2010). In addition, developing countries, especially those with low incomes, suffer from low fiscal efficiency because their governments lack the capacity to collect taxes effectively (Laffont, 2005).

Even assuming that the borrowing country's government can mobilize sufficient taxation to repay the infrastructure loan, one acute problem is that taxation is sometimes diverted for short-term consumption instead of honoring long-term infrastructure debt (the limited commitment problem). A finance minister with cabinet approval to earmark resource revenues for infrastructure might be outvoted in favor of short-term spending interests. Given that infrastructure financing often consists of long-term investments, the risk of limited commitment is likely to frustrate the borrowing government's effort to convince the lender of its ability to overcome short-term expenditure impulses. Such a problem is exacerbated by poor governance. Hence, we assume that

$$\bar{r} = \bar{r}_0 + (\beta * g - d)^{q_2} - f. \quad (8)$$

Here $\bar{r}$ refers to the capacity of the borrowing countries to repay the infrastructure loan, which is positively associated with g ($\beta > 0$). In other words, better-governed countries can

make more credible commitments to repay their sovereign infrastructure loans. $\bar{r}_0$ denotes the full potential of the revenue from the infrastructure through the taxation system.[10]

In addition, $R(I)$ decreases as the infrastructure depreciates. Supposing the depreciation rate is δ, then $\mathrm{R(I)} = (\bar{r}_0 + (\beta * g - d)^{q_2} - f - \delta \mathrm{t}) * I^{\gamma}$. Here $0 < \gamma < 1$, indicating a diminishing return on the investment. The maximum return from the infrastructure is therefore

$$\mathrm{M} = \max_T E \int_0^T R(I)dt = \max_T \left[(\bar{r}_0 + (\beta * g - d)^{q_2} - f)T - \frac{1}{2}\delta T^2\right] * I^{\gamma}$$
$$= \frac{(\bar{r}_0 + (\beta * g - d)^{q_2} - f)^2}{2\delta} * I^{\gamma}. \quad (9)$$

Hence, the size of the infrastructure loan has an upper limit as follows:

$$\mathrm{I} \leq \left(\frac{\bar{r}^2}{2\delta * AC}\right)^{\frac{1}{1-\gamma}} \quad (10)$$

or,

$$\mathrm{I} \leq \left\{\frac{(\bar{r}_0 + (\beta * g - d)^{q_2} - f)^2}{2\delta * \left[\frac{1}{p_H} + \frac{1}{p_H - p_L}((-\alpha * g + c)^{q_1} - e)\right]}\right\}^{\frac{1}{1-\gamma}}. \quad (11)$$

Based on equation 11, we offer the following proposition.

[10] Similar to q_1 in equation (6), we use q_2 to characterize the marginal change.

Proposition 1. *The infrastructure loan size decided in the initial period T_0, I, is positively related to g.*

From Proposition 1, we obtain the following results, *ceteris paribus*. First, a borrowing country with poorer governance will encounter more severe credit rationing. Second, this effect works through two channels: (1) the risk of corrupt government officials stealing or misusing infrastructure loans and (2) the risk of the borrowing government's limited commitment to using taxation to repay an infrastructure loan.

3.2 RFI in the Credit Market with Perfect Competition

In this subsection, we introduce RFI into our aforementioned baseline model to explain how it helps address the two limitations—corruption and limited commitment—in the traditional government infrastructure purchasing model through two innovative mechanisms of monitoring and commitment technologies.

In the RFI model, the monitoring technology reduces agent costs because the lender has direct control over the disbursement of infrastructure loans to the contractor. Accordingly, officials in the borrowing government have little opportunity to steal the infrastructure loan for private benefit. Let $\widetilde{AC}$ denote the agent cost in the RFI model. Hence, $\widetilde{AC}$ is significantly lower than AC in the traditional government infrastructure purchasing model.

