The Dynamics of Informality and Fiscal Policy under Sovereign Risk *

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Abstract

This paper examines how the dynamics of informality affects optimal fiscal policy and default risk. We build a model of sovereign debt with limited commitment and informality to assess the consequences of dynamic distortions induced by fiscal policy. In the model, fiscal policy has a persistent impact on taxable activity, which affects future fiscal revenues and thus default risk. The interaction of tax distortions and limited commitment strongly constrains the dynamics of optimal fiscal policy and leads to (i) more frequent default episodes and (ii) costly fluctuations in consumption.

JEL: E26, E62, F34, F41, H20.

Keywords: fiscal policy, informal economy, sovereign default.

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1 Introduction

With limited commitment, sovereign default risk depends on future incentives for the government to raise fiscal revenues. At heart, a benevolent planner will face a trade-off between imposing the cost of a default to domestic agents or imposing the cost of repayment; the planner will choose to default on its obligations if the latter is high enough. This limited commitment to repay constrains consumption transfers across periods and affects the dynamics of fiscal policy, as shown in Eaton and Gersovitz (1981) or Arellano (2008). In these earlier contributions, however, transfers from and to households are not distortionary and do not affect domestic income. In practice, transfers involve taxation, taxation comes with well-known behavioral responses (e.g., labor supply, tax avoidance, or tax evasion; see Slemrod, 2001; Slemrod and Yitzhaki, 2002), and the cost of repayment comprises the static and dynamic distortionary costs of fiscal policy. How do such distortions affect the previous trade-off and the dynamics of optimal fiscal policy?

This paper fills a gap in the existing literature of sovereign default by studying the role of informality and its interplay with taxes and sovereign risk in environments where transfers from and to households are distortionary. Our contribution is to explicitly consider economic contexts with a non-negligible informal sector. In these contexts, higher taxes lead to an expansion of the informal sector, and the reallocation of the economy away from taxable activity affects fiscal revenues in the short run (a static distortion, as in Aruoba, 2021). These adjustments might outlive the initial contractionary fiscal policy and persistently lower returns to taxation (a dynamic distortion).[1]

We build a model of sovereign debt with limited commitment where local producers may operate in the formal or informal economy. We introduce the possibility for this choice to be sticky in order to understand how the *dynamics* of informality affects optimal fiscal policy and default risk. We then proceed in two steps. In a first step, we study the qualitative properties of a stylized, 2-period version of the model to highlight the respective role of static and dynamic distortions induced by fiscal policy. The latter are shown to further restrict the government in its ability to transfer consumption across periods. Intuitively, the prospect of a future default limits the set of feasible fiscal policies to contractionary policies; these policies however push producers towards the informal sector and persistently so, making it more costly for the government to repay and raising the prospect of a future default even further. In a second step, we quantify

[1]Tax evasion has been shown to be persistent due to the nature of filing costs (Erard and Ho, 2001), to the interaction of tax declarations with other frictional processes for businesses (e.g., consumer search or search for intermediaries, see Pomeranz, 2015), to dynamic incentives built within the tax monitoring system (Engel and Hines, 1999), or to the adjustment of the private sector to a culture of informality (e.g., through bank loans, see Artavanis et al., 2016).

the ignored, yet non-negligible, welfare cost associated with the distortionary dynamics of informality. We exploit data on tax compliance across a sample of selected economies subject to some default risk in order to discipline the dynamics of informality in our stochastic model of sovereign default. We find that both the responsiveness and persistence of informality significantly constrain optimal fiscal policies which, ultimately, has an impact on welfare through more frequent default episodes, costly fluctuations in taxation, and the resulting volatility of household consumption.

Our main contribution is to uncover (i) the dynamics of fiscal policy and default risk and (ii) their welfare consequences, in environments where a non-negligible informal economy makes taxation distortionary in the short and medium run.[2] In particular, it is a well known empirical regularity that consumption is more volatile in emerging economies (Loayza et al., 2007). It is also known that informality constrains the set of feasible fiscal policies (see Elgin and Uras, 2013, for an empirical association between informality, financial instability, and default). Our theory connects these two empirical observations: informality limits the ability of the government to smooth consumption on behalf of households. In economies with higher incidence of informality, we should thus expect the volatility of consumption ("in excess of" the volatility of output) to be larger, in part because governments are expected to default more often and sustain higher debt-servicing costs—a theoretical insight that we bring to the data in Figure 1.

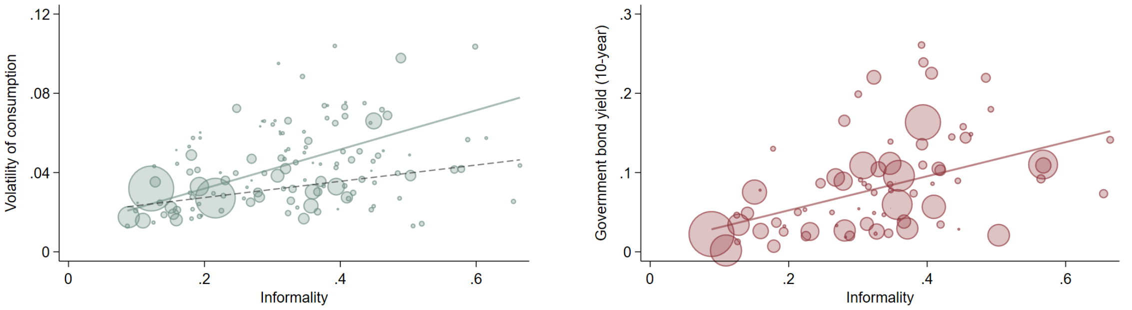
The key ingredients of our model are (i) limited commitment to repay sovereign debt and (ii) production distortions induced by fiscal policy. We build on Eaton and Gersovitz (1981) and consider the benevolent government of a small economy who stabilizes consumption on behalf of a representative household. The government has access to international markets but has limited commitment such that the debt price reflects future incentives to default.[3] The novelty of the model is to introduce dynamic distortions in production—as induced by fiscal policy—which interact with limited commitment. There is a mass of entrepreneurs, and they can adopt two technologies in order to produce the final good: an unobserved technology—which constitutes the informal sector of the economy—and a verifiable technology—the formal sector—in which there are production complementarities.[4] We assume that this choice is staggered, in a similar manner

[2]There is a literature studying the role of taxation and informality in transition economies (see, e.g., Ihrig and Moe, 2004; Saracoğlu, 2008). Our contribution differs from theirs in that we do not model growth or transitions towards a different steady state and rather focus on short to medium-run fluctuations in fiscal policy and their implications on the dynamics of consumption.

[3]Our modeling of sovereign debt follows the standards of the literature. First, there are two punishments following a default which give (limited) commitment to the government: market exclusion and a direct output cost possibly reflecting a failure of the domestic banking sector (Mendoza and Yue, 2012; Arellano et al., 2017). Second, we consider the long-term debt structure introduced in Chatterjee and Eyigungor (2012) to support higher debt levels while disciplining the fluctuations in debt prices.

[4]Our modeling of informality borrows from the literature on shadow economies with dual technology

Figure 1. Informality, the (excess) volatility of consumption, and long-term interest rates across countries.



(a) Volatility of consumption

(b) Long-term interest rate

Notes: Panel (a) displays the volatility of household consumption, calculated as the standard deviation of annual consumption growth per capita, against a measure of average informality between 1995–2018—using data from Elgin et al. (2021), who replicate the approach developed in Schneider et al. (2010). Dots are weighted by the country's population. The plain line shows the relationship between the standard deviation of annual *consumption* growth per capita, against a measure of average informality; and the dashed line shows the relationship between the standard deviation of annual *output* growth per capita, against the measure of average informality. Panel (b) displays the 10-year government bond yield over 1995–2018 (Source: OECD) against the same measure of average informality. The plain line shows the relationship between this average long-term interest rate and informality.

as Calvo (1983), and each entrepreneur may be able to reset technology with a certain probability in each period. These two technologies can be interpreted as two different production lines, where one involves intermediaries and thus needs to be transparent and the other one cannot be monitored. We assume that fiscal policy is the combination of exogenous, stochastic government expenditures and an endogenous, linear tax on production in the formal sector.

