When Does Sovereign Borrowing Pay Off? The Case for Public Investment*

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November 8, 2025

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Abstract

Sovereign borrowing allows governments to finance public capital investment but exposes them and their citizens to default risk, creating an important trade-off for developing countries. Given this trade-off, I analyze the welfare consequences of external sovereign borrowing. Empirically, I document that public investment is positively correlated with private investment, while higher public debt is associated with lower private investment. Motivated by these patterns, I develop a sovereign default model in which the government can borrow externally, allocate resources to public investment, tax, and transfer households. The private sector makes investment decisions while internalizing government policy. The model is calibrated to match the empirical correlations and reproduce the observed response of investment to default. I find that the welfare effects of market access depend on initial capital stocks: economies with low public and private capital gain from borrowing, as high returns to public investment outweigh future default costs, whereas economies with high capital levels experience welfare losses. Finally, I evaluate fiscal rules and show that those encouraging public investment or limiting debt accumulation improve welfare.

Keywords: Sovereign Debt, Sovereign Default, Public Investment, Private Investment, Fiscal Rules.

JEL classification: F34, F41, H63, H54, E62.

*University of Minnesota (email: gambo038@umn.edu). I thank Manuel Amador, Marco Bassetto, Tim Kehoe, and Illenin Kondo for their guidance throughout this project. Thanks to Cristina Arellano, Anmol Bhandari, Chris Ellul, Carlos Esquivel, Juan Carlos Hatchondo, William Jungerman, Tobey Kass, Ioannis Koutsonikolis, Ellen McGrattan, Sergio Ocampo, Facundo Piguillem, Ananth Ramanarayanan, Jacob Wright, Alex Wurdinger, and participants in the Minnesota-Trade Workshop, the Wisconsin-Minnesota Macro Workshop, McMaster University, Western University, and the 20th Economics Graduate Student Conference at Washington University in St. Louis for useful conversations and comments.

1 Introduction

In developing countries public investment is a key driver of economic growth, encouraging private investment and allowing for easier movement of goods within and across countries (Khan and Reinhart, 1990; Bougheas et al., 1999; Cavallo and Daude, 2011). Developing countries often finance public investment with sovereign borrowing (Eden and Kraay, 2014; Francois et al., 2024), and this sovereign borrowing carries default risk, with default episodes being large and costly for developing countries (Kuvshinov and Zimmermann, 2019). This paper examines the trade-off between public investment and sovereign default and asks: what are the welfare consequences of access to sovereign debt?

The sovereign debt literature has shown that restricting government borrowing can improve households welfare, when governments are impatient relative to households. The reason is that the government overborrows and exposes households to default risk and its associated costs (Aguiar et al., 2020). However, the literature has overlooked a key cost: restricting borrowing may also constrain public investment. In this paper, I find that depending on the level of public and private capital, a developing country might benefit from access to international debt markets even under the threat of future costly defaults. For countries with low levels of public and private capital, market access leads to welfare gains, as the return to public investment outweighs the future cost of default. However, for a country with high levels of public and private capital stocks the returns to public investment are low given that in this case the default risk dominates.

I begin by establishing two key facts to understand the relationship between public investment, private investment, and sovereign debt. First, for a sample of emerging and low-income countries I find that public investment is positively correlated with subsequent private investment. This suggests that public and private investment are complementary: increase in public investment raises the marginal product of private investment and crowds it in.

Second, I show that there is a negative correlation between external public debt and private investment. There are two potential interpretations of this. First, a "debt overhang" through which higher debt leads to higher taxes or higher sovereign risk that reduces the return to private investment. Second, a "crowding out" effect where higher debt leads to higher domestic interest rates. Using firm-level data, I find that the debt overhang channel is the empirically relevant mechanism for developing countries. Moreover, I show that there is a negative correlation between external debt service and public investment. This suggests that while debt can be used to finance investment, rising debt service limits a government's ability to sustain high levels of spending over time. This implies two facts motivating the model: (i) rising debt burdens are associated with reductions in public investment and (ii) while public investment crowds in private

investment, external public debt has a negative effect on private capital formation.

Motivated by these facts, I develop a sovereign debt model in which the government can borrow externally, allocates resources to public investment, taxes and lump-sum transfers households, and faces endogenous default risk. The private sector makes investment decisions while taking into account government policy. The model captures the central trade-off faced by governments: the potential gains from financing productive investment through borrowing, versus the costs of debt accumulation and default risk. The government is assumed to be more impatient than households ($\beta_G < \beta_H$), which captures political pressures that lead to higher current spending and borrowing than what households would consider optimal (Alesina and Tabellini, 1990 and Persson and Svensson, 1989). The model is calibrated to a sample of developing countries and successfully replicates two key empirical patterns: (i) a positive correlation between public and private investment, (ii) a negative correlation between public debt and private investment. Complementarity between public and private capital, captured by a low elasticity of substitution in production, allows the model to match the observed crowding in effect of public investment. A threshold that determines when the government must rely on distortionary capital taxation captures how rising debt discourages private investment.

The model sheds light on how public investment affects sovereign debt sustainability. Greater public investment today increases the probability of repayment tomorrow, similar to how private investment raises the price of sovereign bonds (Gordon and Guerron-Quintana, 2018). As public capital increases, the government is able to sustain higher levels of debt while maintaining higher repayment probabilities. However, this relationship weakens at high levels of borrowing. For high levels of borrowing, increases in public capital do not significantly improve repayment probabilities compared to those seen with low levels of borrowing. This reflects diminishing returns to public investment in terms of repayment capacity.

Building on these mechanisms I use the model to conduct a welfare analysis and quantify the importance of public investment. First, I assess whether issuing debt in international markets improves welfare in the competitive equilibrium. Second, I evaluate the effects of implementing a fiscal rule that limits government borrowing. Third, to assess the importance of public investment, I introduce a fiscal rule similar to that present in U.S. states which requires a balanced budget for current expenditures but allows debt to finance capital expenditures (Bassetto with Sargent, 2006; Bassetto and Lepetyuk, 2007). I trace out the welfare gains or losses when I alter the stringency of these rules.

The analysis highlights two opposing forces of market access. Within the model, greater public investment improves repayment probabilities and reduces default risk. However, when an economy transitions from autarky to international borrowing, it is exposed to default risk and its

associated productivity losses. To evaluate this trade-off, I compare welfare in an economy with financial autarky, where the government must finance all investment through taxes, to one with market access, where it can issue debt. Because of government impatience, access to external credit can lower welfare even when borrowing finances productive investment.

At a given point in time, the welfare effects depend on the initial capital stock. Economies with low levels of both public and private capital gain from borrowing, as the high returns to additional public investment outweigh the costs of default risk. Conversely, for economies with high levels of public and private capital, the costs associated with default risk outweigh the returns to public investment, leading to welfare losses from international borrowing. When welfare is instead evaluated in the long run, using the stationary distribution of the economy, a country in autarky would experience welfare losses if it gained access to international debt markets. This means that, on average, financial market access lowers welfare relative to remaining in autarky. This result is consistent with Aguiar et al. (2020) and Gourinchas and Jeanne (2006), who show that the welfare gains from market access are limited or nonexistent. In autarky, governments and households invest more in both public and private capital because they are not exposed to default costs that lower future productivity. By contrast, once borrowing and default risk are introduced, these costs discourage investment, leading to persistently lower levels of capital accumulation. Counterfactual analysis shows that these welfare losses arise primarily from default costs and government impatience underscoring the central role of sovereign risk in shaping the value of market access.

I then explore the welfare implications of fiscal rules. I find that the implementation of both a debt fiscal rule and an investment fiscal rule can be welfare improving. A debt limit improves household welfare by lowering default risk, although the effect depends on the stringency of the rule. A very strict limit, such as a prohibition on new debt issuances, reduces welfare by 0.7 percent in consumption equivalent terms relative to the baseline economy. As the rule is relaxed, households gain from some restriction to government borrowing. A fiscal rule that limits debt to 20 percent of GDP raises output relative to the baseline without increasing sovereign spreads. In this case, the government expands public investment without incurring additional default risk, which generates welfare gains for households.

Similarly, a fiscal rule that specifically targets public investment can lead to welfare increases for the household, although the effect depends on the stringency of the rule. In the baseline economy without a rule, the government allocates about 5 percent of new debt issuances to public investment. The welfare-maximizing rule allocates 21 percent of new debt issuances to public investment, allowing the government to expand public capital while maintaining spreads at baseline levels, generating welfare gains for households. By contrast, a more stringent rule, such as

allocating 40 percent of new debt to investment, increases public capital but also raises spreads due to rising financing needs. Given the restriction on the use of debt the government's ability to smooth consumption is restricted which leads to higher volatility of consumption. Overall this leads to welfare losses for the household.

Related Literature This paper builds on a literature of quantitative sovereign debt models, originating with the seminal contribution of Eaton and Gersovitz (1981). Subsequent work by Aguiar and Gopinath (2007), Hamann (2002), and Arellano (2008) helped formalize and advance this framework.[1]

A growing strand of the literature examines the interaction between sovereign risk and private capital, beginning with Gordon and Guerron-Quintana (2018). Subsequent contributions have explored various dimensions of this relationship. Bai and Zhang (2012) study financial liberalization and default risk, while Arellano et al. (2018) and Deng and Liu (2024) examine how sectoral misallocation affects sovereign risk and capital accumulation. Alessandria et al. (2020) analyze production decisions in the presence of migrant flows. More recently, Asonuma and Joo (2023) investigate the role of public investment in debt renegotiation during default episodes, abstracting from private investment decisions. A common feature of these models is the centralized capital accumulation decision, where the government fully internalizes the effects of investment on sovereign default risk. In contrast, my paper examines the relationship between government debt and private and public investment in a decentralized setting.

Several recent papers feature decentralized equilibrium frameworks similar to the one used in this paper (Galli, 2021; Chatterjee and Eyigungor, 2012; Arellano et al., 2024; Esquivel and Samano, 2024). In particular, Esquivel (2024) develops a decentralized sovereign debt model with tradable and non-tradable capital, highlighting how private agents fail to internalize the impact of their investment decisions on bond prices and sovereign risk. Song and Mihalache (2025) explore how disagreements between households and the government over discount factors can mitigate such externalities. Finally, in a recent paper Esquivel and Samano (2024) explore how fiscal rules can strengthen public finances by increasing long-run income and mitigating private underinvestment. My paper is closest to this line of work but introduces a novel channel, the effect of public investment on private investment.

The model features a debt overhang mechanism, which has been extensively studied in the literature (Aguiar et al., 2009; Aguiar and Amador, 2011; Müller et al., 2019). Higher government debt raises sovereign default probabilities, which in turn crowd out private investment. In a recent paper, Seoane and Yurdagul (2024) rationalize this mechanism using a sovereign debt

[1]For a comprehensive review, see Aguiar and Amador (2014).

model where the government cannot commit to repay its debt or the level of capital taxes. This theoretical mechanism is consistent with a broad empirical literature documenting a negative relationship between government debt and private investment. Following the influential work of Reinhart and Rogoff (2010), numerous studies have used country-level data to document a negative correlation between public debt and both investment and economic growth (e.g., Cecchetti et al., 2011; Checherita-Westphal and Rother, 2012; Khan and Kumar, 1997). Using firm-level data from Orbis, Huang et al. (2018) show that corporate investment declines with higher public debt in both advanced and emerging markets. Similarly, Demirci et al. (2019), using Compustat data, find that higher government debt is associated with lower corporate leverage, suggesting a crowding out effect, particularly through domestic debt. I contribute to this literature by documenting, using Compustat data for developing countries, that external rather than domestic debt drives the negative relationship between government borrowing and corporate investment.

This paper is also related to the literature on the benefits of capital account liberalization in developing countries. The evidence in the literature is mixed. Rodrik (1998) finds no impact on growth, while Bekaert et al. (2002) and Henry (2003) report positive effects. Using a neoclassical growth model, Gourinchas and Jeanne (2006) find that there are positive but limited gains from financial integration. Aguiar et al. (2020) show that once default costs are considered there are welfare losses of allowing governments to borrow. I extend this line of work by quantifying the welfare effects of access to international debt markets when governments face default costs but can allocate borrowing to public investment.

Finally, the paper connects to the endogenous growth literature. Early contributions emphasized the role of public investment in fostering economic growth (Barro, 1990; Barro and Sala-i-Martin, 1992). More recent work has examined the effects of foreign aid and aid-financed public investment (Adam and Bevan, 2006; Berg et al., 2013; Chatterjee and Turnovsky, 2007) as well as the implications of public debt accumulation (Buffie et al., 2012; Greiner, 2007). Although my model does not feature growth explicitly, it contributes to the debate on how government financing influences public investment and, in turn, economic development. My paper is the first to integrate default risk with public and private investment in a sovereign debt model and to analyze the interaction between these variables.

The remainder of the paper is structured as follows. Section 2 describes the motivating facts for the model. Section 3 presents the model environment and equilibrium definition. Section 4 presents the calibration of the model. Section 5 discusses the equilibrium description and key channels in the model. Section 6 reports the results from the welfare analysis. Finally, concluding remarks are provided in Section 7.

2 Motivating Facts

This section presents empirical facts which motivate the structure and calibration of the quantitative model. I establish three key facts to understand the relationship between public investment, private investment, and sovereign debt. First, I show that public investment crowds in private investment and has implications for economic growth.

Second, higher levels of public debt, particularly external debt, are associated with lower private investment. This suggests a debt overhang effect, where rising debt increases sovereign risk and discourages private investment. This motivates a sovereign debt model incorporating default risk and its effect on private investment.

Finally, the data shows that rising debt service is negatively correlated with public investment, suggesting that repayment obligations may limit the governments' ability to sustain capital spending over time. This pattern highlights the trade-off between sovereign debt and public investment, as borrowing can finance current investment but the resulting debt service limits future public capital accumulation.

2.1 Public and Private Investment

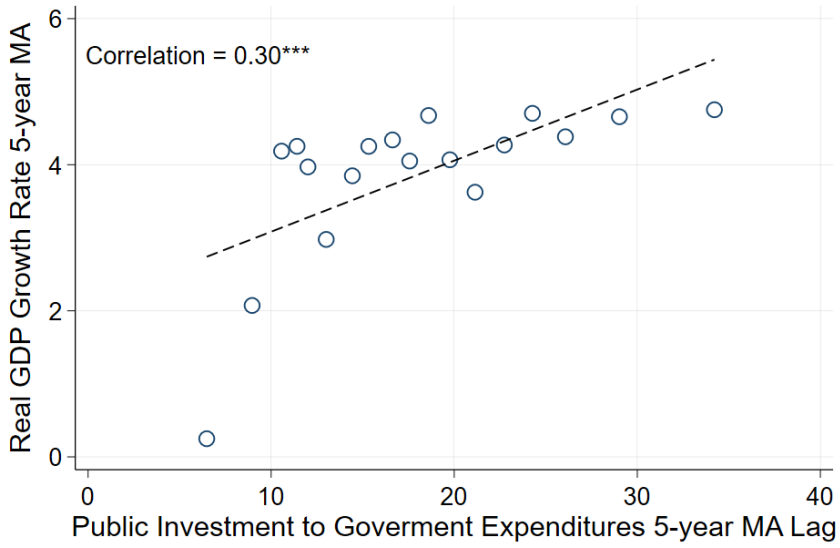
Governments in developing countries have strong incentives to invest in public capital. Extensive evidence shows that infrastructure investment, such as roads and utilities, is complementary to private investment and has positive impacts on economic growth (Khan and Reinhart, 1990; Khan and Kumar, 1997). Infrastructure investment can improve productivity, encourage private investment (Cavallo and Daude, 2011), and make it easier for goods to move within and across countries (Bougheas et al., 1999; Vijil and Wagner, 2012). These effects, can support more sustained economic growth (Esfahani and Ramírez, 2003; Agénor, 2010; Calderón et al., 2015; Gurara et al., 2018).

Using data for a sample of emerging and low-income countries, I compute five-year moving averages of public investment as a share of total government expenditure and of real GDP growth rates. Figure 1 presents a bin-scatter plot showing the relationship between the share of public investment in government expenditure and subsequent real GDP growth, using the five-year lagged moving averages.[2] The positive correlation suggests that countries allocating a larger portion of government spending to public investment tend to experience faster future

[2]The bin scatter groups countries into optimal number of bins as described in Cattaneo et al. (2024). See Figure A.1 in the Appendix for the scatter plot. The relationship also holds using a 3-year moving average, see Figure A.2. The same positive correlation is observed when public investment to GDP is considered, see Figures A.3 in the Appendix for the bin-scatter plot and A.4 for the scatter plot.

growth. While public investment plays a key role in supporting long-term growth, it operates alongside private investment, which contributes to capital accumulation and productivity improvements. Empirical evidence shows that higher private investment is associated with faster economic growth (De Gregorio, 1992). Lucas (1988), Romer (1986), and Barro (1990) emphasize the central role of capital accumulation in sustaining growth, and subsequent empirical work confirms strong linkages between private investment and economic performance (Ghura, 1997; Khan and Kumar, 1997; Tovar Jalles et al., 2024).