Furthermore, the source of repayment in the RFI model is secured by resource revenues in an independent escrow account instead of relying on the fiscal budget. Let $\tilde{r}$ denote the rate of revenue in the RFI model, which is the rate of revenue in a resource development

project separate from the infrastructure project. Instead of selling natural resources or other commodities to international markets, with the borrowing government then taking the revenue into its national budget, RFI secures repayment of an infrastructure loan by channeling the resource revenue directly to an independent escrow account so that the borrowing government has little flexibility in diverting the revenue for short-term expenditure. Therefore, $\tilde{r}$ is almost immune from the risk of limited commitment exacerbated by the borrowing country's poor governance. In other words, $\tilde{r}$ is relatively immune from the governance of the borrowing country's government, g.

In addition, RFI is not immune from political risk; hence, we assume that the loss intensity in the RFI model caused by political risk is the same as in the traditional financing model. Then, the maximum payoff of the lender in the RFI model is

$$\underset{T}{\text{Max}} \int_0^T (\tilde{r} - \delta t) * \tilde{I}^{\gamma} dt = \frac{\tilde{r}^2}{2\delta} * \tilde{I}^{\gamma}. \tag{12}$$

In the RFI model, the investment size is $\tilde{I}$:

$$\widetilde{AC} * \tilde{I}^{1-\gamma} \leq \frac{\tilde{r}^2}{2\delta}. \tag{13}$$

Thus, the size of the infrastructure loan in the RFI model has an upper limit as follows:

$$\tilde{I} \leq \left(\frac{\tilde{r}^2}{\widetilde{AC} * 2\delta}\right)^{\frac{1}{1-\gamma}}. \tag{14}$$

From equations (10) and (14), we derive the following proposition:

Proposition 2: *The investment size of the infrastructure loan, $\tilde{I}$, in the RFI model depends on the same factors that apply to the traditional government infrastructure purchasing model from Proposition 1.*

Given that $\widetilde{AC} \leq AC$, $\tilde{r} \geq \bar{r}$, we derive

$$\left(\frac{\tilde{r}^2}{\widetilde{AC} * 2\delta}\right)^{\frac{1}{1-\gamma}} \geq \left(\frac{\bar{r}^2}{\mathrm{AC} * 2\delta}\right)^{\frac{1}{1-\gamma}} \tag{15}$$

Therefore, the loan size of the infrastructure project in the RFI model is larger than that in the traditional government infrastructure purchasing model.

$$\tilde{I} \geq \mathrm{I} \tag{16}$$

Corollary 1: If $\widetilde{AC} \leq AC$ and $\tilde{r} \geq \bar{r}_0$, then from equation (10) and (14), we infer that $\tilde{I} \geq I$.

Figure 4 below illustrates our model's core economic argument. It shows that poorly governed borrowing countries will experience more severe credit rationing under the traditional government infrastructure purchasing model. By contrast, the monitoring and commitment technologies make the loan size of RFI relatively immune from poor governance. Hence, the

difference in loan sizes between the traditional model and RFI is much larger in poorly governed countries than elsewhere. In other words, as the governance of the borrowing country improves, the investment size of RFI converges with that of the traditional model.

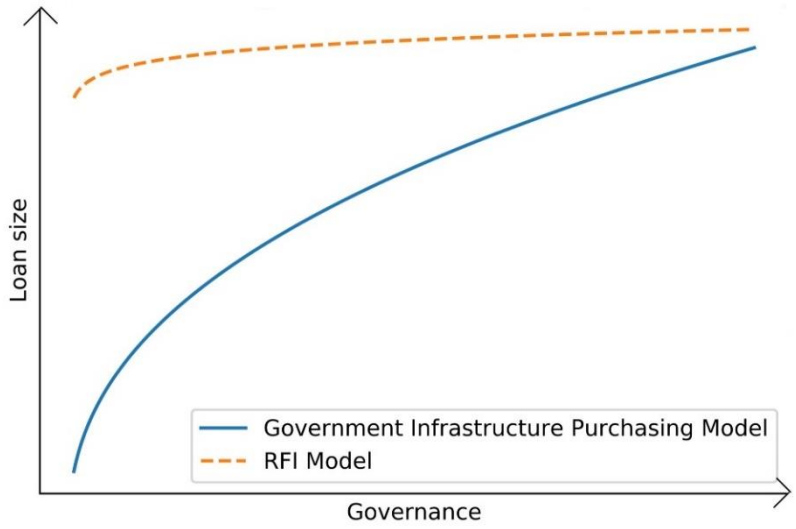

Figure 4: Comparison between RFI and the Traditional Government Infrastructure Purchasing Model