A stylized, deterministic, 2-period version of the model is sufficient to show how the (rigid) dynamics of informality qualitatively impacts optimal fiscal policy and the ability of the government to smooth consumption on behalf of households. We however quantify the possible importance of this novel interaction in an infinite-horizon model featuring exogenous public expenditure shocks. The model is crucially disciplined by the volatility and persistence of informality, whose estimation requires rich variation in fiscal policy and tax compliance.[5] We calibrate our model using empirical, key mo-

(Rauch, 1991; Enste and Schneider, 2000; Straub, 2005). We assume that tax monitoring is perfect for the formal technology and absent for the informal technology. This assumption can be relaxed, as long as the effort by the government in uncovering undeclared activity is exogenous. Another important feature of the model is that there exist strategic complementarities across producers of the formal sector (a feature also present in Dessy and Pallage, 2003). This could be generated by spillovers across production units through innovation, but also be related to increasing returns to tax compliance and built-in incentives to report Value-Added-Taxes. A recent contribution, Pomeranz (2015), presents evidence in favor of enforcement spillovers along the production chain.

[5]We use a measure of VAT (Value-Added-Taxes) compliance built in Pappadà and Zylberberg (2017) and consolidated in Pappadà and Rogoff (2025) as a proxy for general tax compliance. The rationale for analyzing VAT is manyfold: it constitutes a large share of tax revenues; it is an important adjustment tool at business cycle frequency; reconstructing counterfactual tax revenues under perfect tax compliance

ments from a selected sample of countries with non-negligible levels of informality and default risk. More specifically, our simulated model targets and matches three empirical moments characterizing tax compliance (in addition to an externally-derived fiscal multiplier)—an average tax compliance of about 72%, an elasticity with respect to tax rates of about -0.39 (an exercise in which we exploit tax reforms affecting the effective tax rate), and a persistence of about 0.85—to pin down four parameters characterizing domestic production: the location and shape of the distribution of private returns across entrepreneurs in the informal sector; the probability to reset technology; and the level of complementarities in the formal sector.[6] We calibrate the remaining parameters of our economy—pertaining to preferences, shocks, default punishments, and debt maturity—on a benchmark economy (Aguiar and Gopinath, 2006; Arellano, 2008; Chatterjee and Eyigungor, 2012).[7]

We study the interplay between informality, fiscal policy, and sovereign default in the quantitative model. Our analysis proceeds in two steps. First, we examine the dynamic response of fiscal variables and domestic production to an exogenous government spending shock. We simulate many economies subject to the same initial expenditure shock (but allowed to differ in the path followed by subsequent shocks), and we consider the distributional response of of key endogenous variables—debt, tax rates, informality, consumption, and default risk—over a long horizon. Following the shock, the government accumulates more debt *and* raise taxes. While it takes on average about 2 years for debt to come back to pre-shock levels, the hike in informality (and the subsequent drop in consumption) is more sluggish due to the technological frictions, and the government remains susceptible to default in the medium run. These model-based moments are supported by empirical evidence: using a panel of countries and following Born et al. (2020), we identify impulse responses to exogenous expenditure shocks and find an "informality overhang" associated with high tax rates and sovereign spreads. Second, we evaluate how the dynamic properties of informality affect fiscal policy and welfare.

requires very few assumptions. The measure mostly contrasts two different data sources, i.e., taxes as received by the government and the reported consumption of goods at a highly disaggregated level (thus measuring frequent, minor changes in VAT), and captures any discrepancies between these two sources.

[6]The average incidence of the informal technology in the model is jointly characterized by the distribution of returns in the informal sector and the level of complementarities in the formal sector. While we do not explicitly model punishments for operating in the informal sector (monetary punishments from the government or the moral costs of tax evasion), one can interpret returns in the informal sector as being net of such expected punishments. In this interpretation, the idiosyncratic distribution of returns to the informal sector could partly reflect differences in such punishments across entrepreneurs.

[7]We also investigate how our calibrated model matches a few untargeted moments, most notably: the *overall* fluctuations in informality; the volatility of fiscal policy; debt levels; and the volatility of household consumption. The model slightly overshoots for the untargeted volatility of tax rates; one explanation could be that we consider exogenous government expenditures and ignore monetary policy, thus limiting the set of stabilizers which could smooth fluctuations in production and in consumption.

We compare our baseline economy to counterfactual scenarios that vary along three dimensions: the rigidity of technological adjustment in the informal sector; the presence of strategic complementarities in technology choice; and the sensitivity of informality to fiscal policy. Our findings suggest that both the sensitivity and the sluggishness of informality are critical. Economies where technological choices are less persistent, less complementary or less sensitive to taxation better absorb shocks and exhibit smaller welfare losses. We use the model to quantify the welfare costs of these dynamic distortions: Reducing these dynamic distortions yields significant welfare gains—ranging from 1.4% to 3.5% increases in certainty-equivalent consumption. In theory, lower fiscal distortions should allow the government to better insulate households from possible fluctuations in taxation and informality, with a stabilizing effect on consumption. We isolate and quantify the component of welfare gains that is mechanically explained by better consumption smoothing, and find small, yet non-negligible, effects for economies with lower dynamic distortions.[8]

Finally, while our primary research question is "What does (the dynamics of) informality bring to the understanding of fiscal policy and default risk?", and we consider counterfactual economies with different parametrization of technological choices to address it, our quantitative analysis also aims to shed light on how imperfect commitment shapes fiscal policy and the dynamics of informality. To do so, we give perfect repayment commitment (up to a borrowing constraint) to the government in our baseline economy and find that the certainty equivalent consumption would be about 1.8% higher, a large fraction of it being explained by a *much* lower consumption volatility.

Related literature The theoretical environment builds on the literature on sovereign default. In models of sovereign debt with limited commitment (e.g., Eaton and Gersovitz, 1981; Arellano, 2008), default risk typically depends on an endogenous state variable, the debt level, and exogenous state variables, e.g., income shocks. In such a benchmark, a contractionary fiscal policy reduces debt levels and unambiguously lowers default risk. In contrast with these contributions, we explicitly model fiscal policy as a distortionary instrument that affects the future cost of raising tax revenues. A consequence is that another endogenous state variable—informality—affects default risk through the future

[8] Our estimates for the cost of consumption volatility follow Lucas (1987), quantifying the welfare cost of business cycles, and suffer from the same issue: while there is significant consumption volatility in the baseline economy, the welfare gains of stabilizing consumption at a constant level are limited. In our baseline economy, this welfare cost of consumption fluctuations is equivalent to about 0.743% of consumption. This number decreases to 0.523-0.674% in economies where we lower rigidities in technological choice, neutralize strategic complementarities in technology, or reduce the sensitivity of formality to taxation.

cost of raising tax revenues.[9] In our setting, a contractionary fiscal policy diverts entrepreneurs away from the formal sector. This response decreases the contemporary and future cost of raising tax revenues, because of staggered adjustments in technological choice. This indirect effect tilts the future trade-off between repayment and default, and mitigates the gains in debt service through the standard "fiscal surplus" effect.

One novelty of our approach, compared to numerous contributions (see for instance Aguiar et al., 2005; Cuadra et al., 2010; Bi, 2012; D'Erasmo and Mendoza, 2013; Arellano and Bai, 2016; Pouzo and Presno, 2022), is that distortions induced by fiscal policy do not only affect the contemporaneous choice of fiscal policies, but also future repayments. Through this inter-temporal distortion, the economy is at risk of falling into a tax evasion overhang and periods of contractionary fiscal policy *and* high default risk.[10]

Our parametrization builds upon a measure of tax compliance constructed in Pappadà and Zylberberg (2017) (and extended in Pappadà and Rogoff, 2025), which highlights that tax compliance is responsive to tax rates and sluggish.[11] Our research thus relates to the literature discussing tax evasion and its dynamics during recent debt crises (see Pappa et al., 2015; Dellas et al., 2024). In Pappa et al. (2015), taxes increase incentives to produce in the (unproductive) informal sector. This mechanism explains the failure of the recent consolidation plans in Greece, Italy, Portugal and Spain. The contribution of the present analysis is to study the interaction of such distortions with sovereign default.

The paper relates to a wider literature on sovereign default and fiscal policy. A recent literature investigates the impact of sovereign default or fiscal policy on the private sector through the movement of factors: capital and the collapse of the banking sector (as in Mendoza and Yue, 2012; Bocola, 2016; Arellano et al., 2017), or workers (as in Bandeira et al., 2019; Alessandria et al., 2019). In our stylized model, we nest these default costs in an exogenous output cost that provides commitment for the government to repay. A large literature documents the use of pro-cyclical fiscal policies in developing economies (Kaminsky et al., 2004; Ilzetski and Vegh, 2008; Frankel et al., 2013; Vegh and Vuletin, 2015; Bianchi et al., 2023); and many theoretical mechanisms have been discussed to ex-

[9]Reciprocally, default risk distorts the decision of entrepreneurs: (i) a future default would induce low taxes in the future; (ii) persistent default risk without default would induce high taxes in the future.