Figure 1: Public Investment Share of Government Expenditures and GDP Growth (5-Year MA)

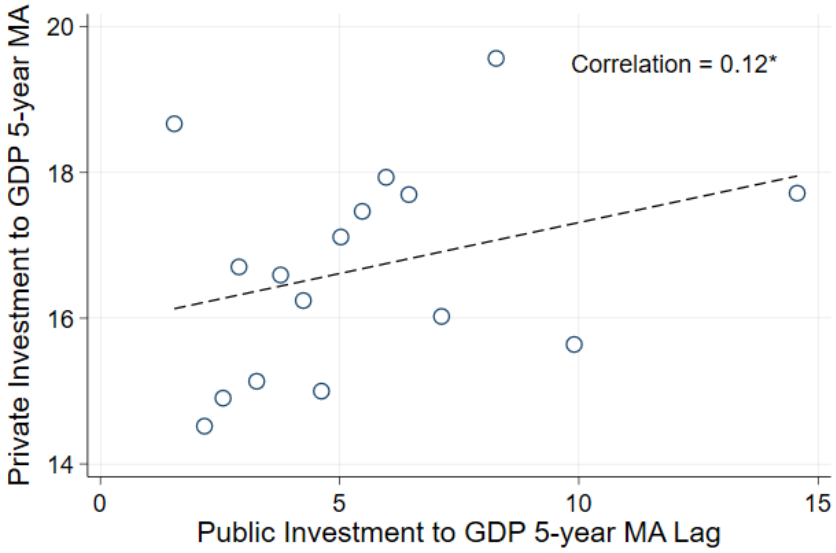


Note: This figure shows the correlation between public investment to government expenditures with real GDP growth rates. Number of bins was selected using IMSE-optimal choice.
Sources: WEO and author's calculations.

There is also a literature that studies the public investment multiplier, which seeks to quantify how much output increases in response to a one-unit rise in public investment spending. A large body of theoretical work (Aschauer, 1989b; Aschauer, 1989a; Baxter and King, 1993) and more recent empirical studies (Auerbach and Gorodnichenko, 2013; Leduc and Wilson, 2012; Eden and Kraay, 2014; Calderón et al., 2015; Furceri and Li, 2017; Ramey, 2021; Espinoza et al., 2024) suggest that the multiplier associated with public investment is substantial. Moreover, Izquierdo et al. (2019) found that countries with a low initial stock of public capital have significantly higher public investment multipliers than countries with a high initial stock of public capital, and show that public investment crowds-in private investment. This complementarity between public and private capital is one of the mechanisms through which public investment raises aggregate output.

Previous literature has found that public capital crowds in private capital and this relationship

Figure 2: Public Investment to GDP and Private Investment to GDP (5 year Moving Average)



Note: This figure shows the correlation between public investment and private investment as percent of GDP. Number of bins was selected using IMSE-optimal choice.
Sources: WEO and author's calculations.

is stronger for less developed countries (Eden and Kraay, 2014; Francois et al., 2024; Boehm, 2020). Consistent with these findings, Figure 2 plots the relationship between private investment as a percent of GDP and the 5-year lag of public investment as a percent of GDP for a sample of developing countries and finds that the relationship is positive. Higher public investment to GDP in the previous five years is associated with higher subsequent private investment to GDP, suggestive of a complementarity between public and private capital.[3]

2.2 Public and Private Investment and Sovereign Defaults

During default episodes, countries enter crisis periods in which government finances are further restrained by restricted access to sovereign markets. In these contexts, emerging market economies face volatile and counter-cyclical interest rates, usually attributed to counter-cyclical default risk (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Arellano, 2008). At the same time, fiscal policy in developing countries has been found to be pro-cyclical which means that governments cut spending during downturns (Frankel et al., 2013).

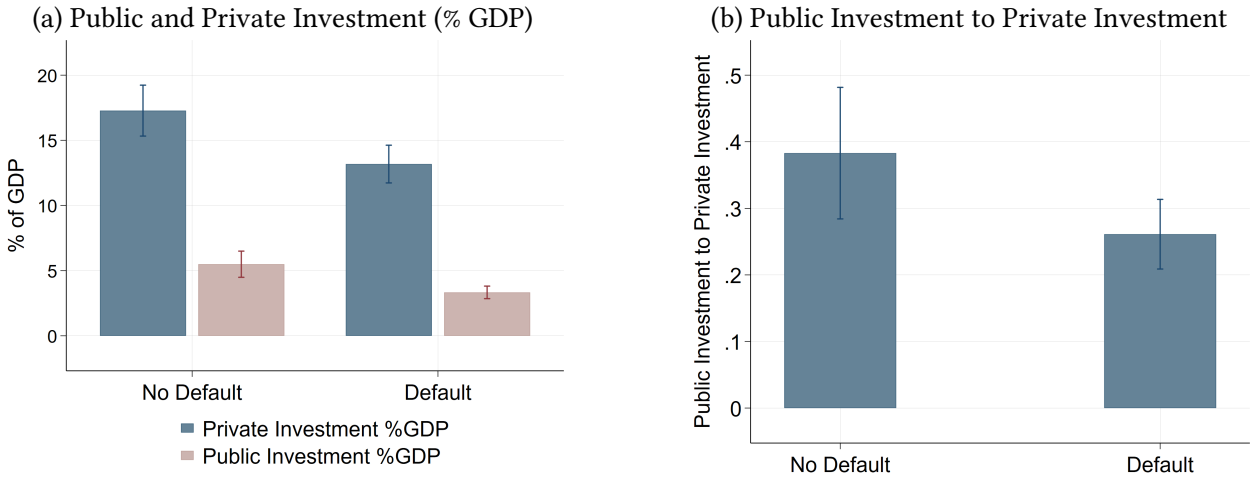
For the same panel of emerging and low-income countries, Figure 3 shows that public investment decreases significantly during default episodes. Panel 3a presents the average level (as

[3]Appendix A.1.1 shows additional evidence of this positive correlation using firm level data for the sample of emerging and developing countries.

a percent of GDP) of private and public investment during normal (i.e., non-default) times and during defaults. On average, public investment is 5.5% of GDP in normal times but falls to 3.3% in default episodes, a decline of approximately 40%. Similarly, private investment falls from 17.3% of GDP in normal times to 13.2% during defaults, a decrease of roughly 23%. Panel 3b shows the ratio of public to private investment. In normal times, public investment is on average just under 40% of private investment, but this ratio falls close to 25% in default episodes. This pattern suggests that governments disproportionately cut public investment during defaults, even relative to the private sector.

Figure A.5 in the Appendix shows how public and private investment decreases during default episodes relative to government and private consumption. Panel A.5a compares public investment and consumption, highlighting that public investment decreases relatively more than public consumption during default episodes. Panel A.5b shows that while private investment also declines on average during defaults, the magnitude of the contraction is smaller than for public investment. This emphasizes the role that public investment plays in government finances when the government is constrained during downturns.

Figure 3: Public and Private Investment during Default Episodes



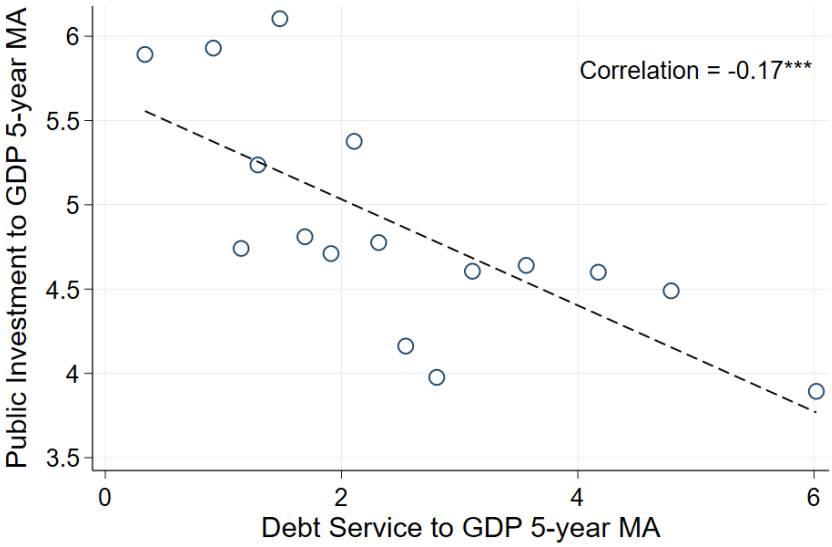
Note: This figure shows the average public and private investment and consumption as a percentage of GDP during normal times and default episodes. The last panel shows the ratio of public to private investment for normal and default times.
Sources: IDS, WEO, and author's calculations.

2.3 Public and Private Investment and Sovereign Debt

Governments fund their expenditures through a combination of tax revenues and borrowing. Debt provides an additional way to fund infrastructure and other types of public capital. However,

rising debt levels lead to higher future debt service, which can limit fiscal space and crowd out more productive spending (International Monetary Fund, 2025; UN Secretary-General's Expert Group on Debt, 2025). Figure 4 shows a negative correlation between external debt service and public investment, both expressed as a share of GDP and using a five-year moving average.[4] This pattern suggests that, while debt can be used to finance investment, rising debt service can limit a government's ability to sustain this spending over time.

Figure 4: Public Investment (% GDP) and Debt Service (% GDP)



Note: This figure shows the correlation between public investment (% GDP) and debt service (% GDP). Number of bins was selected using IMSE-optimal choice.
Sources: IDS, WEO, and author's calculations.

To examine how private investment responds to changes in public debt, I estimate a country-level panel regression for the sample of emerging and low-income countries. The baseline specification estimates private investment as a function of lagged public debt, along with a set of macroeconomic controls. The regression equation is:

$$\frac{\text{Private Investment}_{c,t}}{\text{GDP}_{c,t}} = \beta_1 \frac{\text{Public Debt}_{c,t-1}}{\text{GDP}_{c,t-1}} + \beta_2 X_{c,t-1} + \eta_c + \delta_t + \varepsilon_{c,t} \tag{1}$$

Table 1 reports the results from the OLS regression.[5] The results suggest that a 1 percentage point increase in government debt (% of GDP) is associated with a 0.04 percentage point decrease in private investment (% of GDP). A key concern with this estimate is the potential endogeneity

[4]The bin scatter groups countries into optimal number of bins as described in Cattaneo et al. (2024). See Figure A.6 in the Appendix for the full scatter plot. The relationship holds using a 3-year moving average, see Figure A.7 in the Appendix.

[5]See Table A.4 in the Appendix for the full table with all control variables.

of public debt: firms may adjust their capital investments in response to economic conditions that also influence government borrowing. To address this, I follow Demirci et al. (2019) and instrument government debt with military spending.[6] While military expenditures are not completely exogenous, they are less affected by the macroeconomic environment than other government revenues and expenditures such as taxes and transfer payments and have been shown to occur rapidly, unexpectedly and mostly driven by geo-political shocks. The idea is that such shocks affect the economy only through their impact on government borrowing, not directly through private investment or growth (Ramey and Shapiro, 1998; Berndt et al., 2012; Ramey and Zubairy, 2018).

Table 1: OLS Regression: Private Investment and Government Debt

	(1)
Public Debt (% GDP)$_{t-1}$	-0.0436***
	(0.0137)
Observations	1,799
R^2	0.659

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard error are clustered at country and year level.

Table 2 shows the results of the IV regression, where public debt is instrumented with lagged military spending. Column (1) confirms a stronger negative relationship between public debt and private investment compared to the OLS results: a one percentage point increase in public debt leads to a 0.20 percentage point decline in private investment in the following year. These findings reinforce the presence of a robust negative relationship between government borrowing and private investment.[7]

At the aggregate level, for advanced economies, the empirical literature has found that debt-financed fiscal multipliers vary depending on the location of the debt buyer (Broner et al., 2022; Priftis and Zimic, 2021). That is, the multiplier can be positive or negative depending on whether the fiscal expansion is financed with external or domestic debt. These studies find that the fiscal multiplier tends to increase with the foreign share of public debt: capital inflows help finance government spending without crowding out domestic investment through higher interest rates. However, this mechanism may not generalize to emerging markets, where external public debt often carries greater sovereign risk. In these cases, the dominant effect of increased borrowing

[6] All military spending data comes from the World Bank.

[7] See Table A.5 in the Appendix for the full table with all the control variables.

Table 2: First and Second Stage IV Estimates

	Emerging/Low-Income Countries
Panel A: First Stage (Dep. Var: Public Debt % GDP$_{t-1}$)	
Military Spending$_{t-2}$	0.9339***
	(0.1890)
Panel B: Second Stage (Dep. Var: Private Investment % GDP)	
Public Debt$_{t-1}$ (IV)	-0.2046***
	(0.0427)
Observations	903
R^2	0.457
Kleibergen-Paap rk F-stat	24.41

Notes: Robust standard errors in parentheses, clustered two-way by country and year. Public debt is instrumented with lagged military spending. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

may not be higher interest rates, but instead higher default risk. As external debt rises, private investors may anticipate future repayment problems, which lowers expected returns and suppresses investment. This suggests a debt overhang mechanism, where higher public debt discourages private investment, not by tightening domestic financial markets, but by increased sovereign risk. Appendix A.1.2 explores these channels in more detail and concludes that there is stronger evidence for the debt overhang channel in developing countries.

2.4 Discussion

Taken together, these facts motivate the key assumptions in the model quantitative model introduced in the next section. Developing countries invest, on average, 5.4% of GDP in public capital annually and regularly borrow from external sources to finance their spending. At the same time, rising debt burdens and sovereign default episodes are associated with large reductions in public investment. This motivates the main model specification: a sovereign debt model with public investment.

In the data, I showed that public investment is positively correlated with private investment, while external public debt is negatively correlated with private investment. Moreover, higher debt burdens are associated with higher debt service, which in turn is negatively related to public investment rates. Based on these three observations, I develop a sovereign debt model in which the government can borrow externally, allocate resources to public investment and household transfers, and face endogenous default risk. The private sector makes its own investment decisions

while taking into account government policy, particularly how the levels of public investment and borrowing evolve over time.

The model evaluates the potential gains from financing productive investment through borrowing against the costs of debt accumulation and default risk. It replicates two key empirical patterns: (i) a positive correlation between public and private investment and (ii) a negative correlation between external debt and private investment.

3 Model

The model builds on Eaton and Gersovitz (1981) and most closely follows Gordon and Guerron-Quintana (2018). Their model features capital in a centralized economy while I consider a decentralized economy with public and private capital. Time is discrete and the horizon is infinite. There is a small open economy populated by a measure one of identical households and a government. The government is benevolent and its objective is to maximize the utility of the representative agent. Households own private capital and firms in the economy, but they lack access to foreign borrowing. The government borrows on behalf of the households by issuing non-contingent debt, denoted by B_{t+1} in international financial markets and lacks commitment to repay it.

I assume that governments discount future consumption at a rate $\beta_G < \beta_H$, which allows the model to nest the standard sovereign debt literature (Aguiar et al., 2020). This captures the idea that policymakers are more impatient than households, consistent with the evidence that fiscal policy in developing countries is procyclical (Gavin and Perotti, 1998; Kaminsky et al., 2005; Frankel et al., 2013) and that short political horizons lead governments to favor current spending over long-term investment (Alesina and Tabellini, 1990; Persson and Svensson, 1989). In the model, this political impatience distorts even productive investment decisions, leading the government to borrow excessively and prioritize current transfers over future investment (Battaglini and Coate, 2008).

Firms combine private capital from the households $K_{p,t}$, public capital from the government $K_{g,t}$, and labor L to produce output $Y_t = zF(K_{p,t}, K_{g,t}, L)$. The production function is subject to a productivity shock z_t that follows a Markov process with conditional distribution function $G(z_{t+1}|z_t)$ and associated transition matrix $\pi(z_{t+1}|z_t)$. In each period t, the households value consumption c_t using a utility function $U(c_t) : \mathbb{R}_{++} \to \mathbb{R}$, which is continuous, strictly increasing, and strictly concave. The household supplies L units of labor inelastically to the firm. Households discount the future at rate β_H.

The government can make several decisions within a period t. First, if the government holds

any bonds $B_t > 0$ it can decide to default ($d_t = 1$) or not ($d_t = 0$). If the government decides to default, it then enters the default state and is excluded from financial markets (with re-entry probability θ) and cannot borrow from private lenders in that period (i.e. $B_{t+1} = 0$). The government chooses a tax on capital $\tau^d_{k,t}$, a tax on labor $\tau^d_{\ell,t}$, and lump-sum transfer T^d_t to households and public capital investment $i^d_{g,t}$.

If the government decides to repay, it issues new bonds B_{t+1} at a price q_t to be determined by the private lenders in a competitive market, chooses taxes $\tau_{k,t}$, $\tau_{\ell,t}$, lump-sum transfer T_t, and public capital investment $i_{g,t}$. Having observed the decisions of the government, the household then decides how much private capital to invest in $i_{k,t}$.

The timing of the model is as follows:

1. The productivity shock z_t is realized.
2. The government makes the default decision d_t.
   (a) If the government chooses not to default, it chooses B_{t+1}, $i_{g,t}$ T_t, $\tau_{k,t}$, and $\tau_{\ell,t}$ in order to maximize household utility taking as given the household policy function.
   (b) If the government chooses to default, it enters the default state and loses access to the credit market for this period and the economy faces a productivity loss. It re-enters next period with probability θ and zero debt ($B_{t+1} = 0$). The government chooses $i^d_{g,t}$, T^d_t,$\tau^d_{k,t}$, and $\tau^d_{\ell,t}$ in order to maximize household utility taking as given the household's policy function.
3. Households observe government's policy and make private investment decision $i_{k,t}$.
4. Lenders observe borrowing and investment decision and purchase government debt at price q_t.

I focus on Markov Equilibrium and write all variables using recursive notation (i.e. $B_t = B$ and $B_{t+1} = B'$). The aggregate state of the economy is (z, B, K_p, K_g) and the government's policy is denoted by $p = (B', K'_g, T, \tau_k, \tau_\ell)$.

3.1 Firms

K_g is a public good that provides services used in production by firms. Firms maximize profits π, rent private capital from the households, and pay wages to the households:

$$\pi(z, K_p, K_g) = \max_{K_p} \quad zF(K_p, K_g, L) - r_k K_p - wL \tag{2}$$

where r_k is the return to private capital K_p and w is the wage. Firms only choose how much private capital to rent, and public capital K_g is provided by the government. Labor is inelastically supplied by the household as it is standard. In the default state, there is a productivity loss $\phi(z)$, and so during default episodes the effective productivity observed by the firm is $z - \phi(z)$. Let me denote $\pi(z, K_p, K_g)$ the profits made by firms and note that $r_k = zF_{K_p}(K_p, K_g, L)$ and $w = zF_L(K_p, K_g, L)$ in equilibrium.