Table 5 simulates a hypothetical case based on the above model. Figure 4 uses the basic parameters listed in Table 5. It demonstrates that when country-level governance improves, the loan size of the traditional government infrastructure purchasing model substantially increases, whereas the RFI loan increases only modestly.[11] Moreover, the RFI loan is significantly larger than that of the traditional model in poorly governed countries, while the difference in loan size

[11] This is based on the assumption that the agent cost under RFI does not change much as the governance of the borrowing country improves due to better control of the project by the creditor, who is practically immune from the governance of the borrowing country. Without loss of generality, we specifically set $\widetilde{AC} = 1.12*(g+2.5)^{-0.007}$ which corresponds to a probability of success.

diminishes as the governance improves. This simulation comes with the caveat that it is a hypothetical case intended to illustrate our model's core economic argument, as opposed to a real case.

Table 5: Basic Parameters for Numerical Illustration in a Hypothetical Case

Parameter Set[12]	Poor Governance[13] (g =-0.95)		Fair Governance (g =0.3)		Good Governance (g =0.95)	
$\bar{r}_0 = 0.45$, $\beta = 8 \times 10^{14}$, $d = -9.6 \times 10^{14}$, $f = 1.284$, $\delta = 0.006$, $p_H = 0.85$, $p_L = 0.17$, $\alpha = 8 \times 10^{15}$, $c = 9.6 \times 10^{15}$, $e = 1.3$, $\gamma = 0.9$, $\tilde{r} = 0.37$, $q_1 = 0.008$, q_2 =0.0072,	Loan size of the traditional model	Loan size of RFI	Loan size of the traditional model	Loan size of RFI	Loan size of the traditional model	Loan size of RFI
	3.8×10^9	1.1×10^{10}	9.1×10^9	1.2×10^{10}	1.2×10^{10}	1.3×10^{10}

[12] The assignment of δ is based on the estimation of the depreciation rate of public infrastructure. The choice of $\bar{r}_0/\tilde{r}$ and γ are derived from the evaluation of return on infrastructure investment. For instance, if the investment size is 800 million, then with $\bar{r}_0$=0.45 and $\gamma = 0.9$, it takes about 17 years to cover the investment cost.

[13] The governance indicator ranges from -2.5 to 2.5 in database Worldwide Governance Indicators, it is reasonable to say that -1.19 indicates a poor governance while 1.19 represents a good one.

In sum, as a new form of infrastructure financing, RFI mitigates credit rationing in poorly governed countries through two innovative mechanisms: the direct allocation of funds by the lender to the contractor, dependent on the progress of the infrastructure project (the monitoring technology), and the direct channeling of resource revenues by the SPV to an independent escrow account instead of to the borrowing government (the commitment technology).

3.3 RFI in a Monopolistic Credit Market

In our aforementioned baseline model, we assume that the credit market is characterized by perfect competition. Under perfect competition, the price of the infrastructure project in the RFI model is identical to that in the traditional model; hence, the size of the project depends only on the size of the investment.

Yet in a monopolistic credit market where one main provider can make the RFI deals, the price of the infrastructure project may rise unduly from a lack of competition. Let us denote the price of infrastructure as P_i and the price of resources in the global market as P_e. With monopoly power, the lender may require the borrowing country to purchase equipment or intermediate goods to build infrastructure from the lender country, the price of which would not be competitive absent open bidding. Consequently, the cost of building infrastructure for the borrowing country would be larger, and fewer infrastructure projects denoted by $\frac{\tilde{I}}{P_i}$ would be undertaken for a given amount of infrastructure loans. Furthermore, the lender's monopoly power could also manifest in compelling the borrowing country to compensate for commodity price fluctuations in the global market. Commodity prices, P_e, are exogenously determined and hence beyond the control of either the lender or the borrower. In the case of a sudden drop in