[10]Dovis et al. (2015) develops a model in which a similar dynamic component affects the future cost of fiscal policies. Their framework relies on inequality across domestic citizens as the endogenous state variable affecting default risk, thereby describing an *inequality overhang*.

[11]These observations, also exploited in Pappadà and Zylberberg (2017) and Dellas et al. (2024), may help rationalize differences in estimates of fiscal multipliers across environments and fiscal policy tools (Alesina and Ardagna, 2009; Romer and Romer, 2010; Favero et al., 2011; Auerbach and Gorodnichenko, 2012; Ilzetzki et al., 2013; Alesina et al., 2015). In the same vein, two recent papers discuss the impact of consumption taxes in the presence of informality (see Bachas et al., 2020; Morrow et al., 2022, respectively constructing cross-country measures of tax compliance and informal consumption).

plain this observation.[12] In our model, limited commitment and the proximity to a "debt ceiling" induce the government to implement pro-cyclical fiscal policies (as in Aguiar et al., 2005; Doda, 2007; Cuadra et al., 2010; Bianchi et al., 2023).

The remainder of the paper is organized as follows. In Section 2, we introduce a model of sovereign debt where the government has limited commitment and fiscal policy induces dynamic distortions. Section 3 derives qualitative predictions in a stylized version of the model. Section 4 discusses the dynamics of informality and its welfare cost in a quantitative version of the dynamic, stochastic model. Section 5 concludes.

2 Environment

This section describes a model of a small open economy with a representative household and a government. The model embeds production with different technologies associated with different tax enforcement in an otherwise standard framework à la Eaton and Gersovitz (1981) where a benevolent government with limited commitment issues debt on behalf of the household.

2.1 Preferences and technology

The economy is populated by a continuum of infinitely-lived households of measure one. Letting c_t denote consumption at time t, households in this economy maximize expected utility as given by:

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} u(c_s),$$

where $\beta < 1$ denotes the discount factor and $u(\cdot)$ represents the period utility function, which satisfies $u'(\cdot) > 0$ and $u''(\cdot) < 0$. Since all households are identical, we refer to them throughout as the representative household.

There are two types of agents who populate households. Each household is composed of a unit mass of entrepreneurs who hold one unit of an intermediary good in each period, and a unit mass of producers. There is perfect redistribution within each household such that all agents consume the same in each period.

The consumption good, which is the numeraire, can be produced with two technologies. First, it can be assembled by producers using intermediary goods. We assume that there are many varieties of such intermediary goods, indexed by i, and there are comple-

[12] See Kaminsky et al. (2004) for instance on international capital flows, or von Hagen and Harden (1995); Aaron Tornell (1999); Alesina et al. (2008) for explanations based on the redistribution effect of increasing taxes; the competition among taxpayers to receive the proceeds from the positive shock; or the desire to limit rents that politicians could capture.

mentarities between the intermediary goods when they are used as factors of production for the consumption good.[13] Producers assemble intermediary goods using the following CES technology,

$$y_t = \left(\int_0^1 y_{it}^{\phi} di \right)^{\frac{1}{\phi}},$$

where $\phi < 1$ captures production complementarities. We assume that this technology is transparent and represents the formal sector of our economy.

Second, the consumption good can be directly produced by entrepreneurs. These entrepreneurs can transform their unit of the intermediary good into the consumption good using a private technology with period-specific net return R_{it}. We assume that R_{it} is known to the entrepreneur only and is independently drawn from a continuous probability distribution $H(.)$ in each period. This technology is not observable to the government; it represents the informal sector of our economy.[14] The heterogeneity in net return to the informal technology captures that entrepreneurs may differ in their current reliance on financial intermediation or in any other cost associated with running an informal business, including, for instance, punishments if detected. We assume that markets for intermediary goods and the final good are perfectly competitive.

Moreover, there are rigidities, and technological choice is staggered over time, in the manner of Calvo (1983). In each period, there is an idiosyncratic draw determining whether an entrepreneur is allowed to change her technology.[15] With probability $1 - \theta$, the entrepreneur can choose and either (i) adopt the formal technology and sell her intermediary good to producers or (ii) adopt the private technology. With $\theta = 0$, this choice would be completely flexible across periods and the contemporary choice does not commit the entrepreneur in the future.

There is a benevolent government whose objective is twofold. First, in each period, the government needs to finance a public good whose cost g_t is exogenous and subject

[13] The return to the formal technology increases with the mass of producers adopting this technology, possibly reflecting spillovers across transparent firms through innovation, complementarities along the production chain or (tax) enforcement spillovers along the production chain.

[14] We could allow for a less binary tax monitoring, i.e., there would be imperfect tax monitoring associated with both technologies and entrepreneurs would then pay a fine conditional on being detected. We could also allow for some degree of production complementarities in both technologies. The important feature is that the least monitored technology is the one with relatively low production complementarities such as to generate a gap between the social returns to the two technologies, a quantity directly related to the fiscal multiplier.

[15] The tractability of our framework partly relies on the assumptions that technology draws (both the productivity associated with the private technology and the possibility to reset technology) are independent across periods. This Calvo assumption might not be innocuous, e.g., compared to a Rotemberg framework, as illustrated in Lombardo and Vestin (2008). In particular, technology adoption could be motivated by changes in market conditions, technological improvements, or policy, and entrepreneurs might be more willing to incur the cost of considering such adoption in certain circumstances than others.

to shocks, following a Markov process. Second, the government maximizes the welfare of the representative household by issuing debt and purchasing assets on its behalf: the household's borrowing and saving are done exclusively through the government. In order to finance the public investment and transfer from and to the household, we assume that the benevolent government can only levy indirect, linear taxes τ_t on the consumption good produced through the formal technology.

2.2 Financial markets

We assume that the economy is small relative to the international financial market, and that the government can issue and trade long-term bonds on these markets. In any period t, the international financial market is willing and able to purchase any asset that yields an expected return at least as high as ρ.

The government stabilizes the consumption of the representative household by issuing debt and purchasing assets on its behalf. The government has imperfect commitment and may default on its obligations. As in Chatterjee and Eyigungor (2012), debt is issued as a long-term debt contract with a probabilistic maturity: in each period, a fraction λ of outstanding debt matures, independently of its issuance date (any contract has the same forward-looking payoff structure); and we assume that there is a coupon rate, z, in each period. Let b_{t+1} and q_{t+1} respectively denote the amount and price of debt issued by the government at time t, and let $D_t \in \{0, 1\}$ denote the decision to default on previous obligations. If t_t denotes total indirect taxation levied by the government at time t, the resource constraint for the government is:

$$(1 - D_t)\left[(\lambda + (1 - \lambda)z)\, b_t - q_{t+1}\,(b_{t+1} - \lambda b_t)\right] = t_t - g_t \qquad (1)$$

We suppose that there are two sources of punishment which give some (limited) commitment to the government. As in Arellano (2008), there is an exclusion from the international market following a default and reintegration is stochastic and occurs with probability ν in each period. We further assume that, during market exclusion, there is an exogenous default cost that is directly incurred by the household and is captured by a share of consumption, Δ. Since transfers from the government are made through a distortionary instrument, it is not innocuous to assume that the default cost is paid by the household: the punishment does not distort the choice of entrepreneurs through a direct effect. A government with distortionary tax instruments has incentives to default because a default is then a relatively efficient way to redistribute to the representative household.[16]

[16]This stylized modeling of default costs has another implication: the exogenous default cost equally

In order to solve for the equilibrium of the economy, we need to understand how the government makes borrowing decisions. We turn to these next.

2.3 Timing of actions and equilibrium

We now specify the timing of actions within each period. At the beginning of each period, the aggregate shock g_t is revealed and perfectly observed by all agents. If the government is excluded from international financial markets, a reintegration draw takes place. The government then decides to repay the debt arriving to maturity or default on all its past obligations, b_t, and commits to an indirect taxation rate τ_t. Entrepreneurs choose their technology, if this choice is available to them, with perfect knowledge of the aggregate shock, their own idiosyncratic shock, and government policy. Production takes place and taxes are paid by agents. International financial markets open, and sovereign bonds are traded. Finally, households consume.