3.2 Household's Problem

At time t, if the government has not defaulted in the previous period, a household with individual private capital k_p maximizes consumption and chooses private capital k_p', given the aggregate state of the economy (z, K_p, s), where $s = (B, K_g)$, and government policies $p = (B', K_g', T, \tau_k, \tau_\ell)$. Households are endowed with L units of labor which they supply inelastically to the firm. Households behave competitively and take all prices as given. I assume that households cannot borrow internationally. The value of the household when the government is in good credit standing is given by,

$$
\begin{aligned}
W_R(k_p, z, K_p, s, p) = \max_{c, k_p', i_k} \quad & U(c) + \beta_H \int \Big[d(z', s') W_D(k_p', z', K_p', s', P(z')) \\
& + (1 - d(z', s')) W_R(k_p', z', K_p', s', P(z')) \Big] dG(z'|z)
\end{aligned} \tag{3}
$$

$$
\begin{aligned}
\text{s.t.} \qquad c + i_k + \Psi(k_p, k_p') &= (1 - \tau_\ell) w(z, K_p, K_g) L + (1 - \tau_k) \big(r_k(z, K_p, K_g) k_p \\
&\quad + \pi(z, K_p, K_g) \big) + T \\
k_p' &= i_k + (1 - \delta_k) k_p \\
K_p' &= \Gamma_k(z, K_p, s, p) \\
P(z') &= \Gamma_p(z', K_p', s', d(z')) \\
s' &= (B', K_g')
\end{aligned}
$$

where W_R is the value in repayment and W_D is the value in default and $w(z, K_p, K_g)$, $r_k(z, K_p, K_g)$, and $\pi(z, K_p, K_g)$ are defined as above. The household maximizes consumption subject to the budget constraint, the law of motion for private capital, the perceived law of motion for the aggregate private capital, and the perceived law of motion for the government policies. The household receives income $r_k(z, K_p, K_g) k_p$ from the firm, labor income $w(z, K_p, K_g) L$, and all profits of the firm π. The government taxes capital income at rate τ_k, labor income at rate τ_ℓ, and rebates lump-sum

transfers T. The household owns all private capital in the economy and decides how much to invest in private capital subject to the law of motion as well as adjustment costs $\Psi(k_p, k_p')$. Finally, the household takes as given the law of motion for the aggregate stock of private capital, $\Gamma_k(z, K_p, s, p)$, and forms expectations about the evolution of government policy in repayment and default states, $\Gamma_p(z', K_p', s', d(z'))$. The term $\Gamma_p(z', K_p', s', d(z'))$ captures households' expectations about how government policies evolve with next-period states and default decisions. The evolution of the aggregate private capital, K_p', depends on the set of policies of the government. In particular, it depends on the government's choice of next period public capital K_g' which affects the marginal product of private capital through the production function. Given the set of government policies $P(z')$ for tomorrow, each household optimally chooses its next period private capital k_p'. The aggregation of these individual choices determines $K_p' = \Gamma_k(z, K_p, s, p)$. Hence, the perceived law of motion for aggregate private capital reflects both the direct effect of public investment on private returns and the indirect effect of policy on all households' saving decisions.

If the government is in default, the value of the household is given by,

$$
\begin{aligned}
W_D(k_p, z, K_p, K_g, p) = \max_{c, k_p', i_k} \quad & U(c) + (1-\theta)\beta_H \int \left[W_D(k_p', z', K_p', K_g', P(z')) \right] dG(z'|z) \\
& + \theta\beta_H \int \Big[d'(z', s') W_D(k_p', z', K_p', K_g', P(z')) \\
& + (1 - d(z', s')) W_R(k_p', z', K_p', s', P(z')) \Big] dG(z'|z)
\end{aligned} \tag{4}
$$

$$
\begin{aligned}
s.t. \qquad c + i_k + \Psi(k_p, k_p') &= (1 - \tau_\ell^D) w(z, K_p, K_g) L + (1 - \tau_k^D) \big(r_k(z, K_p, K_g) k_p \\
&\quad + \pi(z, K_p, K_g) \big) + T^D \\
k_p' &= i_k + (1 - \delta_k) k_p \\
K_p' &= \Gamma_k(z, K_p, s, p) \\
P(z') &= \Gamma_p(z', K_p', s', d(z')) \\
s' &= (0, K_g')
\end{aligned}
$$

The household chooses consumption and private investment subject to the budget constraint in the default state, the capital accumulation equation, the aggregate law of motion of capital $\Gamma_k(z, K_p, s, p)$ and the policies of the government $\Gamma_p(z', K_p', s', d(z'))$. Given a solution to the households problem, define $\Gamma_k^R(K_p, z, K_p, s, p)$ and $\Gamma_k^D(K_p, z, K_p, s, p)$ as the policy function for private capital from the household in the repayment and default states, and $c^R(z, K_p, s, p)$ and $c^D(z, K_p, s, p)$ as the policy function for consumption of the household in the repayment and de-

fault states, respectively.

3.3 Government's Problem

If the government starts in good credit standing at time t, it makes the default decision $d = \{0, 1\}$ given the aggregate state of the economy (z, K_p, s) where $s = (B, K_g)$. The value function of the government is given by,

$$V(z, K_p, s) = \max_{d \in \{0,1\}} \quad (1-d)V_R(z, K_p, s) + dV_D(z, K_p, K_g) \tag{5}$$

where V^R is the repayment value function and V^D is the value of entering the default state.

Conditional on choosing to repay, the government chooses public capital investment K_g', how much to borrow B', how much to tax households τ_k, τ_ℓ, and how much to lump-sum transfer or tax households T to solve:

$$V_R(z, K_p, s) = \max_{B', K_g', T, \tau_k, \tau_\ell, i_g} \quad U(c^R(z, K_p, s, p)) + \beta_G \int V(z', K_p', s')dG(z'|z) \tag{6}$$

$$\begin{aligned} s.t. \qquad T + i_g + \Phi(K_g, K_g') + B &= q(z, K_p', s')B' + \tau_k\big(r_k(z, K_p, K_g)K_p + \pi(z, K_p, K_g)\big) \\ &\quad + \tau_\ell w(z, K_p, K_g)L \\ K_g' &= i_g + (1-\delta_g)K_g \\ K_p' &= \Gamma_k^R(K_p, z, K_p, s, p) \\ T &\geq 0 \\ \tau_\ell &\leq \bar{\tau}_\ell \\ s' &= (B', K_g') \end{aligned}$$

The government raises revenue by taxing capital at rate τ_k, labor income at rate τ_ℓ, and by issuing new debt B' at price $q(z, K_p', s')$. Revenue is used to invest in public capital i_g, to repay debt B to private lenders, and to make lump-sum transfers T to households. Public capital is subject to a standard capital accumulation equation, and aggregate capital evolves with the perceived law of motion $\Gamma_k^R(K_p, z, K_p, s, p)$. Lump-sum transfers are subject to the constraint $T \geq 0$ such that the government can only lump-sum transfer to the household. Finally, I assume that the government faces a constraint on how much labor taxes it can raise from the households $\tau_\ell \leq \bar{\tau}_\ell$.

This constraint highlights the trade-off faced when the debt stock is large. The government may need to rely on distortionary capital taxation in such cases.

If the government is in bad credit standing, the default value is given by,

$$V_D(z, K_p, K_g) = \max_{K_g', T^D, \tau_k^D, \tau_\ell^D, i_g^D} \quad U(c^D(z, K_p, s, p)) + \beta_G \int \left[(1-\theta)V_D(z', K_p', K_g') + \theta V(z', K_p', s')\right] dG(z'|z) \tag{7}$$

$$\begin{aligned} s.t. \qquad T^D + i_g^D + \Phi(K_g, K_g') &= \tau_k^D \left(r_k(z, K_p, K_g)K_p + \pi(z, K_p, K_g)\right) + \tau_\ell^D w(z, K_p, K_g)L \\ K_g' &= i_g^D + (1-\delta_g)K_g \\ K_p' &= \Gamma_k^D(K_p, z, K_p, s, p) \\ T^D &\geq 0 \\ \tau_\ell^D &\leq \bar{\tau}_\ell \\ s' &= (0, K_g') \end{aligned}$$

In the default state the government has no access to financial markets, hence the only source of income are capital τ_k^D and labor taxes τ_ℓ^D. In the default state the government can still make public investment decision K_g' as well as lump-sum transfers T^D.

3.4 Lender's Problem

Competitive private lenders have deep pockets and can borrow or lend at the risk-free interest rate $r_f \geq 0$. Each individual private lender takes prices q as given. Since private lenders are risk neutral and there is perfect competition, a zero profits condition determines the price for a bond of size B':

$$q(z, K_p', s') = \frac{\mathbb{E}_z[(1 - \hat{d}(z', K_p', s')]}{1 + r_f} \tag{8}$$

The price of the bonds reflects the expected default probability of the government.

3.5 Equilibrium

A Markov recursive competitive equilibrium is a value and policy functions for the household, value and policy functions for the government, price $r_k(z, K_p, K_g)$, price $w(z, K_p, K_g)$, profits $\pi(z, K_p, K_g)$, and a price schedule q, such that:

1. Given government policies, the private sector value W_R and W_d and policy functions $\hat{c}^R, \hat{c}^D$, $\Gamma_k^R(K_p, z, K_p, s, p), \Gamma_k^D(K_p, z, K_p, s, p)$ solve the households problem given in equation (3) and (4).

2. Given household's policy functions and the bond price schedule, the value V, V_D, V_R and policy functions $\hat{B}, \hat{K}_g, \hat{d}, \hat{T}, \hat{\tau}_\ell, \hat{\tau}_k$ for the government solve the government's problem given in equations (5), (6), and (7).

3. Price schedule q satisfies the zero profit condition given by equation (8).

4. Firms maximize profits as in equation (2).

The Markov recursive competitive equilibrium describes a fixed point between the household's and the government's optimal decisions, given the aggregate laws of motion and market clearing conditions. The interaction between the government and households can be viewed as a Stackelberg game in which the government moves first, internalizing household responses to its policy choices. In each period, the government observes the current aggregate state (z, K_p, s) and chooses a set of policies $p = (d, B', K_g', T, \tau_k, \tau_\ell)$. Households take these policies and prices as given and decide how much to consume and invest, forming expectations about how aggregate variables and government policies evolve according to the perceived laws of motion Γ_k^R, Γ_k^D and Γ_p. Their individual decisions aggregate into the next period's private capital stock K_p', which, together with the government's choices, determines the new state $s' = (B', K_g')$. The government then re-optimizes next period, taking as given the household responses implied by these policy rules and the bond price schedule q. The equilibrium is reached when the government's policy functions, the household's decision rules, and the perceived laws of motion are all mutually consistent and jointly satisfy market clearing and zero profit conditions.

Section A.4 in the Appendix describes the planners problem and how it differs from the solution to the competitive equilibrium.

4 Calibration

In this section I present the calibration of the quantitative model. The main quantitative exercise involves choosing parameters to match key moments in the data, and then computing welfare gains or losses associated with different policies. This section describes all external and internally calibrated parameters required to conduct this exercise.

The method of simulated moments is used to minimize the distance between the vector of empirical moments with simulated moments from the model. The sample of countries selected

for the estimation include both emerging market and low-income developing countries. The aim of the model is to match key moments in the data, in particular, the negative correlation between public debt and private investment and the positive correlation between public investment and private investment. More specifically, the two key novel parameters that are introduced are the labor tax limit and the elasticity of substitution between private and public capital. The labor tax limit determines the extent to which distortionary capital taxation is levied by the government which directly affects capital returns. The elasticity of substitution determines how complementary public and private capital are which translates into how public capital affects the returns to private investment. Together, these two parameters recover the observed correlations in the data.

4.1 External Calibration

I make functional form assumptions following the sovereign debt literature. The utility function is CRRA, with relative risk aversion parameter $\sigma = 2$. I assume that the production function is given by $z[(\gamma K_p^{\omega} + (1-\gamma)K_g^{\omega})^{\frac{1}{\omega}}]^{\alpha} L^{(1-\alpha)}$, where γ is a share parameter, ω is the substitution parameter, and α is the capital share of the economy. Data is collected from several sources spanning 1990-2024. The external debt data is from the International Debt Statistics (IDS) and other macroeconomic variables are from the World Economic Outlook (WEO).

The first set of parameters are those set outside the model and are taken directly from the data or literature. The annual risk free interest rate is set to be $r_f = 0.04$ and is standard in the sovereign debt literature (see for example Bianchi and Sosa-Padilla, 2024). To estimate the productivity process, log real TFP in domestic currency is used for each of the countries in the sample. The series are detrended before estimating. The TFP data comes from the Feenstra et al. (2023). The persistency coefficient of the first-order autoregressive process (AR(1)) is $\rho_z = 0.80$ and the innovation standard deviation is $\epsilon_z = 0.060$. Data on depreciation rates for public capital stock comes from International Monetary Fund (2019). The estimated depreciation rates for middle income countries is $\delta_g = 0.032$ for public capital. The private capital depreciation rate comes from Mercado and Cicowiez (2013) and is set to $\delta_k = 0.08$. The discount of the household is set to a standard value of 0.96 which is slightly lower than the discount factor of the foreign lenders. The capital share of the economy α is set to a standard value of 0.33. The probability of re-entry to private debt markets, θ, matches the length of the default episode in the data. Table 3 summarizes the externally calibrated parameters in the model.

Table 3: Externally Calibrated Parameters

Parameter	Value	Description	Source
σ	2.0	Constant Relative Risk Aversion	Standard
ρ	0.80	Persistency Productivity Shock	Feenstra et al. (2023)
η	0.06	Volatility Productivity Shock	Feenstra et al. (2023)
δ_k	0.08	Private Capital Depreciation Rate	Mercado and Cicowiez (2013)
δ_g	0.032	Public Capital Depreciation Rate	International Monetary Fund (2019)
r_f	0.04	Risk Free Interest Rate	Standard
β_H	0.96	Household Discount Factor	Standard
α	0.33	Capital Share	Standard
θ	0.3095	Time excluded from financial market	Asonuma and Trebesch (2016)

Note: This table presents model parameters, a brief description of their role, the externally calibrated value, and the source.

4.2 Internal Calibration

While all parameters are jointly calibrated, I describe the intuition for which parameter is most closely associated to which moment. Table 4 summarizes the values of parameters that are internally calibrated. The default penalty follows Chatterjee and Eyigungor (2012), $\phi(z)$, to be $\phi(z) = \max\{0, d_0 z + d_1 z^2\}$, with $d_0 < 0 < d_1$. The discount factor of the government β_G is set to match the debt-to-GDP ratio. The output costs when in default d_0 and d_1 are set to match the average spread and the standard deviation of the spread observed in the data. The CES share γ is set to match private investment to public investment ratio. The capital adjustment for private capital, ϕ, where $\Phi(k'_p, k_p) = \frac{\phi}{2}\frac{(k'_p-(1-\delta_k)k_p)^2}{k_p}$ is set to match the volatility of private investment to output, and the capital adjustment cost for public capital, ψ, where $\Psi(K'_g, K_g) = \frac{\psi}{2}\frac{(K'_g-(1-\delta_g)K_g)^2}{K_g}$ is set to match the volatility of public investment to output.[8]

The additional two moments of interest are the regression relating private and public investment and the regression relating private investment and debt.[9] The data shows a negative relationship between public debt and private investment which the model captures as it features external sovereign borrowing subject to default risk and distortionary taxes that affect capital returns. Higher levels of debt are associated with higher default risk, which discourages private investment due to the default penalty. Additionally, the labor taxes threshold $\bar{\tau}_\ell$ controls whether the government has to use distortionary capital taxation. Hence, this parameter is set to match the negative correlation between public debt and private investment. If the government has a

[8] The functional form for the capital adjustment costs follow Esquivel (2024).

[9] The targeted moments are the regression coefficients using aggregate country data, see Table A.9 in the Appendix for the specification.

Table 4: Internally Calibrated Parameters

Parameter	Value	Definition
β_G	0.9055	Government Discount Factor
ϕ	12	Private Capital Adjustment Cost
ψ	16	Public Capital Adjustment Cost
γ	0.67	CES Share
$\bar{\tau}_\ell$	0.027	Labor Tax Threshold
d_1	1.039	Cost of Default
d_0	-0.94	Cost of Default
ω	-1.8	CES Substitution

Note: This table presents model parameters, a brief description of their role and the internally calibrated value.

large stock of debt that requires high tax revenues to repay, the government will have to resort to capital taxes which affect the returns to investment.

The second relationship of interest in the model is between public and private investment. The data exhibits a positive correlation between public and private investment. In the model, the key parameter governing the complementarity between public and private capital is the CES substitution parameter ω. As $\omega \to -\infty$ public and private capital become perfect complements, and when $\omega \to 1$ they are perfect substitutes. As ω increases, the degree of complementarity decreases, and we should expect the correlation between public and private investment to weaken accordingly. The model is able to match the positive relationship between private and public investment with an appropriate value of ω.

Table 5 reports the targeted moments in the data and the counterpart in the model. Overall, the model replicates the data well. The moments related to default behavior are closely matched. The average spread is 0.035 in the data and 0.036 in the model. The debt-to-GDP ratio is also well matched, with a value of 23.57 in the data and 23.25 in the model. The private to public investment rates in the model are close to the data. The volatility rate for both public and private capital are slightly higher in the model than in the data.