commodity prices, the lender may leverage its monopoly position to compel the borrowing country to compensate for the price drop. For example, the lender may require a "reserve tail" clause so that additional resources must be extracted and sold to international commodity markets to make up the shortfall. Consequently, natural resources in the borrowing country may be severely depleted, whereas they could be preserved in the absence of RFI deals. This outcome will indirectly increase the cost of infrastructure projects, thus diminishing the role of RFI in solving the credit rationing problem.

In sum, we begin our analysis by presenting a classical credit rationing model that illustrates the limitations of the traditional government infrastructure purchasing model, namely corruption and limited commitment. Then we introduce RFI to elucidate the mechanisms that immunize RFI from poor governance and alleviate credit rationing. Finally, we relax the assumption that the credit market is characterized by perfect competition and discussed the potential pitfalls of RFI when the foreign creditor has a monopoly.

4 Concluding Remarks

Conventional wisdom holds that poor country-level governance exacerbates credit rationing in infrastructure financing, but few have explored why RFI—a new infrastructure financing model—helps fill the infrastructure gap even in poorly governed countries. The paucity of research is largely due to lack of data on RFI. To fill the gap in the literature, we have used a novel project-level data set to identify the following robust stylized facts: (1) the loan size of resource-financed infrastructure is much larger than that of the traditional government infrastructure purchasing model, and (2) such a difference is especially significant in poorly

governed countries. This indicates that RFI is relatively immune from poor governance. We then apply the credit rationing model to articulate insights arising from interviews with key stakeholders into why RFI can alleviate credit rationing in poorly governed countries.

Although the existing literature predicts that poor governance leads to infrastructure deficits, our core economic argument is that RFI alleviates credit rationing even in poorly governed countries through two innovative mechanisms: (1) monitoring technology, whereby loans allocated directly from the lender to the contractor serve to reduce government corruption; and (2) commitment technology, whereby resource revenues channeled into an independent escrow account are used to repay infrastructure loans. Hence, the two innovative mechanisms provide RFI with immunity from poor country-level governance.

Our study has practical implications for the problem of infrastructure deficits in developing countries. First, it goes beyond general discussion of the adverse effects of poor governance on infrastructure financing to explain how two specific dimensions of poor governance exacerbate credit rationing. One limitation is that a borrowing country's government officials may siphon infrastructure funds into their own pockets. The other is that a borrowing country's government may fail to honor its commitment to repay infrastructure loans. Delving deeper into these two limitations helps us better grasp the nature of the problem of infrastructure deficits in poorly governed countries.

Second, our study illuminates the specific mechanisms by which RFI can outperform the traditional government infrastructure purchasing model. Despite its real-world significance given the sheer size of RFI deals, this nascent infrastructure financing model deserves to be

better understood by economists. As a result, the practice has run ahead of the theory. The lack of rigorous academic research has left us with polarized debates on the role of RFI. On one hand, the opaque nature of RFI deals has drawn criticism and suspicion from the media and the international development community. On the other hand, the Chinese government and the borrowing country's government regard RFI as a "win-win" deal by bartering or swapping commodities for infrastructure. Yet little is known about the specific mechanisms that enable RFI to achieve a much larger loan size in poorly governed countries. Our research highlights the importance of monitoring and commitment technologies, which may be used to innovate financing models and resolve credit rationing in other fields.

Finally, we urge Chinese policy banks to consider introducing more accountability and transparency into their RFI deals to ensure that they can maximize the development outcome in borrowing countries while achieving public-policy goals set by the Chinese government. Because of the monopoly power of Chinese policy banks, resource-rich countries may find themselves exceeding the original budget of infrastructure projects. This might occur if the risk of commodity price fluctuations is disproportionately borne by borrowing governments or if the construction costs of infrastructure projects are higher than they would be with opening bidding.