2.4 The programs

In a preliminary step, we derive the optimization problem of producers, entrepreneurs, the government and investors in order to characterize the equilibrium of this economy. We turn to the different programs in order.

Producers We first describe the (static) program of producers. In each period, producers take prices p_{it} of each intermediate good variety and taxes τ_t as given and maximize:

$$\max_{\{y_{it}\}} \left\{ (1-\tau_t) \left(\int_0^1 y_{it}^{\phi} di \right)^{\frac{1}{\phi}} - \int_0^1 p_{it} y_{it} di \right\}.$$

The resulting demand for variety i is characterized by the following equation:

$$(1-\tau_t) y_{it}^{\phi-1} \left(\int_0^1 y_{it}^{\phi} di \right)^{\frac{1}{\phi}-1} = p_{it}.$$

In equilibrium, all varieties will be produced at the same price, which will be denoted thereafter by r_t—the return to the formal sector. Entrepreneurs will decide whether to

affects consumption proceeds from the informal sector and from the formal sector. If these costs are thought to capture a shock to domestic intermediation through a capital flight (Mendoza and Yue, 2012; Bocola, 2016; Arellano et al., 2017), we might expect those to affect differentially entrepreneurs across different technologies: the formal sector should be more reliant on credit access. Embedding a proper credit channel in our quantitative model would be very challenging. In the online Appendix A.3, we do however explore how imposing a default cost on the production side, and differentially so across the two technologies, affects our theoretical insight within the lens of a stylized two-period model.

supply one unit of the variety or not, $y_{it} \in \{0, 1\}$, depending on this price. Letting γ_t denote the mass of entrepreneurs producing and selling their variety to producers, the price for each such unit is,

$$r_t = (1 - \tau_t)\gamma_t^{1/\phi - 1}.$$

Entrepreneurs We now focus on the program of entrepreneurs. In each period, there is a draw determining the return to the private technology, a random variable R, and an idiosyncratic draw determining whether an entrepreneur can set her technology. With probability $1-\theta$, the entrepreneur can choose to adopt any of the two technologies. With probability θ, the entrepreneur keeps the same technology as in the previous period.

The reader interested in the exact derivation of technological choices can refer to Appendix A.1; the description below simplifies the argument. An entrepreneur with the opportunity to re-optimize in period t and with unobserved individual net return in the informal sector, R, considers the path of future (and possibly stochastic) returns to the different technologies and chooses the technology with the highest expected revenues, which is equivalent to maximizing revenues in future states of nature where re-optimization is not possible. The discounted expected revenues in the formal sector *in those states of nature*, V^r, follow a recursive equation:

$$V_t^r = r_t + E_t\left[\theta\delta_{t,t+1}V_{t+1}^r\right],$$

where r_t is the price for one unit of the differentiated good in the formal sector in period t, θ is the probability of not having re-optimized after one period and $\delta_{t,t+1} = \beta\frac{u'(c_{t+1})}{u'(c_t)}$ is the discount factor between period t and period $t + 1$. The equivalent discounted expected revenues in the informal sector are,

$$V_t^R = R + E_t\left[\theta\delta_{t,t+1}V_{t+1}^R\right].$$

Let $\tilde{R}_t$ denote the level of unobserved net return in the informal sector for which an individual is indifferent between the two technologies. The indifference threshold, $\tilde{R}_t$, verifies the following recursive equation,

$$\tilde{R}_t = r_t + E_t\left[\theta\delta_{t,t+1}(V_{t+1}^r - V_{t+1}^R)\right]. \tag{2}$$

Among entrepreneurs with the opportunity to modify their technology, the mass of them adopting the formal technology, γ_t^*, should be equal to the ones with sufficiently low net returns to the informal sector (those facing the highest cost of running an informal business), i.e.,

$$\gamma_t^* = H\left[\tilde{R}_t\right] \tag{3}$$

Finally, the aggregate share of entrepreneurs operating in the formal sector, γ_t, verifies the following dynamics:

$$\gamma_t = (1-\theta)\gamma_t^* + \theta\gamma_{t-1}. \tag{4}$$

We combine the previous equations to derive the (sluggish) dynamics of production across technologies (see Appendix A.1, which govern distortions on the production side of the economy, as a function of returns to the formal sector:

$$H^{-1}\left(\frac{\gamma_t - \theta\gamma_{t-1}}{1-\theta}\right) = r_t + \theta\beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}\left(H^{-1}\left(\frac{\gamma_{t+1} - \theta\gamma_t}{1-\theta}\right) - \bar{R}\right)\right], \tag{5}$$

where the return to the formal sector, r_t, is equal to $(1-\tau_t)\gamma_t^{1/\phi-1}$ and $\bar{R} = \int R dH(R)$ is the expected return to the private technology in future periods, which is the same across entrepreneurs because these returns are drawn independently across periods.

Equation (5) describes the sluggish dynamics of technological choices: (i) some entrepreneurs have not been given the opportunity to respond to economic conditions (see Equation 4); and (ii) entrepreneurs with the opportunity to re-optimize internalize that they may not be able to do so in subsequent periods. The latter effect is best understood in Equation (2): the contemporary indifference threshold depends on the returns to the formal sector but requires a premium to compensate for future losses induced by not adjusting technology and the gap between the future indifference threshold and the expected returns to the informal technology. Two assumptions guarantee that the past allocation of entrepreneurs across technologies, γ_{t-1}, is sufficient to keep track of past choices of entrepreneurs: (i) the independence of draws determining whether an entrepreneur can re-optimize; and (ii) the independence of returns to the private technology across periods.

Equation (5) also shows how expectations about future technological choices influence their current choice. A large formal sector in future periods increase expected returns to the formal sector and induce more re-optimizing entrepreneurs to opt for the formal sector today. Through this channel, default risk directly affects the current choices of entrepreneurs, independently from the current level of taxes.

Households Households make no saving or borrowing decisions in our economy. Once they receive the output net of taxes, w_t, their consumption is given by,

$$c_t = w_t,$$

in each period t. In order to smooth consumption, the government needs to smooth output net of taxes through the level of these indirect taxes.

Bond prices Investors are ready to buy any bonds in period t as long as these bonds guarantee at least ρ in expectation. The bond price verifies,

$$q_{t+1} = E_t \left[\frac{1 - D_{t+1}}{\rho} \left(\lambda + (1 - \lambda) (z + q_{t+2}) \right) \right]. \tag{6}$$

Bond prices range between 0, when default is expected with certainty next period, and close to $\lambda / (\rho - (1 - \lambda))$, when repayment is certain.

Government The government is assumed to be benevolent and to maximize the welfare of households in each period t by choosing the levels of taxes τ_t, public savings b_{t+1} and default decisions D_t, subject to the budget constraint (1), the endogenous response of entrepreneurs, as characterized by Equation (5), and the bond price equation (6).

We are now ready to define a recursive equilibrium of our economy and shed light on the main trade-off underlying government decisions.

Recursive equilibrium Our environment is one in which entrepreneurs and the government do not interact cooperatively over time: entrepreneurs form beliefs about future government decisions in order to set their current technology. Since we suppose limited commitment towards foreign investors, we also assume that the government does not have any commitment device towards domestic entrepreneurs about its future choices. The set of equilibria that will be considered are thus Markov perfect equilibria in which agents perfectly observe a common state vector.

Let us define the state of the economy. Given the assumptions that (i) expenditure shocks follow a Markov process, (ii) technological choices are staggered in the manner of Calvo (1983), (iii) returns to the private sector are independently drawn across periods, (iv) market reintegration is idiosyncratic, the following quantities fully characterize the economy at the beginning of period t: the state of the economy with respect to international markets, $h_t \in \{A, X\}$, where A is access and X is exclusion; the inherited asset position b_t; the inherited state of technological choices γ_{t-1}; and current public expenditures g_t. For convenience, let $\mathbf{s_t} = (b_t, \gamma_{t-1}, g_t)$ denote the state of the economy, notwithstanding access to international bond markets.