The model also matches the two key regression coefficients. The crowding in regression, which measures the relationship between public and private investment, is 0.10 in the data, and the model produces a value of 0.14. The parameter governing the substitutability between public and private capital is calibrated to $\omega = -1.8$ which suggests and elasticity of substitution of 0.36 making private and public capital highly complementarity. The value of this coefficient is in line with the literature that has estimated the sustitutability parameter for developing countries to be between $(-0.4, 5)$ with the average economy having the parameter at -1.72 (Eden and Kraay,

Table 5: Data vs. Moments

Moment	Data	Model
Spread	0.035	0.036
Spread (std)	0.019	0.051
Debt to GDP (%)	23.45	23.25
Private Investment to Public Investment (%)	3.16	2.38
$\frac{\sigma_{i_g}}{\sigma_y}$	1.81	2.24
$\frac{\sigma_{i_k}}{\sigma_y}$	2.05	2.35
Correlation public debt and private investment	-0.04	-0.03
Correlation public and private investment	0.12	0.14

Note: This table presents the moments from the data and from the model. The columns provide a comparison between the model and the data for selected targeted moments.

2014; Francois et al., 2024). The estimate for the share of public capital in the CES production function is also in line with the estimates in the literature which ranges from $(0.05, 0.49)$ with the average economy having the share of public capital at 0.4, the estimate in my calibration is 0.33. The debt overhang regression coefficient, which captures the relationship between sovereign debt and private investment, is -0.04 in the data, while the model generates a slightly lower value of -0.03.

Table 6 further reports untargeted moments. The model is able to match additional business cycle statistics, the trade balance is counter cyclical and consumption is more volatile than GDP. Default probabilities are slightly higher in the model than in the data and the volatility of the trade balance is slightly higher as well. Summarizing, the calibrated model delivers on all the usual statistics used in the sovereign debt literature, while matching well the behavior of public and private investment.

Table 6: Untargeted Moments

Moment	Model	Data
Probability Default (%)	3.3	2.07
$\frac{\sigma_c}{\sigma_y}$	1.09	1.30
$\sigma_{tb/y}$	8.3	5.30
$\rho_{y,tb/y}$	-0.19	-0.19

Note: This table presents selected untargeted moments from the data and from the model.

5 Equilibrium Description

This section describes the equilibrium properties of the model and how they relate to the empirical moments described in Section 2. Figure 5 illustrates how bond prices vary with levels of private capital, debt, and public capital. Panel 5a confirms the standard result from sovereign debt models where the bond price decreases as the level of debt increases. This reflects the higher risk of default associated with higher debt levels. The price is also increasing in the productivity z as higher productivity leads to higher income in the next period, due to the Markov nature of the exogenous process, which leads to higher repayment probability for a given debt level.

Panel 5b shows that bond prices are increasing in the private capital stock. Greater capital stock implies higher future output, improving the government's ability to repay and thus raising the price of debt. This result aligns with the findings of Gordon and Guerron-Quintana (2018), who were the first to solve a sovereign default model with endogenous capital accumulation. They argue that capital serves as a form of saving and borrowing that is less sensitive to default risk, delaying default in response to adverse productivity shocks because capital can be liquidated to meet payment obligations. Similarly, Panel 5c shows that bond prices are increasing in public capital for given debt. Although public capital requires upfront government taxes, it raises future income, thereby enhancing repayment capacity.

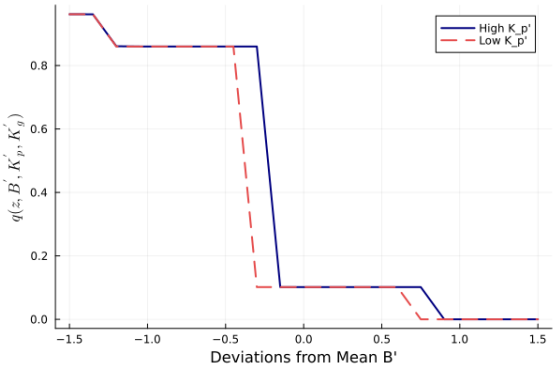
Overall, the price schedule reflects how debt, private, and public capital affect default probabilities. For example, even if the level of public capital is high, a high level of debt B still results in a lower bond price compared to a situation with lower debt (see Panel 5c). This highlights the importance of both the composition of government liabilities and assets in determining sovereign borrowing costs.

Figure 6 plots the repayment probability as a function of future debt B' and public capital K_g'. The figure highlights the trade-off the government faces when deciding between borrowing and public investment. As public capital increases, the government is able to sustain higher levels of debt while maintaining higher repayment probabilities. However, this relationship weakens at high levels of borrowing. For high levels of borrowing, increases in public capital do not significantly improve repayment probabilities compared to those seen with low levels of borrowing. This reflects diminishing returns to public investment in terms of repayment capacity when debt levels are already high.

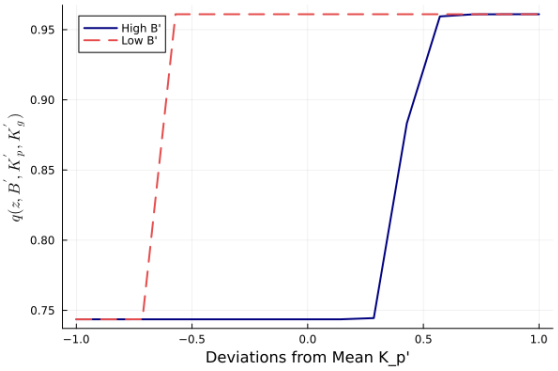
An additional untargeted moment is the relationship between debt service and public investment. Because government resources are limited, higher debt service obligations crowd out spending on public investment. The model generates a negative correlation between debt service and public investment, consistent with the empirical findings in Section 2. The correlation in

Figure 5: Debt Price Schedule

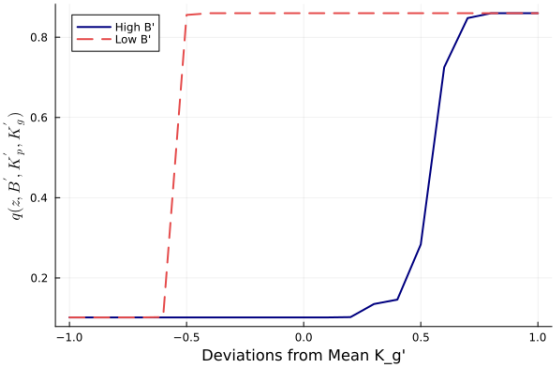
(a) Price Schedule for different levels of B'



(b) Price Schedule for different levels of K_p'

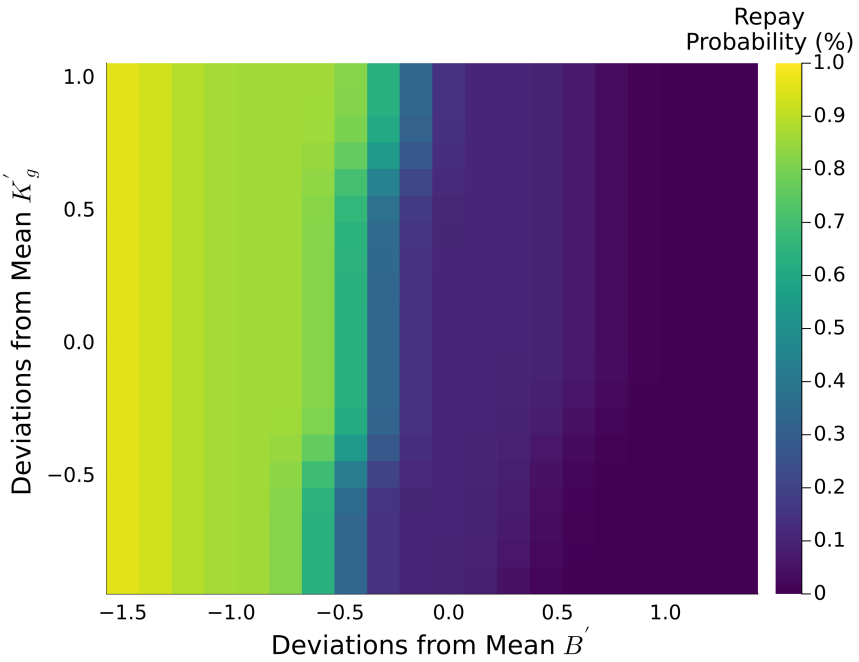


(c) Price Schedule for different levels of K_g'



Note: This figure shows the price schedule for different variables in the model.

Figure 6: Repayment Probability



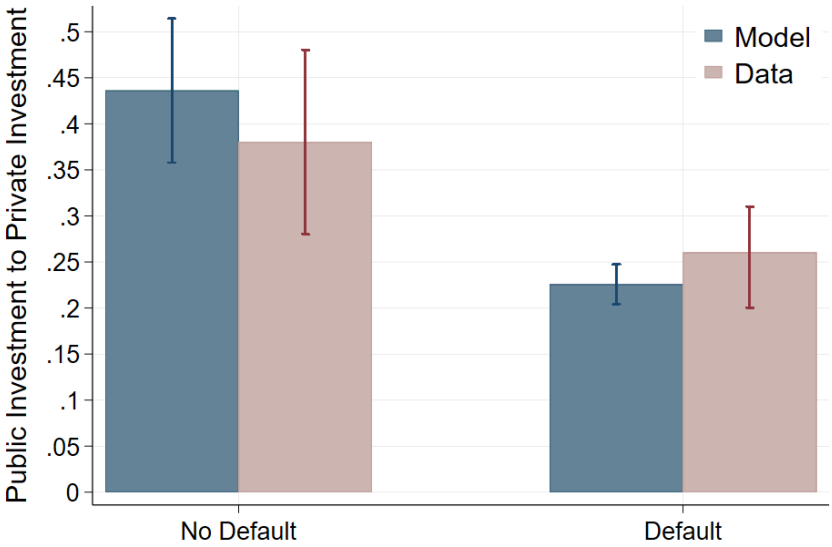
Note: This figure shows the repayment probability for different levels of B' and K'_g for a given level of z and K'_p.

the model is −0.03, compared to −0.17 in the data. The smaller magnitude in the model reflects the behavior of the impatient government, which keeps public investment relatively stable while adjusting debt issuance and taxes primarily to meet its debt service obligations.

As described in Section 2 public investment decreases more than private investment during default episodes. Using the model, I plot the average ratio of public to private investment during default and non-default (i.e. normal) times. Figure 7 shows the untargeted ratio of public to private investment in default and non-default episodes. The model replicates well the decrease in both public and private investment during the default episodes, on average the ratio of public to private investment falls to 23% compared to 44% in normal times. Default episodes reduce productivity which directly affects private and public investment. At the same time, the government's resources are constrained which leads to cuts in public investment. However, when the government defaults it does not have to repay its stock of debt and transfers directly resources to the household, this mitigates the negative effects of default costs. Nonetheless, given that public and private investment are complementary, default episodes not only affect the economy by being in a crisis, but can also further constrain private investment as public investment falls significantly.

Overall, the model reproduces well the main empirical patterns described in Section 2. It captures the key mechanisms linking sovereign risk, debt accumulation, and investment behav-

Figure 7: Public to Private Investment



Note: This figure shows the average public to private investment during non-default episodes and the first year of the default episode.

ior. Higher debt levels lower bond prices and repayment probabilities, while public investment strengthens repayment capacity but with diminishing returns when debt is high. Default episodes lead to simultaneous declines in public and private investment, consistent with the data, and the complementarity between the two amplifies the downturn. Taken together, these results highlight the central role of public investment in influencing borrowing costs.

6 Welfare Analysis

This section presents the paper's main counterfactual exercises that quantify the welfare implications of public investment, sovereign borrowing, and fiscal rules. I begin by assessing the welfare effects of government access to financial markets. Then I evaluate two types of fiscal rules: a debt ceiling and an investment rule. Each exercise quantifies the change in household welfare using a consumption equivalent metric.

To evaluate the welfare gains from different policies, I define the consumption-equivalent change in welfare, denoted by λ:

$$(1+\lambda) = \left(\frac{W(z, K_p, s; \mu)}{W(z, K_p, s)}\right)^{\frac{1}{1-\sigma}}$$

where $W(z, K_p, s; \mu)$ is the welfare of the household contingent on policy μ (i.e. no access to financial markets, debt ceiling rule, and public investment rule) and $W(z, K_p, s)$ is the baseline welfare function of the household. The benchmark welfare gains and losses are computed as the average welfare across the states in the simulation.

Access to Financial Markets

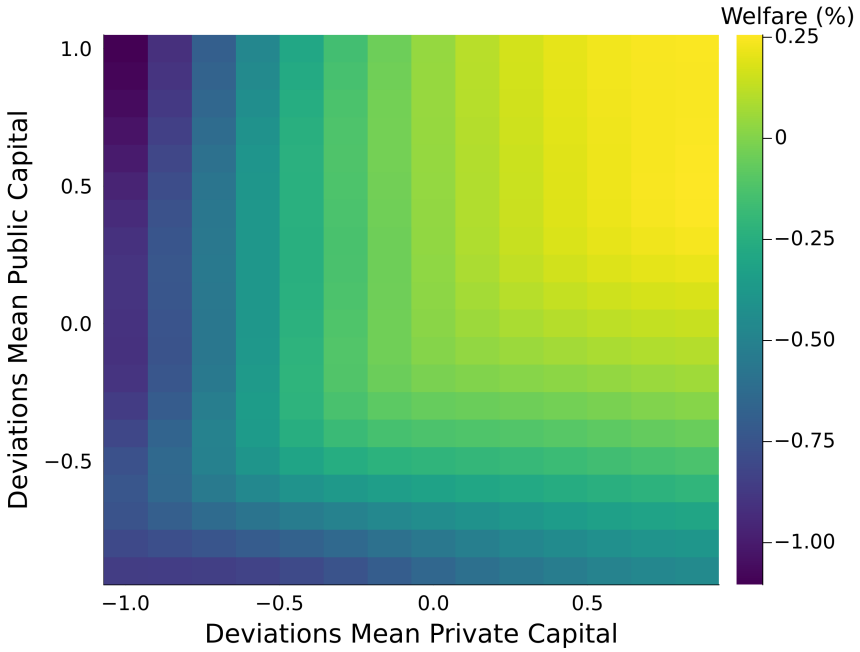
The model is motivated by the trade-off between default risk and public capital accumulation in economies that rely on external borrowing to finance productive investment. In theory, external borrowing allows governments to finance capital accumulation and smooth consumption, potentially offsetting the inefficiencies associated with government impatience. In practice, however, impatient governments may overborrow, triggering costly default episodes that depress productivity and crowd out private investment. The model provides a unified framework to quantify this trade-off: it embeds sovereign default risk, public investment, and the endogenous response of private capital. This setup allows me to assess whether the benefits of borrowing to finance necessary public goods are sufficient to outweigh the long-run costs of excessive debt accumulation and default.

This section examines the value of external credit in the model by comparing an economy with access to international debt markets to one in financial autarky. In financial autarky, the government is prohibited from issuing debt and must finance all public investment through taxes. The household discount factor satisfies $\beta_H > \beta_G$, implying that households are more patient than the government. Because of this difference, when the government has access to debt markets it tends to borrow more than what households would consider optimal. The government places greater weight on current consumption relative to future welfare, while households place more value on future outcomes.

As shown by Aguiar et al. (2020), this difference in discount factors can make households prefer autarky when the losses associated with default are large. In the absence of default risk, relying on distortionary taxes to finance investment would reduce welfare. However, when default risk is present, the productivity and investment losses it creates can make autarky preferable despite the tax burden. As a result, private investment is not negatively affected by sovereign risk, and the government can still fund public investment through taxation. The welfare increases or decreases will be determined by whether the returns to public investment outweigh the costs of default risk.

Figure 8 plots the welfare gains and losses from transitioning from financial market access with no debt (i.e., $B = 0$) to autarky. For low levels of both public and private capital, the econ-

Figure 8: Autarky Welfare



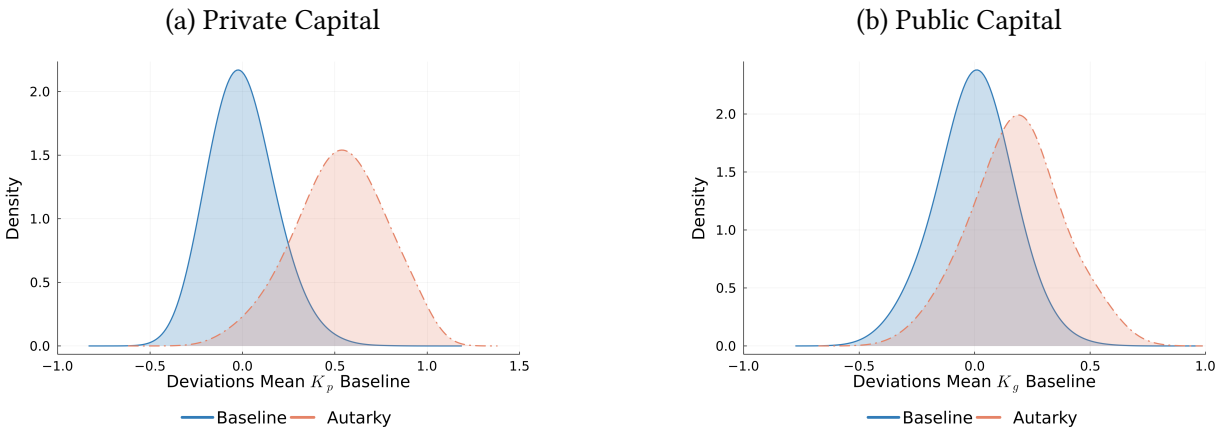
Note: This figure shows the welfare gains when the government cannot issue debt for all levels of public and private capital and for the mean productivity z.

omy benefits from access to financial markets. This suggests that countries with low capital stocks benefit from the additional resources that external borrowing provides, even when those resources carry default risk and the government is more impatient than the household. In this region, the returns to public investment outweigh the costs of sovereign debt. Countries use part of those resources not only to smooth consumption but also to increase public capital, which yields additional benefits. As public and private capital stocks rise, there are welfare losses associated with credit access. At higher levels of public and private capital, the marginal return to public capital declines, and because the government discounts the future more heavily ($\beta_H > \beta_G$), it continues to borrow even when the benefits of additional investment no longer offset the costs of default risk. The government's impatience therefore increases the welfare losses associated with excessive borrowing. This result highlights the trade-off the government faces, depending on the development level of the economy it might be beneficial to households for the government to have access to international debt markets even when the resources carry default risk.