Appendixes

Appendix I: List of RFI loans

Loan ID	Country	Size (USD Million)	Number of projects/ tranches	Sector	Resource Security
AO.003	Angola	1993.40	50	Education, health, agriculture, power, transport, communication, government, water	10000 bpd oil
AO.005	Angola	1786.03	13	Water, agriculture, transport, multi-sector	oil-backed
AO.006	Angola	492.05	18	Education, health, transport, agriculture, power, water, communication	oil-backed
AO.009	Angola	1426.41	50	Water, power, agriculture, transport, multi-sector	oil-backed
AO.078	Angola	2500	1	Housing	oil-backed
AO.089	Angola	15546.34	88	Education, transport, water, environment, government, power, multi-sector, mining	oil-backed
CD.006	Democratic Republic of the Congo	815.52	27	Transport, government, health, industry	copper
CG.005	The republic of Congo	1685.42	10	Water, power, transport, housing, communication	oil-backed
CG.009	The republic of Congo	1009.35	10	Power, education, social, transport, government	oil-backed
GH.005	Ghana	306	1	Power	cocoa
GH.006	Ghana	292	1	Power	cocoa
GH.015	Ghana	1000	2	Power	oil-backed
GQ.004	Equatorial Guinea	978.2	3	Power	oil-backed
SD.097	Sudan	1665.1	12	Transport, power, water, social, agriculture	oil-backed
SS.015	South Sudan	169	1	Transport	30000 barrels per day oil

ZW.014	Zimbabwe	107.136	1	Government (security system management and reform)	diamond

Note: Multi-sector should only be used for projects with multiple but identifiable sectors. For example, the “Africa Port Project – rail, road, and special economic zone” would be assigned Multi-sector (Bräutigam and Hwang, 2019: 16).

Source: CARI China-Africa Loan Database, 2020.

References

Agénor, P., 2010. A theory of infrastructure-led development. JEDC 34, 932–950.

Ajayi, I., Ndikumana, L., 2015. Capital Flight from Africa: Causes, Effects, and Policy Issues. Oxford University Press, Oxford.

Bolton, P., 2016. Debt and Money: Financial Constraints and Sovereign Finance. J. Finance, 71, 1483–1510.

Bräutigam, D., Gallagher, K.P., 2014. Bartering Globalization: China's Commodity-backed Finance in Africa and Latin America. Glob. Policy, 5, 346–352.

Bräutigam, D., Hwang, J., 2019, China-Africa Loan Database Research Guidebook, SAIS China-Africa Research Initiative, Washington DC.

Brueckner, J.K., 1997. Infrastructure financing and urban development: The economics of impact fees. J. Public Econ., 66, 383–407.

Chan, C., Forwood, D., Roper, H. and Sayers, C., 2009. Public infrastructure financing-an international perspective. Productivity Commission Staff Working Paper, Australian Government Productivity Commission, Canberra.

Checchi, A., Behrens, A., Egenhofer, C., 2009. Long-Term Energy Security Risks for Europe: A Sector-Specific Approach. CEPS Working Documents, Centre for European Policy Studies, Brussels.

Collier, P., Cust, J., 2015. Investing in Africa's infrastructure: financing and policy options. Annu. Rev. Resour. Econ. 7, 437–493.

Corkin, L., 2012. Chinese Construction Companies in Angola: A Local Linkages Perspective. Resour. Policy. 37, 475–483.

Della Croce, R., Yermo, J., 2013. Institutional investors and infrastructure financing. OECD Working Paper on Finance, Insurance and Private Pensions No. 36, Organisation for Economic Co-operation and Development, Paris.

De Wet, W.A., 2004. The role of asymmetric information on investments in emerging markets. Econ. Model., 21, 621–630.

del Río, F., 2018. "Governance, social infrastructure and productivity," MPRA Paper 86245, University Library of Munich, Germany.

Estache, A., 2007. Infrastructure and Development: A Survey of Recent and Upcoming Issues. ULB Institutional Repository, Brussels.