A recursive Markov perfect equilibrium is given by a sequence of debt $\{b_{t+1}\}$, aggregate technological choices $\{\gamma_t\}$, default decisions $\{D_t\}$ and bond prices $\{q_{t+1}\}$ satisfying the following conditions in all periods and histories:

Definition 1. *In each period t, the government debt and default decisions maximize the representative household's welfare, given the state $(h_t, \mathbf{s_t})$ of the economy, and subject to the period budget constraint (1) and the bond price equation (6). The entrepreneurs maximize their profits, and Equation (5) defines the resulting dynamics of production choices.*

3 A stylized two-period model

This section describes how limited commitment and technological choices shape optimal fiscal policy in a stylized two-period version of the previous model where the government aims to insulate households from variation in public expenditures across periods.

We consider a stylized, deterministic economy with the following features: all entrepreneurs can freely set their technology in the first period and the return to the private technology is drawn in the first period and constant from then on; initial debt is 0, the debt contract is a one-period contract (thus without coupon obligations), and $\rho_1^{-1} = \beta$; the proportional default cost, Δ, is incurred by the household directly and within the period of default; and the state of nature (g_1, g_2) is deterministic.

We further consider two polar cases: (i) technological choices are unconstrained and fiscal policy does not have distortionary effects beyond the contemporaneous period; and (ii) technological choices are rigid and fiscal policy distorts present and future technological choices.

Flexible technological choice The following proposition characterizes optimal fiscal policy when the technological choice is fully flexible (a polar case with $\theta = 0$).

Proposition 1 (Flexible technology)**.** *With perfect commitment to repay, the optimal fiscal policy would ensure that there is perfect consumption-smoothing, i.e., $c_1 = c_2$:*

$$b_2 = b_2^* = \frac{g_1 - g_2}{1 + \beta}, \tag{7}$$

and production is the same across periods, i.e., $\tau_1 = \tau_2$ and $\gamma_1 = \gamma_2$.

With limited commitment, perfect consumption smoothing is not always feasible,

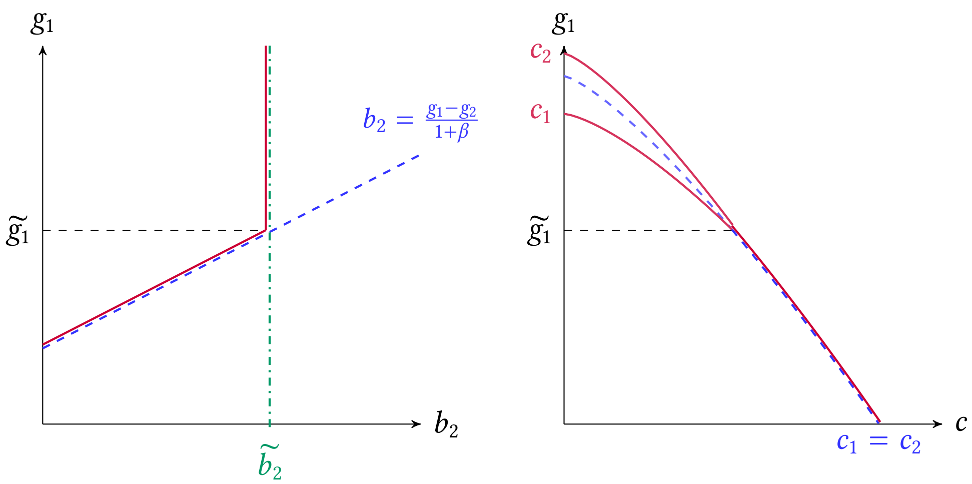
$$b_2 = \begin{cases} b_2^* & \text{if} \quad b_2^* \leq \widetilde{b}_2 \\ \widetilde{b}_2 & \text{otherwise} \end{cases}, \tag{8}$$

where $\widetilde{b}_2$ is a debt ceiling, which only depends on the state of nature in the last period (g_2) and the underlying parameters of the model (i.e., the production parameters, H and ϕ, and the default cost, Δ).

Proof. See Appendix A.2. □

To best understand how limited commitment and imperfect tax enforcement discipline fiscal policy, we display in Figure 2 how the state in the economy in the first period (g_1) affects debt (b_2, in panel a) and consumption (c_1 and c_2, in panel b).

Figure 2. Optimal fiscal policy and consumption in the flexible economy.



(a) Debt (b) Consumption

Notes: This figure represents debt (b_2, in panel a) and consumption (c_1 and c_2, in panel b) in the flexible economy ($\theta = 0$). In panel (a), the dashed line represents the relationship between debt and the state of nature when the government has perfect commitment to repay its obligations; the vertical line represents the debt ceiling; and the plain line represents the relationship between debt and the state of the economy under limited commitment. In panel (b), the dashed line represents the relationship between consumption (in both periods) and the state of nature when the government has perfect commitment to repay its obligations; and the plain lines represent the (possibly different) consumption schedules under limited commitment.

As apparent in Figure 2, the state of nature in the first period has different effects on fiscal policy, depending on the required level of debt to ensure perfect consumption smoothing. When the state of nature is not too bad, i.e., $g_1 \leq \widetilde{g}_1$, the government insures the households against higher expenditures by issuing more debt: the levels of consumption decrease, but similarly so across periods. As the state of nature deteriorates, it may reach a point where such fiscal policy is not feasible ($g_1 > \widetilde{g}_1$): the required debt level would be too high and the government would have incentives to default under limited commitment. After this point, the government incurs as much debt as it can in the first period, i.e., $b_2 = \widetilde{b}_2$, and there is a gap between the first-best debt level (dashed line) and the one chosen under limited commitment (plain line) that widens as g_1 increases. This gap affects welfare through two distinct effects. First, there is a welfare cost to imperfect consumption smoothing that would exist even with lump-sum payments (a *consumption-smoothing cost*). Second, raising revenue is distortive, and a lower consumption in period

1 comes with high taxation and a highly-distorted economy (a *distortion cost*).[17]

Persistent technological choice Consider now that technological choices from entrepreneurs in period 1 are fully persistent ($\theta = 1$) such that $\gamma_2 = \gamma_1$. The following proposition characterizes optimal fiscal policy in this other polar case.

Proposition 2 (Persistent technology). *With perfect commitment to repay, the optimal fiscal policy ensures that there is perfect consumption-smoothing, i.e., $c_1 = c_2$:*

$$b_2 = b_2^* = \frac{g_1 - g_2}{1 + \beta}, \tag{9}$$

and production is the same across periods, i.e., $\tau_1 = \tau_2$ and $\gamma_1 = \gamma_2$.

With limited commitment, perfect consumption smoothing is not always feasible,

$$b_2 = \begin{cases} b_2^* & \text{if} \quad b_2^* \leq \widehat{b}_2 \\ \widehat{b}_2 & \text{otherwise} \end{cases}, \tag{10}$$

where $\widehat{b}_2$ is a debt ceiling, which depends on the state of nature in both periods (g_1, g_2) and parameters of the model (i.e., the production parameters, H and ϕ, the default cost, Δ).

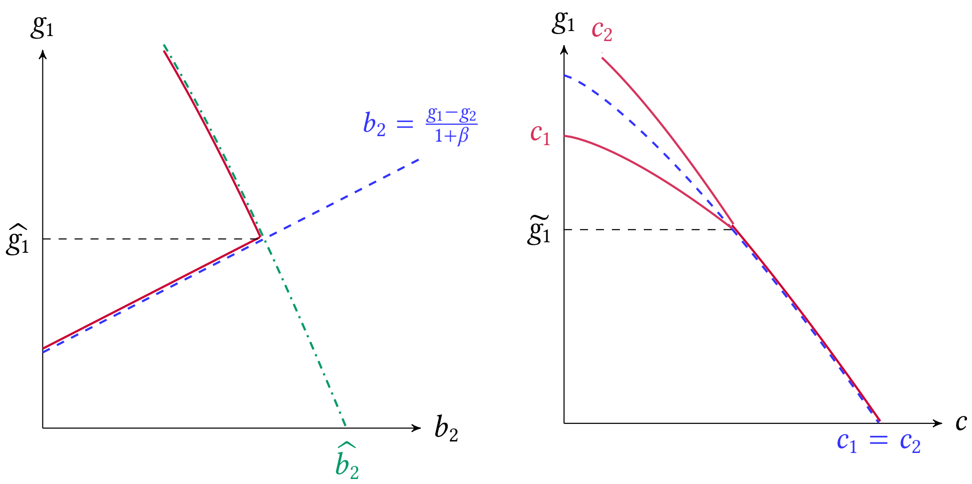
Proof. See Appendix A.2. □

Proposition 2 closely mirrors Proposition 1 in its structure, but the optimal fiscal policies in these polar cases markedly differ because of the nature of the present debt ceiling, $\widehat{b}_2$, versus the previous one, $\widetilde{b}_2$. We illustrate these differences in Figure 3.