For the sample of middle-income countries used in the calibration, the model shows that moving from autarky to financial market access leads to average welfare losses of 0.2 percent in the ergodic distribution. That is, in the ergodic distribution default costs outweigh the gains from additional public investment. Access to international debt markets yields a lower private

capital stock, so in the long run the economy is better off in autarky. Autarky delivers persistently higher capital stocks, private capital is on average 33 percent higher and public capital 12 percent higher compared to the economy with financial market access. Figure 9 shows the distribution of public and private capital in both the baseline and autarky economies relative to the mean in the baseline economy.

Figure 9: Private and Public Capital Distribution Baseline Economy and Autarky



Note: This figure shows the private and public capital distribution in the baseline economy and autarky relative to the mean in the baseline economy.

The intuition is that default costs in the economy with market access are large relative to the benefits of the extra resources that lending delivers. Private investment does not recover quickly enough to converge to the autarky path, and repeated defaults further slow down convergence. As a result, even though governments can use borrowing to raise public investment, the long-run cost of default dominates. [10]

These results are also consistent with Prasad et al. (2007), who show that developing countries with lower reliance on foreign capital have grown faster. Similarly, Gourinchas and Jeanne (2006) find that while the welfare gains from financial integration are positive, they are small and negligible relative to the gains from higher domestic productivity. Unlike their analyses, however, my framework incorporates both income fluctuations and default costs, which makes the welfare losses from financial market access even more apparent. Taken together, the results reinforce

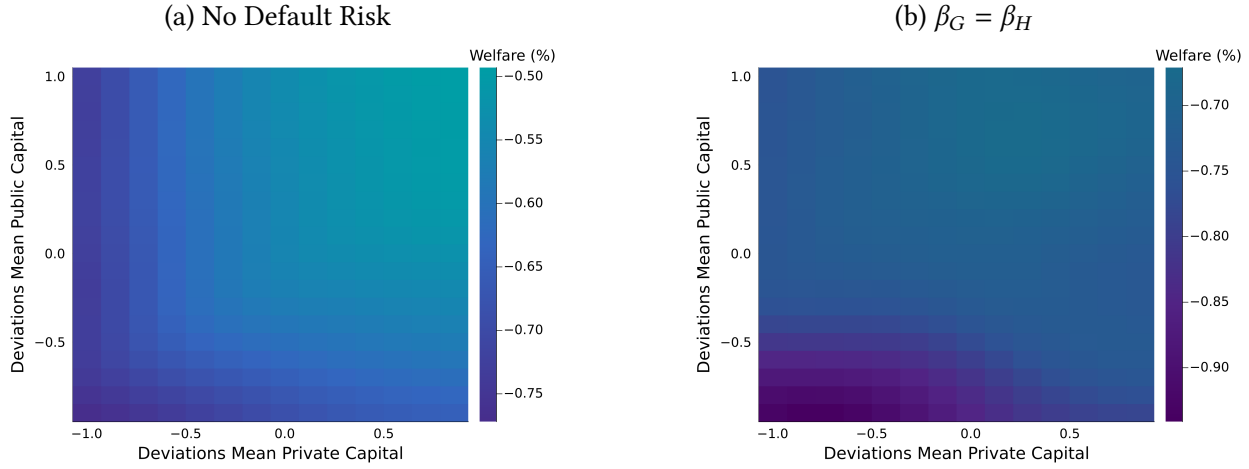
[10] Figure A.8 in the Appendix shows the policy function for public capital when the economy has no debt ($B = 0$), has debt ($B > 0$), and is in autarky, for different levels of private capital K_p. For low levels of private capital, having debt allows the government to increase public capital. However, as private capital rises, the government increases public capital more rapidly when it faces no debt repayment obligations. The autarky economy starts with low levels of public capital when private capital is low, but for high levels of private capital it expands public investment more than the economy with debt.

the conclusion that financial market access offers limited benefits and may reduce welfare once default risks are taken into account.

To understand the mechanisms underlying this result, I examine two variants of the model that isolate different sources of inefficiency in the baseline economy. Figure 10 plots the welfare gain or losses from transitioning from having access to international debt markets to autarky for each of these variants. In both counterfactuals, as public and private capital stocks rise, the relative welfare advantage of autarky increases, since lower marginal returns to investment reduce the benefits of borrowing and make financial autarky less costly or even desirable, consistent with the results from the baseline economy.

The first counterfactual economy removes default risk, allowing the government to borrow (up to an exogenous limit $\bar{B}$) at the risk-free rate and eliminates any productivity losses from default. This setup allows the government to smooth income fluctuations and finance investment without the possibility of default. However, because the government remains more impatient than households, it continues to overborrow and reallocates part of these funds toward current transfers and consumption. Panel 10a shows the welfare losses from restricting this economy to autarky. When borrowing does not carry default risk, the economy always benefits from access to international debt markets. This suggests that default costs are central to evaluating the welfare effects of external borrowing. Productivity losses from default are large enough to offset the potential gains from public investment.

Figure 10: Heatmap Welfare Gains or Losses of Autarky of Alternative Economies



Note: This figure shows the welfare gains or losses from transitioning from having access to international debt markets to autarky for different counterfactual economies.

In the second counterfactual economy, the government and households share the same discount factor ($\beta_G = \beta_H$). When impatience is no longer a source of distortion, the government val-

ues future income more and therefore invests more in public capital. Given the complementarity between public and private capital, households also raise their investment. Panel 10b shows the welfare losses from moving from financial market access to autarky. Even though default remains possible, it does not occur as often, as the government no longer finds it optimal to overborrow. Given that there is no disagreement between the household and the government moving to autarky results in welfare losses. This counterfactual highlights that the welfare losses from market access in the baseline economy stem largely from government impatience rather than borrowing itself. Overall, the key driver of the welfare gap is the interaction between impatience and default risk.

Although the model finds welfare losses from credit access in the long run, financial autarky should be viewed only as a counterfactual benchmark rather than a feasible policy. In practice, countries already participate in international debt markets and have accumulated substantial external liabilities. If one considers a sudden transition in which the government can no longer issue new external debt but continues to service its existing obligations, the model implies welfare losses of about 0.7 percent in consumption equivalent terms. The next sections discuss policies that are feasible and have been implemented and discussed by several countries (Eyraud et al., 2018).

Fiscal Rules

Fiscal rules aim to reduce the time inconsistency of fiscal policy and limit debt accumulation by constraining budget deficits. The number of countries adopting such rules has grown steadily, from fewer than 20 in the 1990s to nearly 100 in recent years (Eyraud et al., 2018; Andrián et al., 2024). Several studies examine fiscal rules in the context of sovereign debt models (Acalin et al., 2021; Esquivel and Samano, 2024; Felli et al., 2021; Hatchondo et al., 2022a; Hatchondo et al., 2022b). Unlike these studies, which primarily examine fiscal rules as mechanisms to stabilize debt dynamics or mitigate default risk, my analysis focuses on how fiscal rules interact with public investment and sovereign risk to shape welfare and investment outcomes.

I consider two types of fiscal rules: a debt limit and a public investment rule. The first restricts the amount of debt the government can issue relative to output. The second is inspired by fiscal frameworks known as "golden rules," which require the government to maintain a balanced budget for current expenditures while allowing borrowing to finance capital investments (Bassetto with Sargent, 2006). Variants of this rule have been implemented in U.S. states and have also been adopted in countries such as Brazil, the United Kingdom, and Germany (Basdevant et al., 2020). In particular, Bassetto and Lepetyuk (2007) show that budget rules should favor long-term investment (by allowing borrowing for productive projects) over spending that yields only

short-term benefits. However, they emphasize that the correct rule should exclude net investment rather than gross investment from the balanced-budget requirement. Accordingly, I consider a rule based on net investment, consistent with their approach. Both rules capture institutional mechanisms aimed at controlling government overborrowing given the relative impatience of the government. I evaluate the welfare implications of each rule by varying their stringency and tracing out the resulting changes in welfare.

Debt Ceiling

The first type of fiscal rule that I study is a debt limit, where the fiscal rule is of the form:

$$B' \leq \chi_B z F(K_p, K_g, L) \tag{9}$$

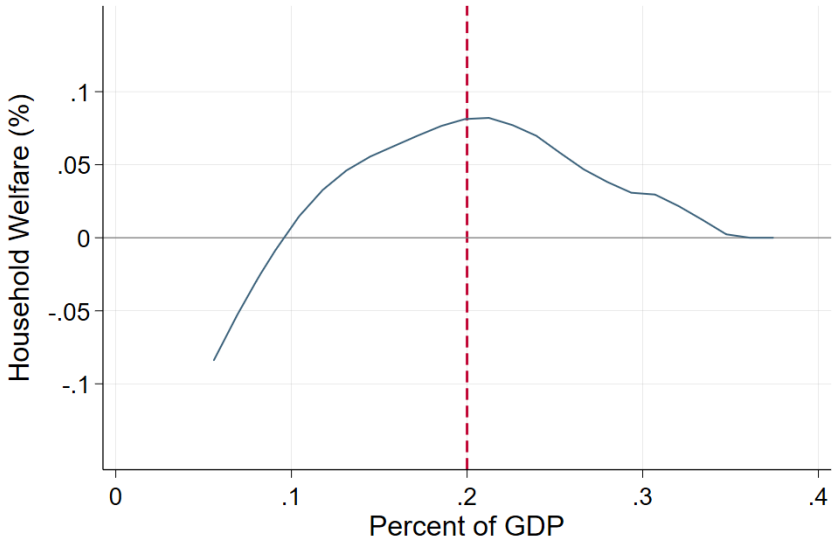
where $\chi_B \in (0, 1)$. This formulation imposes that the debt to GDP ratio cannot exceed χ_B. This type of rule has been studied in both Hatchondo et al. (2022a) and Esquivel and Samano (2024). The repayment problem for the government as before in equation (7), but with equation (9) included in the constraint set.

Figure 11 shows the welfare gains associated with different levels of fiscal rule stringency, as determined by the parameter χ_B. The welfare gains or losses are calculated as the average welfare change from implementing the rule, evaluated at the ergodic distribution of the benchmark economy. When the rule is very stringent (lower χ_B), households experience welfare losses for imposing the rule. This result is consistent with the findings from the previous discussion that going directly to autarky leads to large welfare losses as debt has to be repayed. As the rule becomes less strict, but still binding in some cases, households experience welfare gains. While households benefit from government debt, higher levels of sovereign debt increase default risk. The results suggest that, in some cases, reducing the default risk leads to welfare gains for households. For sufficiently large values of the parameter, the fiscal rule is no longer binding, and households experience no welfare gains or losses from its implementation.

These findings suggest that restricting the government's ability to borrow improves welfare, even when some of that debt would otherwise finance public investment. The costs associated with sovereign default and the negative spillovers of high public debt on private investment appear to outweigh the potential benefits of marginal increases in public capital. The fiscal rule lowers default risk and ameliorates underinvestment from households.

To assess the effects of the debt rule in the economy, Figure 12 reports the distributions of GDP and spreads under a ceiling of 20 percent of GDP. Relative to the economy without a rule, GDP

Figure 11: Debt Limit Welfare



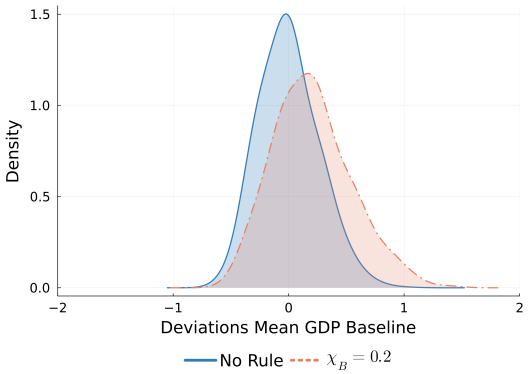
Note: This figure shows the welfare gains when the government faces a debt fiscal rule. The stringency of the rule is lower as χ_B is larger.

is higher (Panel 12a) and borrowing spreads are lower (Panel 12b). The debt ceiling encourages greater investment in both public and private capital while simultaneously reducing borrowing costs. The government invests more in public capital which incentivizes private investment due to the complementarity between the two and additionally the lower debt levels reduce default risk which additionally incentivizes private investment. The rule lowers default risk, which reduces spreads and crowds in private investment, while allowing the government to sustain productive public investment. The government is then able to increase public investment without incurring in additional default costs. Together, these effects generate an increase in overall welfare.

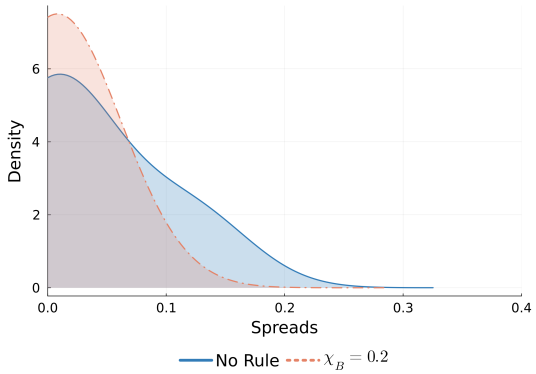
Figure 13a shows the evolution of capital taxes relative to the baseline for different levels of the debt limit. For low levels of rules stringency the counterfactual economy faces lower capital taxes relative to the baseline as the government does not have to repay as high levels of debt. As the rule is relaxes capital taxes increases until they are in line with the level of capital taxes in the baseline economy. This drop in capital taxes incentivizes private investment which ultimately leads to overall higher GDP in the economy. Figure 13b shows the default probabilities for different levels of the debt rule. For low levels of the rule the default probability in the counterfactual economy is lower than in the baseline reflecting the lower debt levels, as the rule stringency is relaxed the default probabilities increase.

Figure 12: GDP and Spreads Distribution Debt Rule Economy

(a) GDP Distribution



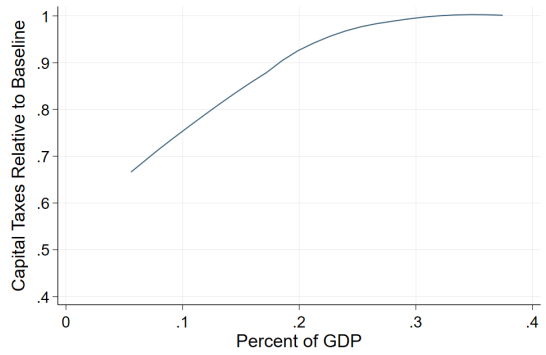
(b) Spreads Distribution



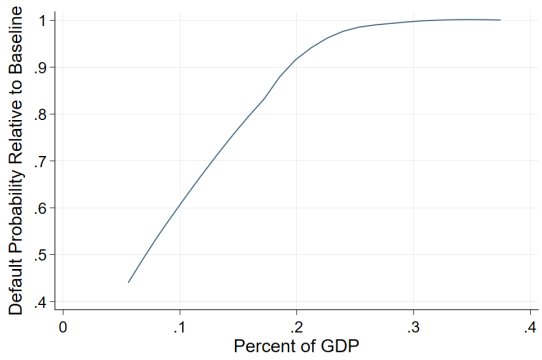
Note: This figure shows the GDP and spreads distribution of the baseline economy and an economy with a debt rule of $\chi_B = 0.2$.

Figure 13: Capital Taxes and Default Probabilities for Different Debt Limit Rule

(a) Capital Taxes



(b) Default Probabilities



Note: This figure shows the counterfactual capital taxes relative to the baseline economy when the government faces a debt fiscal rule. The stringency of the rule is lower as χ_B is larger.

Public Investment Rule

The second fiscal rule I evaluate focuses on public investment. It is motivated by "golden rule" frameworks, which allow government borrowing for capital expenditures but prohibit borrowing to cover current spending. To evaluate the welfare implications, I implement the following constraint,

$$K_g' - (1 - \delta_g)K_g \geq \xi(B' - (1 - \delta_g)B) \tag{10}$$

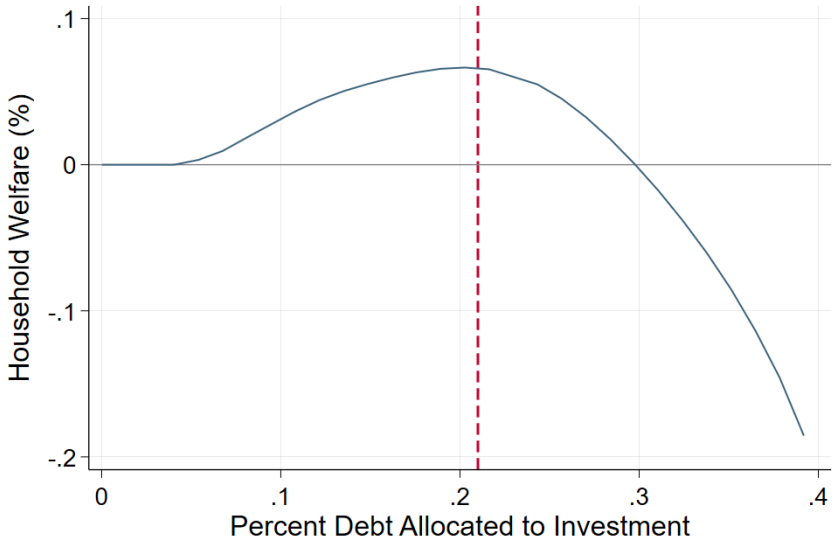
Although the model does not explicitly include government expenditure, the fiscal rule operates like a golden rule by requiring that a minimum share of debt is allocated to public capital investment. The repayment problem for the government is as before in equation (7) but with equation (10) as an additional constraint.