Estache, A., Wren-Lewis, L., 2009. Toward a theory of regulation for developing countries: following Jean-Jacques Laffont's lead. J. Econ. Lit. 47, 729–770.

Ferry, M., 2019. The carrot and stick approach to debt relief: overcoming moral hazard. J. Afr. Econ. 28, 252–276.

Habiyaremye, A., 2013. 'Angola-mode' Trade Deals and the Awakening of African Lion Economies. Afr. Dev. Rev. 25, 636–647.

Halland, H., Beardsworth, J., Land, B., & Schmidt, J., 2014. Resource Financed Infrastructure: A Discussion on a New Form of Infrastructure Financing. World Bank Publications, Washington, DC.

Hamdi, H., Sbia, R., 2013. Dynamic relationships between oil revenues, government spending and economic growth in an oil-dependent economy. Econ. Model., 35, 118–125.

Hashimzade, N., Myles, G., 2010. Growth and public infrastructure. Macroecon. Dyn. 14 (S2), 258–274.

Holmstrom, B., Tirole, J., 1997. Financial intermediation, loanable funds, and the real sector. Q. J. Econ. 112, 663–691.

Laffont, J., 2005. Regulation and Development. Cambridge University Press, Cambridge.

Lin, J., Wang, Y., 2016. New structural economics and resource financed infrastructure. Pacific Econ. Rev. 21, 102–117.

Mamatzakis, E., Tsionas, M., 2018. Revisiting the returns of public infrastructure in Mexico: a limited information local likelihood estimation. Econ. Model. 75, 132–141.

Martimort, D., Straub, S., 2009. Infrastructure privatization and changes in corruption patterns: The roots of public discontent. J. Dev. Econ. 90, 69–84.

Naoyuki, Y., Taghizadeh–Hesary, F., Nakahigashi, M., 2019. Modelling the social funding and spill-over tax for addressing the green energy financing gap, Econ. Model., Volume 77, 34–41.

Ndikumana, L., 2016. Causes and effects of capital flight from Africa: lessons from case studies. Afr. Dev. Rev. 28, 2–7.

Ra, S., Li, Z., 2018. Closing the financing gap in Asian infrastructure., South Asia Working Paper Series No. 57, Asian Development Bank, Manila.

Schclarek, A., Xu J., Yan J., 2019. The Maturity Lengthening Role of National Development Banks, Working Paper Series, Institute of New Structural Economics, Beijing.

Soumaré, I., 2016. An analysis of government loan guarantees and direct investment through public-private partnerships. Econ. Model., 59, 508–519.

Tang, X., 2014. China–Africa Economic Diplomacy and Its Implication to Global Value Chain (in Chinese). World Knowledge Publishers, Beijing.

Tirole, J. M. P., 2006. The theory of corporate finance. Princeton University Press, Princeton.

van der Ploeg, F., 2011. Natural resources: curse or blessing? J. Econ. Lit. 49, 366–420.

Voss, G.M., 2002. Public and private investment in the United States and Canada. Econ. Model., 19, 641–664.

Woetzel, J., Garemo, N., Mischke, J., Hjerpe, M., Palter, R., 2016. Bridging global infrastructure gaps. June 2016 Report, McKinsey Global Institute, San Francisco.

World Bank, 1994. World Development Report 1994: Infrastructure for Development: Executive Summary. World Bank Publications, Washington, DC.

World Bank, 2015. Global financial development report 2015–2016: long-term finance. World Bank Publications, Washington, DC.

World Bank, 2017. Africa's pulse: an analysis of issues shaping Africa's economic future. World Bank Office of the Chief Economist for the African Region, Washington, DC.

Xu, J., 2017. Market maker: the role of China Development Bank in incubating market. Man and the Econ. 4, 123.

Xu, J., Ren, X., Wu, X., 2019. Mapping development finance institutions worldwide: definitions, rationale and varieties. Development Financing Report No. 1, Institute of New Structural Economics, Beijing.

Zhang, Y., Ji, S., 2018. Does infrastructure have a transitory or longer-term impact? Evidence from China. Econ. Model. 73, 195–207.