Contrasting Figure 3 with Figure 2, we see that the persistent and flexible economies share two common aspects—the first-best policies are the same and fiscal policies are constrained by a debt ceiling when the state of nature is bad enough in the first period—and one main difference—the shape of the latter constraint. In the persistent economy, the debt ceiling does not only depend on the state of nature in the second period; it crucially depends on the state of nature in the first period (panel a). When expenditures are high in the first period, the government will need to implement higher taxes. In turn, these taxes will affect the technological choices of entrepreneurs. Entrepreneurs will choose a production technology based on the relative returns of the two technologies in the first period and in the second period, as their current choice will fully persist in the subsequent period. Through these persistent technological choices, a poor state of nature

[17] As will be shown later, the distortionary effect of taxation disciplines two aspects of the optimal fiscal policy under limited commitment: (i) it will affect the level of the debt ceiling—higher distortions leading to a lower debt ceiling; and (ii) it will affect the curvature of consumption as a function of government expenditures (through the mediation role of taxation).

Figure 3. Optimal fiscal policy and consumption in the persistent economy.



(a) Debt

(b) Consumption

Notes: This figure represents debt (b_2, in panel a) and consumption (c_1 and c_2, in panel b) in the persistent economy ($\theta = 0$). In panel (a), the dashed line represents the relationship between debt and the state of nature when the government has perfect commitment to repay its obligations; the dashed/dotted line represents the debt ceiling; and the plain line represents the relationship between debt and the state of nature under limited commitment. In panel (b), the dashed line represents the relationship between consumption (in both periods) and the state of nature when the government has perfect commitment to repay its obligations; and the plain lines represent the (possibly different) consumption schedules under limited commitment.

in the first period makes reimbursement more costly in the second period and thereby reduces the government's commitment to repay. Beyond the point where the first-best fiscal policy is feasible ($g_1 > \widehat{g}_1$), the government incurs as much debt as it can in the first period, but this debt actually decreases with first-period expenditures—while the incentives to accumulate debt increase. The gap between the first- and second-best fiscal policies thus markedly widens with g_1. In turn, the welfare cost of limited commitment markedly increases through a more pronounced *consumption-smoothing cost* and a more pronounced *distortion cost*.

The distortionary effect of taxation shapes the debt constraint in two distinct ways: (i) higher distortions shift the debt ceiling schedule inwards; and (ii) higher distortions tilt the debt ceiling schedule which becomes more sensitive to the state of nature in the first period. We turn to these comparative statics next.

Comparative statics We now provide simple comparative statics, which further shed light on the implications of having distortionary redistribution between the government and households when there is limited commitment.

Proposition 3 (Comparative statics)**.** *The expenditure threshold from which first- and second-best fiscal policies differ is higher in the flexible economy than in the persistent econ-*

omy, i.e., $\widetilde{g}_1 \geq \widehat{g}_1$*, and the debt ceiling is uniformly higher, i.e.,* $\widetilde{b}_2 \geq \widehat{b}_2\left(\widehat{g}_1\right)$*.*

Proof. See Appendix A.2. □

Proposition 3 illustrates the following mechanism. Higher expenditure implies higher taxation; and a higher taxation lowers the contemporary return r_1 to the formal sector through two channels. There is a direct effect deriving from higher taxes. There is an indirect channel deriving from entrepreneurs switching to the informal sector thereby lowering the returns to the formal sector. Through Equation (5), this affects the indifference threshold between the formal and the informal sector, and thus the number of entrepreneurs operating in the informal sector. With flexible technological choices, this response does not affect the incentives to repay in the second period. With persistent technological choices, this response increases the future costs of raising tax revenues.

While the previous mechanism is always at play, at least qualitatively, when there is some rigidity in technology, its quantitative relevance crucially depends on fundamentals of the economy: the sensitivity of technological choices to economic conditions, their persistence, and the nature of exogenous fluctuations. To shed light on such quantitative relevance, we now turn to analyzing the proper dynamic, stochastic model under a reasonable calibration.

4 Quantitative model

In this section, we analyze the full-fledged model developed in Section 2. We first calibrate the model to match key empirical moments, and we discuss how the resulting economy fares against a few untargeted moments; we then derive quantitative results about the joint dynamics of fiscal policy and default risk in the model; and we finally discuss the welfare implications of these dynamics.

4.1 Solution method and calibration

Value functions and solution method We solve for the government optimization program in a recursive fashion and as a fixed-point problem. We write the government problem as a Bellman equation and consider two value functions corresponding to different default histories. At any period t, the government may have access to international markets, A, or be excluded, X. Letting $\mathbf{s_t}$ denote the state of the economy, the government value function in period t is $v(\mathbf{s_t}) = \mathbb{1}_{h_t=A} \cdot v_A(\mathbf{s_t}) + \mathbb{1}_{h_t=X} \cdot v_X(\mathbf{s_t})$, where the conditional value functions v_A and v_X are defined as,[18]

$$v_A(\mathbf{s_t}) = \max_{D_t, b_{t+1}, \gamma_t, \tau_t} \left\{ u\left(c_t\right) + \beta(1 - D_t) E_t v_A(\mathbf{s_{t+1}}) + \beta D_t E_t v_X(\mathbf{s_{t+1}}) \right\},$$

and,

$$v_X(\mathbf{s_t}) = (1 - \nu)\left[u(c_t(1 - \Delta)) + \beta E_t v_X(\mathbf{s_{t+1}}) \right] + \nu \max_{b_{t+1}, \gamma_t, \tau_t} \left\{ u\left(c_t\right) + \beta E_t v_A(\mathbf{s_{t+1}}) \right\},$$

subject to Equations (1), (5), and (6). Note that, as the government is not allowed to return the proceeds of its external borrowing to the representative household as a lump-sum transfer, there is only one instrument to transfer from and to the household: in effect, the choice of future debt pins down the choice of the tax rate (through the budget constraint) and reciprocally. The government does face a debt price schedule which depends on: endogenous state variables, (b_{t+1}, γ_t), but the two arguments are always tied through the budget constraint; and the exogenous shock, through the recursive Equation (6).

We solve numerically for these value functions as a fixed-point problem. The government does not have commitment on future policy and takes it as given when deciding upon contemporary choices. The problem is solved by iteration, and we find the fixed point by looping over the future behavior of the government and debt pricing. More specifically, we initially set two policy functions $\mathbf{s} \mapsto \gamma(\mathbf{s})$ and $\mathbf{s} \mapsto q(\mathbf{s})$, which characterize future production and future expected default, both as a function of state variables $(\mathbf{s})$. Given the policy functions $\mathbf{s} \mapsto \gamma(\mathbf{s})$ and $\mathbf{s} \mapsto q(\mathbf{s})$, we solve the dynamic problem of the government through value function iteration. We then update the policy functions $\mathbf{s} \mapsto \gamma(\mathbf{s})$ and $\mathbf{s} \mapsto q(\mathbf{s})$, using the policy functions obtained in the previous step, and we iterate until convergence.

In practice, we need to keep track of three state variables: the inherited debt level, the inherited incidence of the formal sector (sometimes referred to as "formality" in what follows) and the contemporary values for the exogenous stochastic process. We create rough grids for each of the state variables, and the AR(1) process for public expenditures is discretized using the Tauchen (1986) method. In each iteration, we use spline interpolation to approximate the value functions, v_A and v_X, and the (given) policy functions, following Hatchondo et al. (2010), such that the government effectively solves a continuous problem.

Calibrated parameters In order to calibrate the previous model, we proceed as follows. We first set the parameters characterizing preferences, default risk, debt maturity,

[18]Without market access, the government makes no decisions because the period tax rate, and thus technological choices, are pinned down by the budget constraint $t_t = g_t$.

and shocks *directly*, for a synthetic, average economy. We then estimate production parameters to *match* key empirical moments that we identify in a dataset of selected countries with non-negligible informality and default risk.