Figure 14 shows the welfare gains as the stringency of the investment rule (i.e., ξ) increases. The welfare gains or losses are calculated as the average welfare change from implementing the rule, evaluated at the ergodic distribution of the benchmark economy. The rule imposes a borrowing constraint tied to the productive use of debt. For low levels of stringency, imposing the investment rule generates welfare gains. When the government can allocate more resources to public capital, households benefit through higher public capital accumulation and greater overall output. However, as the rule's stringency rises above 30 percent, welfare decreases. In this case, even though most of the debt is directed toward public investment, the government loses flexibility and its ability to adjust borrowing to smooth income fluctuations. These results suggest that there is a threshold beyond which additional borrowing for investment no longer improves welfare, since the government sacrifices its ability to smooth fluctuations through debt issuances. Thus, this type of fiscal rule benefits households only when the government retains some flexibility to use debt for consumption smoothing as well as for public investment.

Table 7 reports selected moments under different levels of the investment rule. When the rule requires 21 percent of new debt issues to be allocated to public investment, the government raises public investment relative to private investment, achieving the intended outcome of the rule. Importantly, this increase occurs without higher spreads, so overall welfare improves. Households benefit from higher public capital, which raises the return to private investment through complementarity, without facing additional default risk.

By contrast, when the rule mandates a 40 percent allocation, public investment rises further but spreads also increase. The higher borrowing costs, combined with the restriction on how debt can be used, raise consumption volatility relative to GDP. In this case, the extra public investment

Figure 14: Investment Rule Welfare Gains and Losses



Note: This figure shows the household's welfare gains when the government faces an investment fiscal rule. The stringency of the rule is higher as ξ is larger.

comes at the expense of higher default risk and reduced insurance against shocks. Taken together, the economy experiences welfare losses under the more stringent rule.[11]

Table 7: Investment Rule Select Moments

	Baseline	$\xi = 0.21$	$\xi = 0.4$
Private to Public Investment	2.38	2.22	2.33
Average Spread	0.036	0.036	0.043
$\frac{\sigma_c}{\sigma_y}$	1.09	1.06	1.21

Notes: This table shows the average public to private investment, spread, and volatility of consumption relative to GDP for the baseline economy and for two investment rule stringencies.

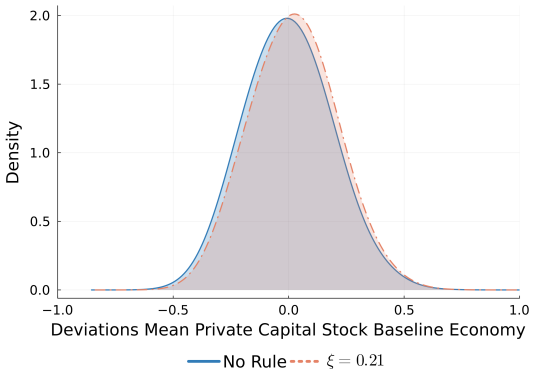
Figure 15 shows the distributions of public and private capital when the investment fiscal rule is set to 21%. Panel 15b indicates that public capital is higher in the economy with a more stringent investment rule than in the baseline, confirming that the government is investing more. Panel 15a shows that private capital also increases under the rule. Given that public and private capital are complementary, the increase in public capital incentivizes higher private investment, leading to overall higher GDP and household income. The government does not increase its debt levels,

[11] Figure A.9 in Appendix A.3 shows the welfare gains and losses from transitioning to autarky when the baseline economy is subject to an investment fiscal rule.

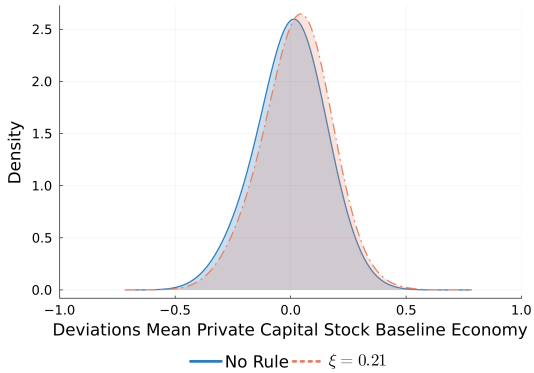
and the spreads it faces are the same as in the baseline economy, suggesting that the economy achieves higher levels of both public and private capital at no additional cost. This rule effectively constrains the government while increasing overall income in the economy.

Figure 15: Public and Private Capital Distribution Investment Rule Economy

(a) Private Capital Distribution



(b) Public Capital Distribution



Note: This figure shows the private an public capital distribution from the baseline and investment rule ($\xi = 0.21$) economies relative to the mean from the baseline economy.

From a policy perspective, fiscal rules are also easier to implement than changing the government's discount factor. In the model, this parameter captures political frictions such as short planning horizons that arise from electoral turnover. In practice, adjusting these structural features of policymaking is difficult, while fiscal rules that constrain debt accumulation or investment allocation can be legislated and monitored directly, achieving the intended goals of reducing debt accumulation and increasing public capital.

7 Conclusion

While there is a large literature on sovereign debt, it has overlooked a key issue: the trade-off governments face when allocating resources between competing priorities such as debt repayment, public investment, and consumption smoothing. This paper examines the trade-off between public investment and sovereign default and asks: what are the welfare consequences of access to sovereign debt?

Using data from a sample of developing countries I document two key relationships in the data. First, public investment crowds in private investment, that is, public investment is positively correlated with private investment. Second, I show that there is a negative correlation between

external public debt and private investment. Motivated by these facts, I develop a sovereign debt model in which the government can borrow externally, tax households, allocate resources to public investment and household transfers, and faces endogenous default risk. The private sector makes its own investment decisions while taking into account government policy. The model captures the central trade-off faced by governments, that is, the potential gains from financing public investment through borrowing versus the costs of debt accumulation and default risk.

Overall, access to international debt markets can be beneficial depending on the level of both public and private capital stock. Access to external credit is welfare improving for countries with low public and private capital, where returns to additional investment are high, but can reduce welfare when capital stocks are already large. I also show that the implementation of fiscal rules can raise welfare. A fiscal rule that limits debt to 20 percent of GDP raises output relative to the baseline without increasing sovereign spreads. In this case, the government expands public investment without incurring additional default risk, which generates welfare gains for households. Similarly, a rule that directs part of government borrowing to public investment increases welfare as long as it is not too strict. The welfare-maximizing rule allocates 21 percent of new debt issuances to public investment, allowing the government to expand public capital while maintaining spreads at baseline levels, generating welfare gains for households.

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A Appendix

A.1 Firm Level Regressions

I obtain firm-level accounting data from Compustat Global and Compustat North America and merge it with country-level variables from the International Monetary Fund's World Economic Outlook (IMF-WEO) database. Data from Compustat is available starting in the early 1990's. I follow Demirci et al. (2019) and Huang et al. (2018) on the data cleaning procedure. My sample covers the period between 1994 and 2023, and the first year of the sample is determined by the availability of the firm-level and country-level data that varies across countries. I drop observations with missing or negative assets, sales, stockholder equity, or employment. I also exclude firms in the financial and insurance sectors, utilities, public administration, and professional services, as well as firms with unusually large percentage changes in total assets. All ratio variables are winsorized at the top and bottom 1%. Table A.1 shows the list of country years included in the sample.

Table A.1: Country-Year Coverage Sample

Country	Years	Country	Years
Argentina	1998–2023	Mongolia	2008–2023
Azerbaijan	2006–2023	Morocco	1996–2023
Brazil	2002–2023	Nigeria	2011–2019
Bulgaria	2000–2023	North Macedonia	2007–2022
China	1998–2023	Pakistan	1996–2023
Colombia	1998–2023	Peru	2002–2023
Costa Rica	2020–2021	Philippines	1996–2023
Dominican Republic	1999–2023	Russia	1999–2023
Ecuador	2005–2023	Serbia	2008–2023
Egypt	2000–2023	South Africa	2002–2023
Indonesia	2002–2023	Sri Lanka	1996–2023
Jamaica	2001–2022	Sudan	2006–2022
Jordan	1997–2023	Thailand	2002–2023
Kazakhstan	2004–2023	Tunisia	2002–2022
Kyrgyz Republic	2010–2023	Turkey	2002–2023
Mauritius	2002–2023	Ukraine	2002–2023
Mexico	1998–2023	Vietnam	2005–2023

Notes: This table reports the years for which each country is included in the sample throughout the paper.

A.1.1 Public Investment and Private Investment

To examine the relationship between public and private investment in a more systematic way and to control for other factors, I next estimate the following regression at the firm level i:

$$\frac{\text{Capital Expenditure}_{i,c,t}}{\text{Assets}_{i,c,t}} = \beta_1 \frac{\text{Public Investment}_{c,t-1}}{\text{GDP}_{c,t-1}} + \beta_2 X_{c,t-1} + \beta_3 Z_{i,c,t-1} + \delta_t + \omega_i + \varepsilon_{i,c,t} \tag{11}$$

where the coefficient of interest is β_1, which captures the effect of public investment on firm-level investment. $X_{c,t-1}$ includes domestic and external public debt, log CPI, the unemployment rate, log exchange rate, and the current account to GDP ratio and $Z_{i,c,t-1}$ are firm specific controls. η_i and δ_t denote firm and year-fixed effects, respectively. Standard errors are clustered at the country and year level.[12] Table A.2 confirms the results from the scatter plot in Figure 2. This finding supports the hypothesis that public investment crowds-in private investment.

The literature identifies that there are gains from productive public investment, that is, one that has direct effects on economic growth. Unfortunately, in the data I cannot observe whether the investment is productive or not as I have aggregate public investment data rather than data on specific projects. To address this concern, the first column of Table A.3 includes the control of corruption index from the World Governance Indicators which serves as a proxy that accounts for possible mismanagement of government funds. The regressions shows that the relationship between public and private investment remains the same. The second specification controls for the level of capital stock, as the literature has identified that public investment has higher returns when the country has low levels of capital stock (Izquierdo et al., 2019). The results in this specification are consistent with the baseline. Columns (3) and (4) show the results when additional lags to the public investment ratio are considered. The results show that past public investment continues to be positively correlated with private investment. Finally, specification (5) checks that the results hold when the dependent variable is the property to assets ratio as another measure of private investment. The coefficient associated with public investment remains positive and significant.

[12] Additional firm-level variables used as control variables are total assets (firm size), operating income before depreciation to sales (operating profitability), fixed assets to total assets (investment intensity), cash to assets (financial constraints), and sales growth. The firm-level data is matched with country level data. In the regression, I control for macroeconomic variables to mitigate any country-specific variation that might affect firm investment aside from government debt or public investment.

Table A.2: Crowding In of Public Investment

	(1)
External Public Debt (% GDP)$_{t-1}$	-0.0214**
	(0.0101)
Domestic Public Debt (% GDP)$_{t-1}$	0.00889
	(0.00706)
Current Account (% GDP)$_{t-1}$	-0.00457
	(0.0237)
Log Exchange Rate$_{t-1}$	0.405
	(0.417)
Unemployment Rate$_{t-1}$	-0.0112
	(0.0292)
Log CPI$_{t-1}$	-0.237
	(0.613)
Log Assets$_{t-1}$	-0.203***
	(0.0579)
EBIT/Assets$_{t-1}$	0.0687***
	(0.00537)
Property/Assets$_{t-1}$	0.00476
	(0.00505)
Cash/Assets$_{t-1}$	0.0555***
	(0.00411)
Sales Growth$_{t-1}$	0.00284***
	(0.000275)
Public Investment (% GDP)$_{t-1}$	0.141***
	(0.0404)
Constant	3.269
	(2.505)
Observations	112,978
R^2	0.428

Notes: Robust standard errors in parentheses, clustered two-way by country and year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.3: Crowding In of Public Investment — Additional Control Variables

	(1)	(2)	(3)	(4)	(5)
External Public Debt (% GDP)$_{t-1}$	-0.0237*	-0.0293**	-0.0248**	-0.0242**	0.0425
	(0.0118)	(0.0128)	(0.0103)	(0.00952)	(0.0600)
Domestic Public Debt (% GDP)$_{t-1}$	0.0100	0.00841	0.00765	0.00867	-0.0675***
	(0.00781)	(0.00763)	(0.00839)	(0.00864)	(0.0240)
Current Account (% GDP)$_{t-1}$	-0.00265	-0.0231	-0.00889	0.00641	0.147**
	(0.0261)	(0.0253)	(0.0251)	(0.0216)	(0.0611)
Log Exchange Rate$_{t-1}$	0.270	0.249	0.473	0.471	-0.442
	(0.410)	(0.453)	(0.449)	(0.472)	(1.664)
Unemployment Rate$_{t-1}$	-0.0101	0.0149	-0.0209	-0.0221	0.207
	(0.0288)	(0.0408)	(0.0296)	(0.0294)	(0.158)
Log CPI$_{t-1}$	-0.101	-0.953	-0.336	-0.372	0.607
	(0.562)	(0.581)	(0.699)	(0.668)	(2.697)
Log Assets$_{t-1}$	-0.205***	-0.241***	-0.204***	-0.237***	0.786**
	(0.0594)	(0.0755)	(0.0579)	(0.0601)	(0.305)
EBIT/Assets$_{t-1}$	0.0665***	0.0713***	0.0683***	0.0710***	-0.126***
Property/Assets$_{t-1}$	0.00237	0.00176	0.00385	0.00486	
	(0.00490)	(0.00624)	(0.00534)	(0.00513)	
Cash/Assets$_{t-1}$	0.0534***	0.0616***	0.0569***	0.0563***	-0.168***
	(0.00360)	(0.00548)	(0.00422)	(0.00427)	(0.0104)
Sales Growth$_{t-1}$	0.00287***	0.00274***	0.00296***	0.00293***	-0.00645***
	(0.000280)	(0.000415)	(0.000399)	(0.000393)	(0.00150)
Public Investment (% GDP)$_{t-1}$	0.135***	0.151***		0.147***	0.406**
	(0.0427)	(0.0470)		(0.0414)	(0.174)
Public Investment (% GDP)$_{t-2}$			0.103**		
			(0.0486)		
Public Investment (% GDP)$_{t-3}$				-0.00967	
				(0.0415)	
Capex/Assets$_{t-1}$					0.531***
					(0.0329)
Control of Corruption$_{t-1}$	-0.257				
	(0.284)				
Capital Stock (% GDP)$_{t-1}$		-0.00269			
		(0.00249)			
Constant	2.982	8.836***	4.188	4.052	23.61*
	(2.420)	(3.133)	(2.827)	(2.744)	(11.75)
Observations	109,047	90,436	110,769	102,152	112,075
R^2	0.435	0.434	0.430	0.433	0.819

Notes: Robust standard errors in parentheses, clustered two-way by country and year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

A.1.2 Private Investment and Government Debt

Table A.4: OLS Regression: Private Investment and Government Debt

	(1)
Public Debt (% GDP)$_{t-1}$	-0.0436***
	(0.0137)
Current Account (% GDP)$_{t-1}$	-0.211***
	(0.0420)
Unemployment Rate$_{t-1}$	-0.0899
	(0.0979)
Log GDP per capita$_{t-1}$	1.505
	(2.806)
Log CPI$_{t-1}$	-5.276
	(3.620)
Log Exchange Rate$_{t-1}$	3.693
	(2.772)
Constant	28.51
	(16.85)
Observations	1,799
R^2	0.659

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard error are clustered at country and year level.

In theory, the negative relationship between government debt and private investment can arise through a crowding out effect, where increased government borrowing raises domestic interest rates and reduces returns to private capital, or through a debt overhang effect, where rising debt increases the future probability of sovereign default or of future tax action, discouraging private investment. This section examines the channels through which public debt affects private investment.

To investigate whether the composition of public debt matters for private investment, I perform the following regression at the firm level i,

$$Y_{i,c,t} = \beta_1 \frac{\text{External Public Debt}_{c,t-1}}{\text{GDP}_{c,t-1}} + \beta_2 \frac{\text{Domestic Public Debt}_{c,t-1}}{\text{GDP}_{c,t-1}} + \beta_4 X_{c,t-1} + \beta_5 Z_{i,c,t-1} + \eta_c + \delta_t + \omega_i + \varepsilon_{i,c,t} \tag{12}$$

where $Y_{i,c,t}$ is either the capital expenditure to assets ratio or the book leverage to assets ratio.

Table A.5: First and Second Stage IV Estimates

	Emerging/Low-Income Countries
Panel A: First Stage (Dep. Var: Public Debt % GDP$_{t-1}$)	
Military Spending$_{t-2}$	0.9339***
	(0.1890)
Panel B: Second Stage (Dep. Var: Private Investment % GDP)	
Public Debt$_{t-1}$ (IV)	-0.2046***
	(0.0427)
Current Account$_{t-1}$	-0.2188***
	(0.0553)
Unemployment Rate$_{t-1}$	0.2053
	(0.1967)
Log GDP per capita$_{t-1}$	2.4008
	(4.9769)
Log CPI$_{t-1}$	-7.6156
	(5.9735)
Log Exchange Rate $_{t-1}$	7.0826
	(4.9913)
Constant	53.9343**
	(21.4121)
Observations	903
R^2	0.457
Kleibergen-Paap rk F-stat	24.41

Notes: Robust standard errors in parentheses, clustered two-way by country and year. Public debt is instrumented with lagged military spending. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Column (1) of Table A.6 shows the results of the regression. A one percentage point increase in external public debt (as percent of GDP) is associated with a 0.027 percentage point decrease in the investment to asset ratio. This result is consistent with Huang et al. (2018), who also find a negative correlation between public debt and corporate investment using Orbis data, though they do not distinguish between external and domestic debt. This finding is consistent with a debt overhang mechanism, where higher external borrowing raises sovereign default risk and discourages private investment. In contrast, the coefficient on domestic debt is small and statistically insignificant, suggesting no systematic relationship between domestic borrowing and private investment.

To examine whether the negative correlation between public debt and private investment is mostly explained by credit constraints, which would be consistent with a crowding out mechanism, I use the book leverage to assets ratio as the dependent variable. Column (2) of Table A.6 presents the results. In line with the findings of Demirci et al. (2019), there is a negative correlation between domestic public debt and the leverage to assets ratio. This indicates that domestic public debt may crowd-out private credit. However, this does not appear to translate into lower investment rates from the firm. In contrast, external debt is more strongly associated with reduced firm investment, consistent with a debt overhang mechanism driven by sovereign default risk.