To discipline the inclination for consumption-smoothing in the quantitative model, we consider risk-averse and rather impatient households. The representative household enjoys consumption following a Constant Relative Risk Aversion (CRRA) utility function, $u = c^{1-\sigma}/(1-\sigma)$, and we set the curvature parameter towards the high-end in the spectrum of reasonable values ($\sigma = 2$, as in Aguiar and Gopinath, 2006; Arellano, 2008; Chatterjee and Eyigungor, 2012). The household is impatient, leading to debt accumulation—even absent any fluctuations: we set a discount factor (β) corresponding to an annual discount rate of 15%; external investors are more patient, and we set the annual risk-free interest rate ($1/\rho - 1$) to be 5.5% (close to the quarterly rate used in Chatterjee and Eyigungor, 2012, for example). One rationale for the government—on behalf of the household—to be impatient relative to the market is political friction (and the high probability to lose office, see, e.g., Aguiar et al., 2009).

Impatience is one factor leading to debt accumulation. Another, limiting factor is the (imperfect) commitment for the government to repay. In the model, commitment comes from two sources of punishment: one is temporary market exclusion preventing the government from bringing consumption forward for impatience-related or risk-related purposes; another one is a direct output cost possibly reflecting a capital flight from investors (Mendoza and Yue, 2012). An issue with the calibration of related model parameters is that defaults are infrequent and occur in countries where we do not observe time-varying proxies for informality. We thus rely on available, externally-derived evidence: we set the reintegration probability following a default, ν, to produce an average exclusion length of 10 years (matching the exclusion period following the Argentinian default in 1982, see Chatterjee and Eyigungor, 2012); and the proportional output cost, Δ, is calibrated at 15% in the high range of output losses for "hard defaults" (estimated to be between 6 and 15%, see Trebesch and Zabel, 2017). In order to sustain high debt levels with reasonable fluctuations in debt prices, each debt contract has a probabilistic maturity; and we set the fraction of outstanding debt which matures in each period, λ, equal to 0.10 such that the average time for a debt unit to be repaid is 10 years.

The benevolent government issues debt to insulate households from fluctuations in economic conditions. We consider an auto-correlated spending shock, whose logarithm follows an AR(1) process, and we set the AR(1) parameter and the standard deviation of innovation shocks to mimic the observed persistence and volatility of (log) public expenditures.[19] Panels 1 to 3 of Table 1 list all these "non-estimated" parameter values.

[19] More specifically, we extract government expenditures across a large sample of 45 economies be-

Table 1. Parameters selected directly and by matching empirical moments.

Description	Parameter	Value
1. Preferences (directly)		
Discount factor	β	0.85
Risk-free interest rate	$1/\rho - 1$	0.055
Risk-aversion (CRRA)	σ	2.00
2. Default and debt (directly)		
Probability of reintegration	ν	0.10
Output cost	Δ	0.15
Maturity (years)	$1/\lambda$	10
Coupon rate	z	0.00
3. Shocks (directly)		
Expenditures $\{\log g_t\}$, autocorrelation	s_g	0.906
Expenditures $\{\log g_t\}$, standard deviation	σ_g	0.138
4. Production (matched)		
Informal returns (Pareto, $H(x) = 1 - \left(\frac{a_1}{x}\right)^{a_2}$)	a_1	0.38
Informal returns (Pareto, $H(x) = 1 - \left(\frac{a_1}{x}\right)^{a_2}$)	a_2	2.10
Probability to set technology	θ	0.15
Complementarities	ϕ	0.975

Notes: See Appendix B.1 for a detailed description of the data sources and the derivation of empirical moments underlying the panel *4. Production (matched)*. We set the average level of public expenditures, $E[g_t]$, to equal 19.3% of output (an average across our large sample of 45 economies). The time unit is a year, such that the discount factor corresponds to a quarterly discount factor of 0.96.

Targeted moments The model requires parameter values for fundamentals governing the production side of the domestic economy. Equation (5) characterizes the dynamics of domestic production as a function of fiscal policy—through the contemporary returns to the formal sector—, the dispersion of contemporary and future returns in the informal sector, and the future economic environment. The main fundamentals governing this relationship are: (i) the distribution of returns in the informal sector, $H(\cdot)$, mostly translating into an average level of (in)formality and an elasticity of technological choices to economic conditions (typically, to the tax rate); and (ii) the Calvo parameter, θ, mostly translating into technology rigidities over time.

The variability of technological choices and their persistence are crucial to our analysis, and we put additional care into estimating them. To do so, we rely on data collection started in Pappadà and Zylberberg (2017) and consolidated in Pappadà and Rogoff (2025) that we harmonize across countries and over time to measure VAT compliance from the observation of consumption and tax rate across goods. The final dataset is an unbalanced panel of about 45 economies between 1995 and 2020. We complement the data

tween 1995 and 2020 (later described in this section), we residualize the logarithm of government expenditures using year and country-fixed effects, and we estimate the standard deviation of the remaining, centered variable as well as its auto-correlation within an AR(1) specification.

with government expenditures, sectoral shares (services, agriculture, industry), output (GDP per capita, constant USD, PPP), government debt stocks, and ten-year government bond rates, as collected from different sources (e.g., the Word Indicator Database, the OECD, and the IMF). Appendix B.1 further describes the different data sources and details how one can recover the incidence of informal transactions from observing actual consumption patterns against tax revenues.

A caveat with our data is that it relies on the availability of harmonized data on household consumption and tax receipts: our original sample thus disproportionately features rich economies. Our model is however designed to best capture economic contexts with relatively high informal sectors and default risk: we thus restrict the baseline sample to economies with high levels of informality and long-term sovereign debt spreads.[20] The resulting sample primarily features "middle-income" countries with high informality levels (e.g., Colombia, Chile, Russia, Serbia, South Africa), Eastern-European countries (e.g., Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania) and Southern-European countries (e.g., Greece, Italy, Portugal, Spain). For the sake of transparency, we however consider a sensitivity analysis in Appendix B.1 and report the selection of targeted moments for five alternative samples, e.g., including all economies or focusing on "middle-income" economies or peripheral European countries.

We exploit rich variation over time across our selected economies with non-negligible informality and default risk to identify the average elasticity of technological choices to tax rates and their average persistence. More specifically, we first identify the elasticity of tax compliance to tax rates by considering a country c in year t and estimating the following baseline specification in difference:

$$\Delta \ln \gamma_{t,c} = \varepsilon_{\gamma} \Delta \ln \tau_{t,c} + \beta \mathbf{X}_{t,c} + \delta_t + \mu_c + e_{t,c}, \tag{11}$$

where: $\Delta \ln \gamma_{tc}$ is the annual change in (log) tax compliance; and $\Delta \ln \tau_{tc}$ is the annual change in (log) effective VAT rate.[21] The vector $\mathbf{X}_{tc}$ includes the following set of time-varying controls: the annual change in (log) output per capita (in constant USD and PPP-adjusted); annual changes in the sectoral decomposition of economic activity across 1-digit sectors and in the ratio of exports and imports over GDP; and the annual changes in government expenditures as a ratio of output. These controls partly clean for confounding factors co-moving with tax compliance and fiscal policy. Second, we identify

[20] More specifically, we drop countries that are either below median for the average level of informality (i.e., below 14.1%) or within the bottom quartile for average long-term sovereign debt spreads (i.e., below 3.34%).

[21] We use a specification in difference to account for non-stationarity in informality (and, to a second order, in fiscal pressure). Note, however, that our estimates would not be markedly different in a level specification, which is the first-stage of our "persistence" specification (B1) (see Appendix B.1).

the persistence in tax compliance in a two-stage AR(1) specification where tax compliance, $\ln \gamma_{t,c}$, is regressed on its lagged level, and the latter is instrumented in a first-stage by the lagged effective VAT rate. In this exercise, we consider the same controls as in Equation (11). We report these key targeted moments in Table 2, along with the average incidence of the formal sector (0.72) and an externally-derived targeted moment: an average fiscal multiplier of 1.40 based on the estimates for informal economies (see Table 1 in Pappa et al., 2015).

Our approach minimizes the distance between moments of the simulated economy and these four targeted moments: (a) the average formality, (b) the elasticity of such formality to tax rates, (c) the persistence of formality, and (d) the fiscal multiplier. In effect, we allow for four degrees of freedom to characterize technological choices and match these moments: we use a Pareto distribution of returns H with location and shape parameters a_1 and a_2; and we then estimate these parameters (a_1, a_2), the degree of complementarity within the formal sector (ϕ), and the Calvo parameter (θ) to best match the four targeted moments. Intuitively, the average volatility of technological choices mostly pins down the dispersion of returns in the informal sector; the fiscal multiplier disciplines complementarities in the formal sector; and the persistence of technological choices pins down the period probability to reset technology. We report the distance-minimizing parameters under the heading "4. Production (matched)" in Table 1, and we contrast the targeted and simulated moments—based, for the elasticity and persistence, on regressions using simulated data—in Panel A of Table 2.