Additional specifications are presented in Table A.7, which shows the regression results when the credit default swap (CDS) is included as a control. The CDS spread serves a proxy for country risk or the sovereign interest rate. Although the sample size is smaller due to data limitations, the main conclusions remain unchanged.

Finally, using data from the International Financial Statistics, I estimate a cross-country regression where the dependent variable is average lending rate for country c. Based on the previous firm-level results, we would expect domestic debt to be positively correlated with lending rates. The relationship is less clear for external debt. Higher external borrowing raises default risk, which could increase country risk and eventually translate into higher domestic interest rates. Table A.8 shows that domestic debt is indeed positively correlated with lending rates. This finding reinforces the evidence from the firm-level regressions, indicating that domestic debt is more likely to crowd out private credit than external debt. The coefficient on external debt is negative and statistically significant, suggesting that higher external debt is not associated with higher lending rates in this sample of countries.

Table A.6: Debt Overhang vs. Crowding Out

	(1) Capex/Assets	(2) Book Leverage/Assets
External Public Debt (% GDP)$_{t-1}$	-0.0271**	0.0515
	(0.0111)	(0.0519)
Domestic Public Debt (% GDP)$_{t-1}$	-0.00121	-0.0777*
	(0.00565)	(0.0425)
Current Account (% GDP)$_{t-1}$	-0.00613	-0.140***
	(0.0235)	(0.0363)
Log Exchange Rate$_{t-1}$	0.612	3.294
	(0.435)	(2.140)
Unemployment Rate$_{t-1}$	-0.0363	0.203
	(0.0331)	(0.146)
Log CPI$_{t-1}$	-0.282	-2.587
	(0.749)	(3.724)
Log Assets$_{t-1}$	-0.217***	2.190*
	(0.0577)	(1.117)
EBIT/Assets$_{t-1}$	0.0683***	-0.243***
	(0.00546)	(0.0166)
Property/Assets$_{t-1}$	0.00490	0.126***
	(0.00509)	(0.0122)
Cash/Assets$_{t-1}$	0.0561***	-0.154***
	(0.00386)	(0.00762)
Sales Growth$_{t-1}$	0.00280***	0.00337***
	(0.000310)	(0.00109)
Constant	5.158	14.76
	(3.064)	(16.83)
Observations	113,529	117,405
R^2	0.427	0.684

Notes: Robust standard errors in parentheses, clustered two-way by country and year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.7: Debt Overhang vs. Crowding Out: CDS Specifications

	(1) Capex/Assets	(2) Book Leverage/Assets
External Public Debt (% GDP)$_{t-1}$	-0.0365*	0.0299
	(0.0194)	(0.0744)
Domestic Public Debt (% GDP)$_{t-1}$	0.0153	-0.111*
	(0.00956)	(0.0578)
Current Account (% GDP)$_{t-1}$	0.0339	-0.176**
	(0.0282)	(0.0781)
Log Exchange Rate$_{t-1}$	2.237***	2.625
	(0.499)	(2.225)
Unemployment Rate$_{t-1}$	-0.0760	0.339
	(0.0576)	(0.268)
Log CPI$_{t-1}$	-2.725***	-0.530
	(0.667)	(3.599)
Log Assets$_{t-1}$	-0.167**	2.084*
	(0.0588)	(1.070)
EBIT/Assets$_{t-1}$	0.0601***	-0.226***
	(0.0101)	(0.0129)
Property/Assets$_{t-1}$	0.00308	0.121***
	(0.00381)	(0.0107)
Cash/Assets$_{t-1}$	0.0515***	-0.150***
	(0.00272)	(0.00688)
Sales Growth$_{t-1}$	0.00304***	0.00275*
	(0.000340)	(0.00139)
CDS$_{t-1}$	-0.000478	-0.00392
	(0.000287)	(0.00238)
Constant	14.72***	7.636
	(3.044)	(19.82)
Observations	86,952	88,758
R^2	0.460	0.695

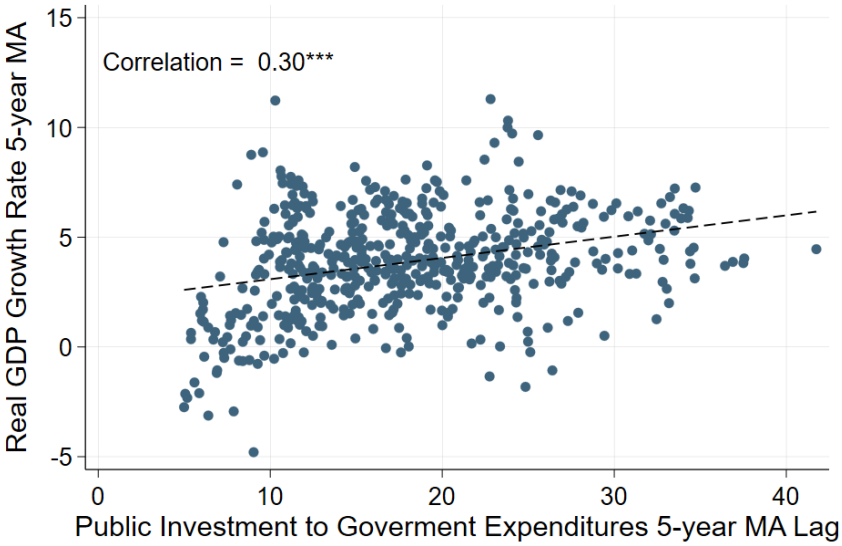
Notes: Robust standard errors in parentheses, clustered two-way by country and year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.8: OLS Regression: Lending Rate and Public Debt

	(1)
External Public Debt (% GDP)$_{t-1}$	-0.150**
	(0.0645)
Domestic Public Debt (% GDP)$_{t-1}$	0.123*
	(0.0636)
Current Account (% GDP)$_{t-1}$	0.0118
	(0.0329)
Unemployment Rate$_{t-1}$	-0.0470
	(0.134)
Log CPI$_{t-1}$	-4.240*
	(2.101)
Log Exchange Rate$_{t-1}$	10.13***
	(3.500)
Constant	3.907
	(17.34)
Observations	557
R^2	0.839

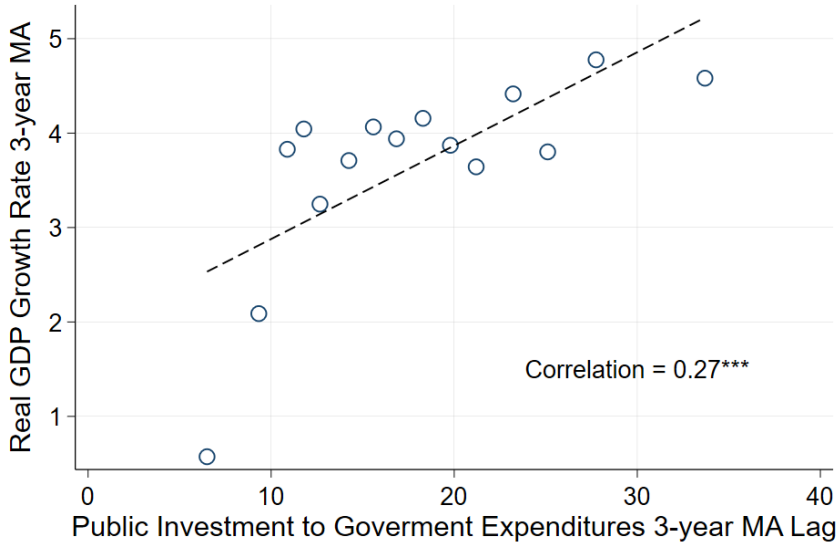
Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are clustered at country and year level.

Figure A.1: Public Investment to Government Expenditures and Real GDP Growth Rate (5 year Moving Average)



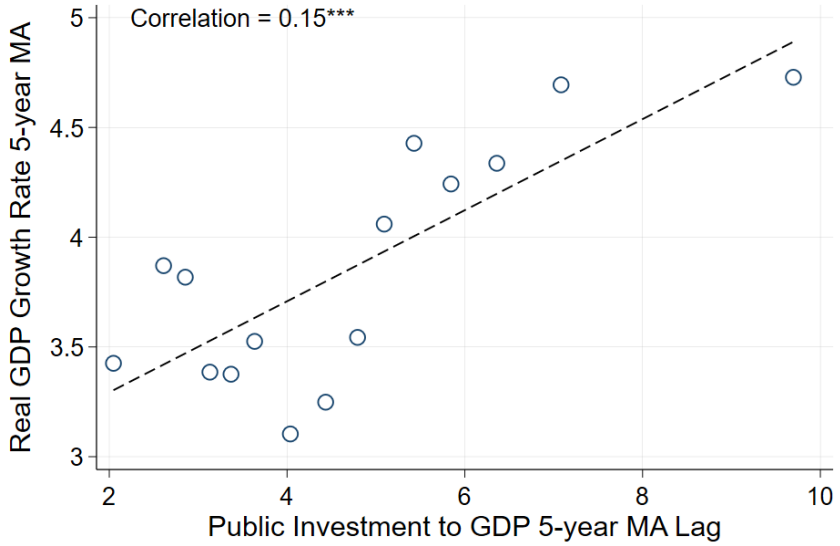
Note: This figure shows the correlation between public investment to government expenditures with real GDP growth rates.
Sources: WEO and author's calculations.

Figure A.2: Public Investment to Government Expenditures and Real GDP Growth Rate (3 year Moving Average)



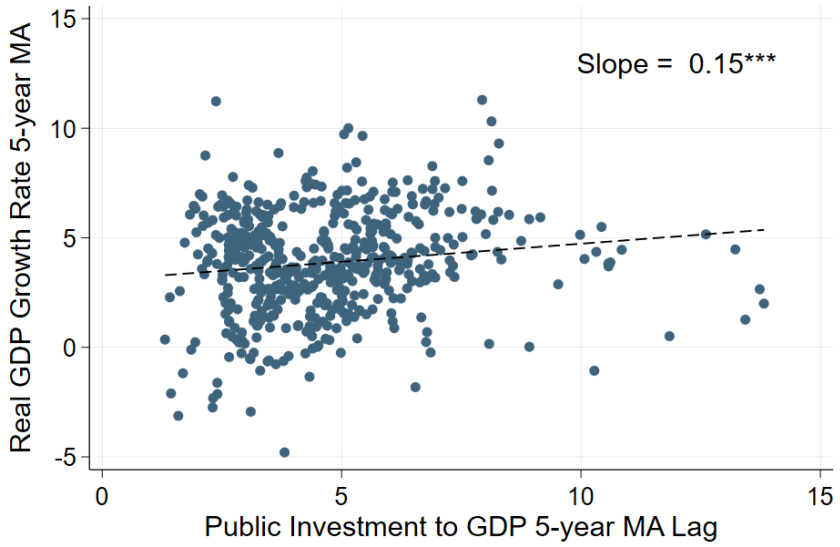
Note: This figure shows the correlation between public investment to government expenditures and real GDP growth rates. Number of bins was selected using IMSE-optimal choice.
Sources: WEO and author's calculations.

Figure A.3: Public Investment to GDP and Real GDP Growth Rate (5 year Moving Average)



Note: This figure shows the correlation between public investment to GDP and real GDP growth rates. Number of bins was selected using IMSE-optimal choice.
Sources: WEO and author's calculations.

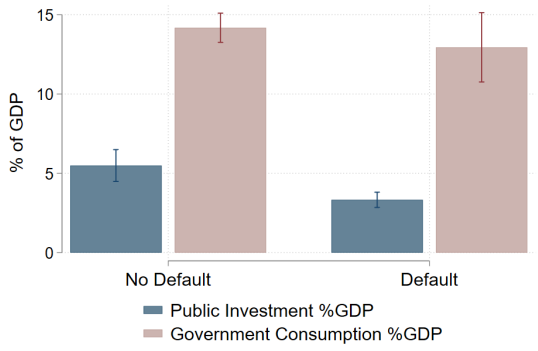
Figure A.4: Public Investment to GDP and Real GDP Growth Rate (5 year Moving Average)



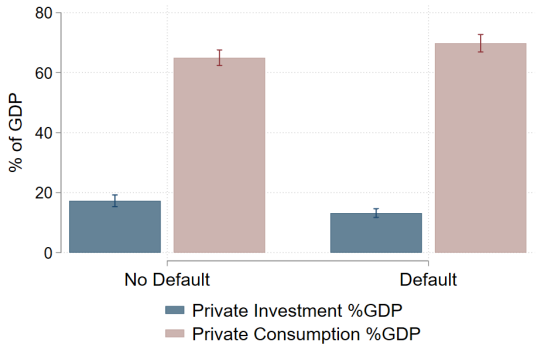
Note: This figure shows the correlation between public investment to GDP and real GDP growth rates.
Sources: WEO and author's calculations.

Figure A.5: Public and Private Investment during Default Episodes

(a) Public Investment and Consumption (% GDP)

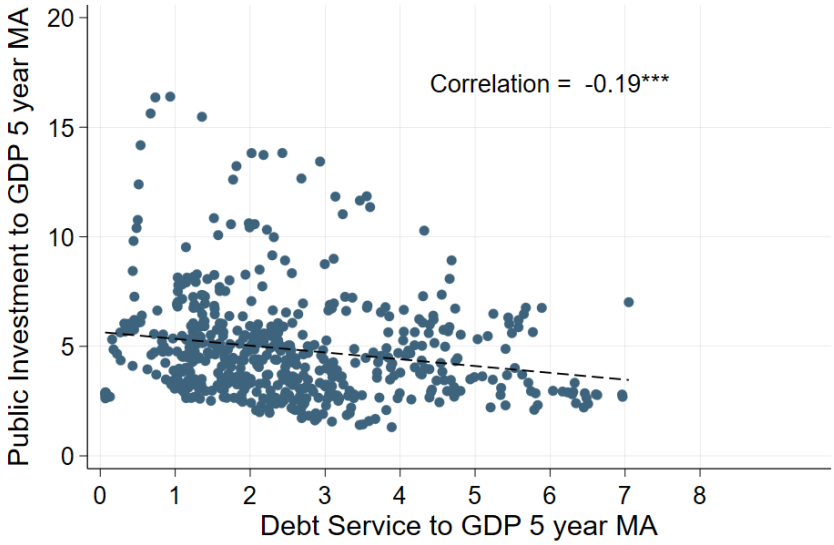


(b) Private Investment and Consumption (% GDP)



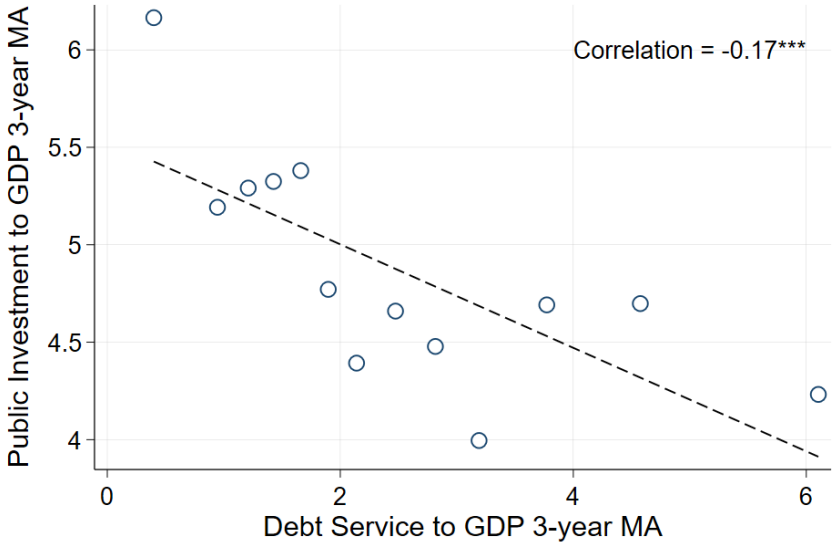
Note: This figure shows the average public and private investment and consumption as a percentage of GDP during normal times and default episodes.
Sources: IDS, WEO, and author's calculations.

Figure A.6: Public Investment (% GDP) and Debt Service (% GDP) (5-year moving average)



Note: This figure shows the correlation between public investment (% GDP) and debt service (% GDP).
Sources: WEO and author's calculations.

Figure A.7: Public Investment (% GDP) and Debt Service (% GDP) (3-year moving average)



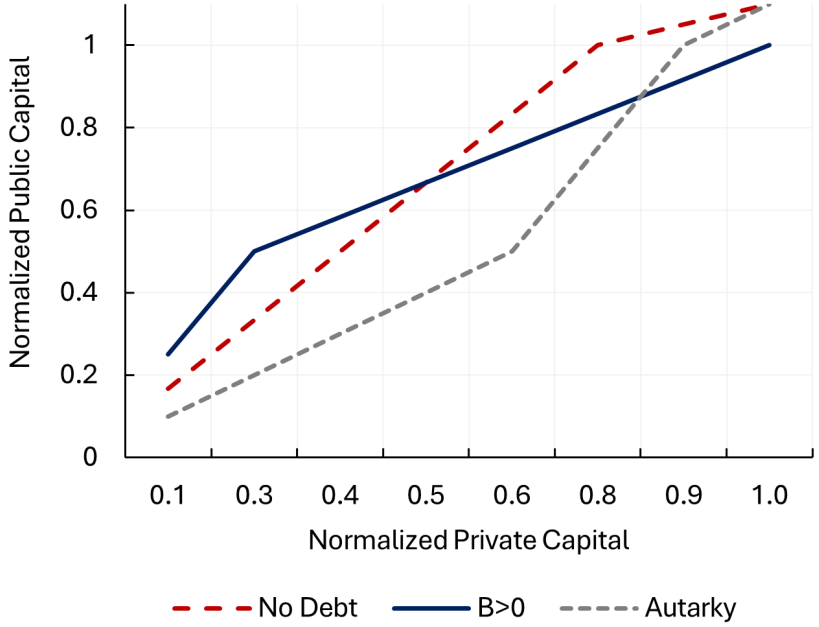
Note: This figure shows the correlation between public investment (% GDP) and debt service (% GDP). Number of bins was selected using IMSE-optimal choice.
Sources: WEO and author's calculations.

Table A.9: Calibration Regressions

	(1)	(2)
Public Debt (% GDP)$_{t-1}$	-0.0444*	-0.0362
	(0.0235)	(0.0237)
Current Account (% GDP)$_{t-1}$	-0.194***	-0.121**
	(0.0489)	(0.0514)
Unemployment Rate$_{t-1}$	-0.0289	-0.0777
	(0.108)	(0.127)
Log CPI$_{t-1}$	-1.410	-3.801
	(2.152)	(2.441)
Log Exchange Rate$_{t-1}$	0.613	1.516
	(1.693)	(1.885)
Public Investment (% GDP)$_{t-1}$		0.120
		(0.208)
Primary Balance (% GDP)$_{t-1}$		0.0618
		(0.0571)
GDP Growth$_{t-1}$		0.0735*
		(0.0408)
Constant	26.23***	37.36***
	(8.521)	(10.65)
Observations	979	602
R^2	0.640	0.757

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Year and country fixed effects included.

Figure A.8: Public Capital Policy Function for Different Levels of Private Capital



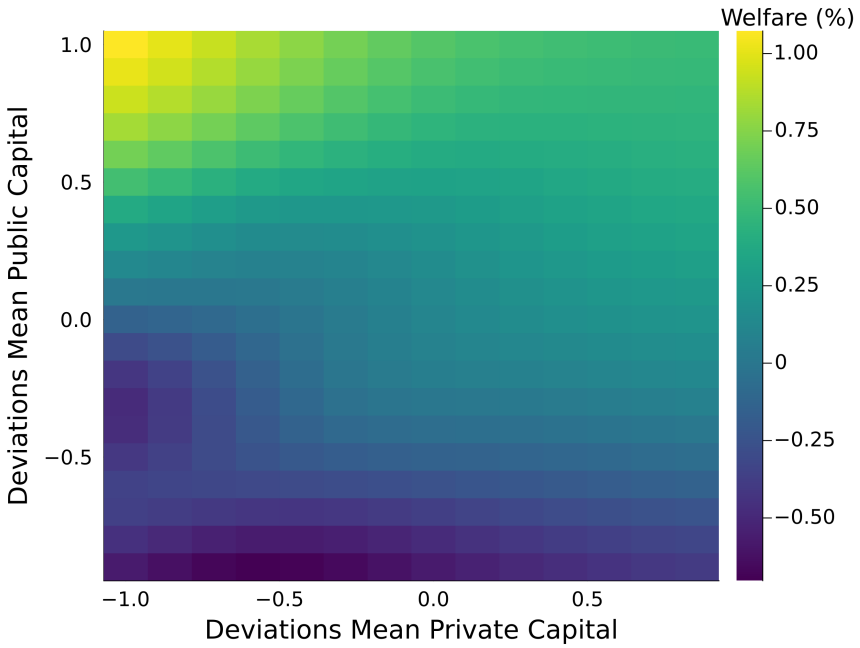
Note: This figure shows the policy function of public capital for a given z and K_g and for different levels of K_p.

A.2 Additional Figures and Tables

A.3 Investment Fiscal Rule

Figure A.9 shows the welfare gains from transitioning to autarky when the baseline economy is subject to an investment fiscal rule. The results indicate that, under such a rule, the welfare effects of autarky are driven not only by the returns to public capital but also by the composition of public and private capital. When the economy has high levels of public capital relative to private capital, moving to autarky yields welfare gains. Because the government must allocate a fixed share of its borrowing to public investment, high public to private capital ratios make additional borrowing less productive. Conversely, when public capital is relatively scarce, the economy does not gain from moving to autarky, as the fiscal rule channels additional resources into public investment rather than private capital accumulation. In these cases, having access to international debt markets even under default risk is preferable.

Figure A.9: Autarky Welfare with Investment Rule



Note: This figure shows the welfare gains when the government cannot issue debt for all levels of public and private capital for the mean productivity z and where the baseline economy faces an investment rule of 21 percent.

A.4 Efficiency and Decentralization

Consider now a benevolent social planner that can choose all allocations in the economy. The value of the planner in good credit standing that makes the default decision $d = \{0, 1\}$ is given by,

$$V(B, K_p, K_g, z) = \max_{d \in \{0,1\}} \quad (1-d)V_R(B, K_p, K_g, z) + dV_D(K, K_g, z) \tag{13}$$

In the centralized problem, the planner chooses consumption c, public capital K_g', private capital K_p', and debt B'. The planner maximizes consumption subject to the budget constraint and both the public and private capital accumulation equations. The value of repayment is given by,

$$V_R(B, K_p, K_g, z) = \max_{c, B', K_g', K_p'} \quad U(c) + \beta \mathbb{E}_z[V(B', K_p', K_g', z')] \tag{14}$$

$$\begin{aligned} s.t. \qquad & c + i_g + \Phi(K_g, K_g') + i_k + \Psi(K_p, K_p') + B = \tilde{q}(B', K_p', K_g', z)B' + zF(K_P, K_g, L) \\ & K_g' = i_g + (1 - \delta_g)K_g \\ & K_p' = i_k + (1 - \delta_k)K_p \end{aligned}$$

where $\tilde{q}$ is the price schedule for bonds issued by the planner.

If the government chooses to default, then it maximizes consumption c and chooses public and private capital K_g', K_p'. The value of default is given by,

$$V_D(K_p, K_g, z) = \max_{c, K_g', K_p'} \quad U(c) + \beta \mathbb{E}_z\left[(1 - \theta)V_D(K_p', K_g', z') + \theta V(0, K_p', K_g', z')\right] \tag{15}$$

$$\begin{aligned} s.t. \qquad & c + i_g + \Phi(K_g, K_g') + i_k + \Psi(K_p, K_p') = zF(K_p, K_g, L) \\ & K_g' = i_g + (1 - \delta_g)K_g \\ & K_p' = i_k + (1 - \delta_k)K_p \end{aligned}$$

A constrained efficient equilibrium is value and policy functions $\tilde{B}, \tilde{K_p}, \tilde{K_g}, \tilde{d}$ for the planner and a price schedule $\tilde{q}$, such that:

1. Given $\tilde{q}$, the value and policy functions solve the planner's problem, that is, equations (13), (14), and (15).
2. The price schedule $\tilde{q}$ satisfies equation (8) with $d' = \tilde{d}(B', K_p', K_g', z')$

The capital allocations in the competitive equilibrium are inefficient because the household fails to internalize how private investment affects future default incentives, which in turn affect borrowing costs.[13] To show this inefficiency, the Euler equation from the household in the competitive equilibrium is given by,

[13]For ease of exposition, "tilde" variables denote the constrained efficient equilibrium and "hat" variables denote the competitive equilibrium.

$$u'(\hat{c})\left[1+\frac{\partial\Psi(\hat{K_p}',K_p)}{\partial\hat{K_p}'}\right]=\beta_H\mathbb{E}_z\left[\hat{d}u'(\hat{c}')\left(\hat{r}_k+(1-\delta_k)+\frac{\partial\Psi(\hat{K_p}'',\hat{K_p}')}{\partial K_p'}\right)\right] \tag{16}$$
$$+\beta_H\mathbb{E}_z\left[(1-\hat{d})u'(\hat{c}')\left(\hat{r}_k+(1-\delta_k)+\frac{\partial\Psi(\hat{K_p}'',\hat{K_p}')}{\partial K_p'}\right)\right]$$

where price $\hat{r}_k$ represent the price given the policy functions in the competitive equilibrium. Note that in equilibrium, $\hat{r}_k = z\gamma\alpha K_p^{\omega-1}(\gamma K_p^{\omega}+(1-\gamma)K_g^{\omega})^{\frac{\alpha}{\omega}-1}L^{(1-\alpha)}$

Similarly, the Euler equation for private capital from the planner's problem is given by,

$$u'(\tilde{c})\left[1+\frac{\partial\Psi(\tilde{K_p}',K_p)}{\partial\tilde{K_p}'}-\frac{\partial\tilde{q}}{\partial\tilde{K_p}'}\tilde{B}'\right]=\beta\mathbb{E}_z\left[\tilde{d}u'(\tilde{c}')\left(z\gamma\alpha K_p^{\omega-1}(\gamma K_p^{\omega}+(1-\gamma)K_g^{\omega})^{\frac{\alpha}{\omega}-1}L^{(1-\alpha)}+(1-\delta_k)\right.\right. \tag{17}$$
$$\left.+\frac{\partial\Psi(\tilde{K_p}'',\tilde{K_p}')}{\partial K_p'}\right)\Big]$$
$$+\beta\mathbb{E}_z\left[(1-\tilde{d})u'(\tilde{c}')\left(z\gamma\alpha K_p^{\omega-1}(\gamma K_p^{\omega}+(1-\gamma)K_g^{\omega})^{\frac{\alpha}{\omega}-1}L^{(1-\alpha)}\right.\right.$$
$$\left.\left.+(1-\delta_k)+\frac{\partial\Psi(\tilde{K_p}'',\tilde{K_p}')}{\partial K_p'}\right)\right]$$

Comparing both Euler equations, as long as $\beta_H = \beta$ the only difference between the planners problem and the competitive equilibrium is the effect of private capital on the price of debt that the household fails to internalize in the competitive equilibrium. The term $-\frac{\partial\tilde{q}}{\partial\tilde{K_p}'}\tilde{B}'$ on the left side of equation (17) shows how resources borrowed by the planner change with private investment. This margin is ignored by the households because they take the evolution of aggregate capital as given. If there was no default risk, the price $\tilde{q}$ would be constant and so the disagreement between the competitive equilibrium and the planners problem would disappear.

The constrained efficient equilibrium allocation can be implemented as a competitive equilibrium with state contingent subsidies to private capital, where $\tau_k(B,K_p,K_g,z)=\frac{\partial\tilde{q}(B',K_p',K_g',z)}{\partial\tilde{K_p}'}\tilde{B}'$ in repayment and $\tau_k(K_p,K_g,z)=0$ in default. The budget constraint for the household with the appropriate private capital subsidies in the competitive equilibrium becomes,

$$c+i+\Psi(k_p,k_p')-\tau_k k_p' = wL+r_k k_p+\pi \tag{18}$$

which would then entail an Euler equation equal to,

$$u'(\hat{c})\left[1+\frac{\partial\Psi(\hat{K_p}',K_p)}{\partial\hat{K_p}'}-\tilde{\tau}_k\right]=\beta_H\mathbb{E}_z\left[\hat{d}u'(\hat{c}')\left(\hat{r}_k+(1-\delta_k)+\frac{\partial\Psi(\hat{K_p}'',\hat{K}')}{\partial K'}\right)\right] \tag{19}$$
$$+\beta_H\mathbb{E}_z\left[(1-\hat{d})u'(\hat{c}')\left(\hat{r}_k+(1-\delta_k)+\frac{\partial\Psi(\hat{K_p}'',\hat{K_p}')}{\partial K_p'}\right)\right]$$

where $\tilde{\tau}_k(B,K_p,K_g,z)=\frac{\partial\tilde{q}(B',K_p',K_g',z)}{\partial\tilde{K_p}'}\tilde{B}'$ which is the same Euler equation from the planners problem.

The results from the planners problem are similar to the results from the competitive equilibrium.[14] However, the comparison is not entirely symmetric, as the planner's problem assumes the government's discount factor rather than the household's. There is no disagreement between the household and the government. A lower discount factor increases the planner's incentive to front load consumption, which, in turn, reduces the incentives to invest in public and private capital relative to the competitive equilibrium. As shown by Song and Mihalache (2025), when the government is more impatient than the household, allowing the government to choose private capital can result in welfare losses for the household. This arises because the government places greater value on current consumption, which leads to reduced private investment.

Overall, the planner sustains higher levels of debt as well as higher spreads compared to the competitive equilibrium. Table A.10 presents a comparison of selected moments between the two models. The planner incurs in higher debt, but it does not translate into higher public investment levels. The ratio of public investment to debt is 40 percent lower in the planners solution compared to the competitive equilibrium. Although the negative correlation between debt and private investment is still present, the coefficient is smaller in the planner's problem, indicating that the debt overhang effect is somewhat mitigated. Finally, the regression coefficient from the crowding in is larger in the planners problem, suggesting that the planner is more effective at exploiting the complementarity between public and private investment.

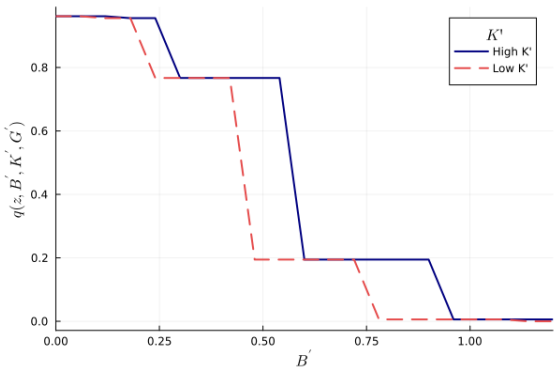
A.5 Sensitivity Analysis

This Appendix presents a sensitivity analysis showing how the results change when two key parameters of the model, β_G and ω, differ from the baseline. Table A.11 reports selected

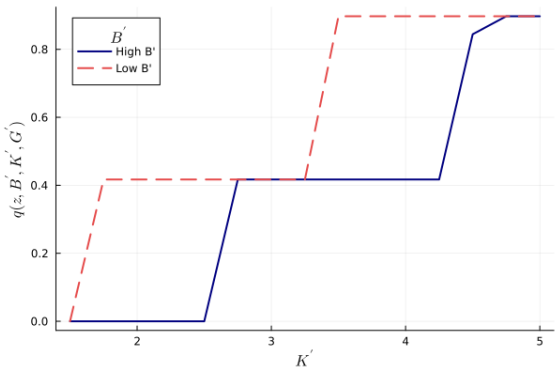
[14] Figure A.10 in the Appendix shows the price schedule as a function of B', K_p', and K_g' for the planner's problem. The same relationships from the competitive equilibrium hold for the planner.

Figure A.10: Debt Price Schedule

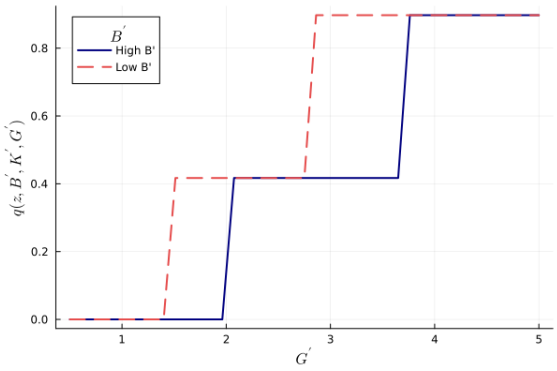
(a) Price Schedule for different levels of B'



(b) Price Schedule for different levels of K'_p



(c) Price Schedule for different levels of K'_g



Note: This figure shows the price schedule for different variables for the planner's problem.

Table A.10: Competitive Equilibrium vs. Planning Problem

Moment	Planner
Debt to GDP (%)	1.51
Spread	1.43
Public Investment to Debt (%)	0.61
Correlation Debt and Private Investment	0.19
Correlation Public and Private Investment	2.62

Note: This table presents the moments from the planning problem relative to the competitive equilibrium moments. The column provides a comparison for selected targeted moments.

moments for each alternative calibration relative to the baseline economy. When the production function features $\omega = 0.65$, indicating that public and private capital are gross substitutes, the government borrows roughly the same amount of debt as in the baseline since it remains more impatient than households. As expected, public capital is lower in this case, while overall GDP is higher because private capital increases relative to public capital. Private capital is more productive than public capital and so the private sector invests a larger share. Given that borrowing remains unchanged, the government allocates a larger share of resources to transfers rather than to public investment, leading to significantly higher household transfers.

The second column of the table shows the results when the government discounts the future at the same rate as households. In this case, the government cuts borrowing sharply and raises public investment. This behavior reflects the higher discount factor, as a more patient government values future outcomes more and prioritizes investment over consumption. As a result, GDP rises while transfers fall substantially, consistent with lower debt accumulation and greater public capital formation.

Table A.11: Sensitivity Analysis

	$\omega = 0.65$	$\beta_G = 0.96$
Debt to GDP	1.02	0.28
Average Spread	0.99	0.01
Public Capital	0.80	1.65
GDP	1.23	1.14
Transfers	1.74	0.02

Notes: This table shows how the parameters ω and β_G affect selected moments compared to the baseline economy.

A.6 Computational Algorithm

1. Set parameters and tolerance convergence for V and q.
2. Initialize the following equilibrium objects with sensible initial conditions:
   (a) Value function for the government $V_0(z, B, K_p, K)g)$ from equation (5).
   (b) Expected value for the household $W_0(z, B, K_p, K_g)$ from equation (3) and (4).
   (c) Price schedule $q_0(z, B, K_p, K_g)$ from equation (8).
3. Taking the current guess for the equilibrium objects begin the value function iteration.
   - Compute the conditional value $V_0(z, B, K_p, K_g)$ associated with each action (d, B', K_g').
   - Compute the households capital k' that satisfies the household's Euler equation consistent with government actions (d, B', K_g').
   - Compute the price function $q_1(z, B', K_p', K_g')$ according to equation (8).
   - Assess equilibrium function convergence in terms of the sup-norm.

$$\max \{\sup \|q_1 - q_0\|,\ \sup \|V_1 - V_0\|\}$$

   If less than tolerance, exit the algorithm, otherwise set the updated functions as the "initial" guess and go back to the beginning of step 3.