Non-targeted moments The previous calibration targets production parameters, but does not directly target a few important moments characterizing fiscal policy. In particular, we impose a structure of auto-correlated spending shocks, and this structure crucially disciplines the uncertainty faced by the government.

In this section, we briefly probe whether our model is able to replicate the volatility of fiscal policy and consumption within our selected sample of countries (see Panel B of Table 2). We contrast the *overall* volatility of formality, the volatility of tax rates, the volatility of household consumption, and debt levels in 10,000 simulated economies against those observed in our unbalanced panel of 20 economies between 1995–2020. We see that our structure of shocks, combined with our estimated production parameters, leads to an overshoot in terms of the volatility of tax rates and consumption. A likely explanation is that government expenditure is exogenous in our model and we ignore other macroeconomic stabilizers, such that the linear tax rate and debt are the only "smoothing" instruments. Our structure of long-term debt contracts, borrowed from Chatterjee and Eyigungor (2012), however creates acceptable levels of debt (see Panel B)

Table 2. Simulated and empirical moments.

	Data	Model
Panel A: Targeted moments		
a. Average formality	0.720	0.720
b. Elasticity of formality to tax rate	-0.393	-0.388
c. Persistence of formality	0.846	0.858
d. Fiscal multiplier	1.400	1.410
Panel B: Non-targeted moments		
e. Volatility of formality	0.044	0.039
f. Volatility of tax rates	0.022	0.042
g. Volatility of consumption to output	0.018	0.035
h. Median debt	0.327	0.410
Panel C: Default		
i. Default frequency	-	0.0128
j. Market exclusion	-	0.1426

Notes: This table reports selected moments from the data and from simulated economies. For the sake of exposition, we label the incidence of the formal sector as *formality*. Column (*Data*) relies on our unbalanced panel of selected economies between 1995–2020. The empirical equivalent of the incidence of the formal sector (or *formality*) is the tax compliance. The empirical elasticity of the formal sector is estimated following specification (11); and the persistence of the formal sector is estimated following the AR(1) specification (B1) (see Appendix B.1). The volatilities reported in rows e., f., and g. of Panel B are standard deviations of: the incidence of the formal sector (in levels); tax rates (in levels); and the ratio of household consumption to output (in levels). The default frequency and market exclusion reported in rows i. and j. of Panel C are respectively the likelihood to observe a default across periods and the probability to be excluded from bond markets; none of those events occur in our selected economies between 1995–2020. Column (*Model*) provides the same moments from 10,000 simulated economies over 50 years. In practice, we run simulations across 100 years and only keep the last 50 years to limit the influence of initial conditions. In Appendix B.1 and Tables B1, B2, and B3, we report the selection of targeted and non-targeted moments across five alternative samples (S2: all economies, S3: high informality, S4: high default risk, S5: peripheral European economies, S6: middle-income economies). Finally, note that the model-based statistics in Panel A and Panel B are computed using the subsample of repayment periods.

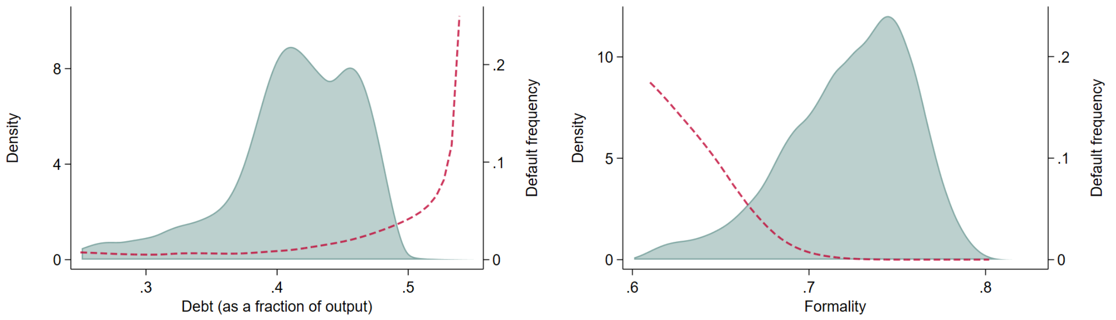
and default (see Panel C). In summary, our calibrated economy is reasonably close to the average economy of our baseline sample—notwithstanding the high(er) fluctuations in fiscal policy and consumption.

4.2 Properties of the calibrated economy

Default and state variables We first analyze the properties of the calibrated economy. To this purpose, we simulate 10,000 similar economies over 50 years, and we display the distribution of the two endogenous state variables, (b_t, γ_{t-1}), and their relationship with default frequency in Figure 4.[22]

[22]The interested reader can refer to Appendix B.1 and Appendix Figure B1 for a visualization of the joint distribution between debt and formality.

Figure 4. Distribution of debt, technological choices, and default frequency.



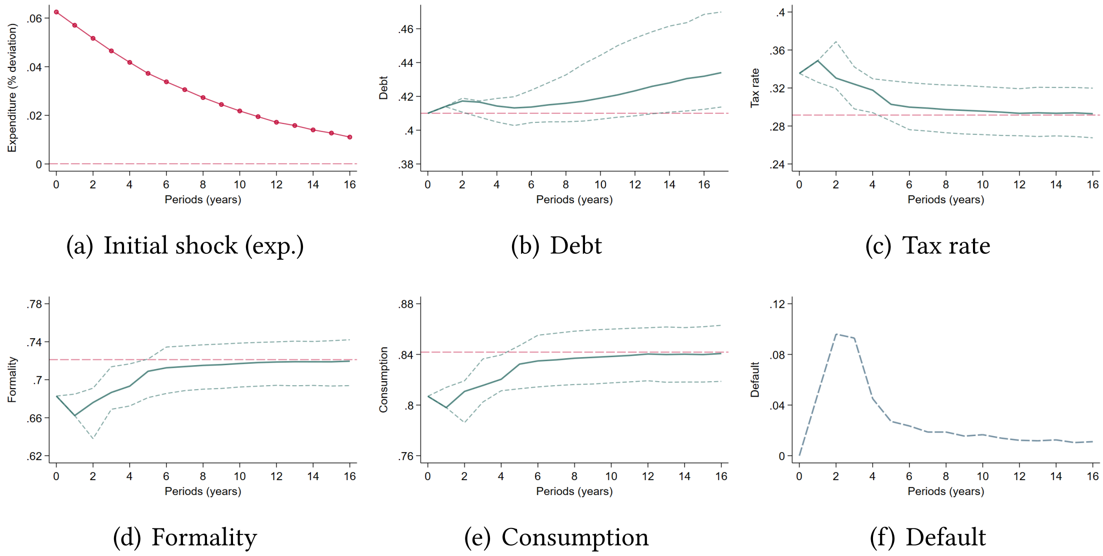
(a) Debt (b) Formality

Notes: This Figure displays the distribution of the two endogenous state variables, (b_t, γ_{t-1}), and their relationship with the occurrence of a default across 10,000 simulated economies over 50 years. In practice, we run simulations across 100 years and only keep the last 50 years to limit the influence of initial conditions. Panel (a) shows the distribution of debt (as normalized by *average* output), and the average likelihood to observe a default as a function of inherited debt level (as a dashed line). For visualization purposes, we omit the less frequent debt levels below 25% of output. Panel (b) shows the distribution of technological choice (the incidence of the formal sector). For the sake of exposition, we label the incidence of the formal sector as *formality*. The default frequency, reported in the second y-axis, is the likelihood of default occurrences in period t (excluding periods of autarky and averaged over the other endogenous or exogenous state variables); and the constructed distributions are based on simulated data *during periods of repayment*.

First, we find that the government has incentives to accumulate debt, but it comes at a cost. The government mostly accumulates debt over a range going from about 0 to 55% of output, but debt levels above 50% of output are very rarely observed (the latter could be interpreted as a "sustainable" debt ceiling); default is nil for low levels of inherited debt b_t but sharply increases for b_t between 40% and 55% of output. This increase of default with inherited debt implies that: (i) there exists a region in the set of state variables where default is likely, and (ii) the government is still tempted to accumulate debt within this region, as the marginal cost of doing so is not immediately prohibitive. Second, informality is key to understanding default decisions. The share of entrepreneurs in the formal sector ranges between 0.60 and 0.82 with a slightly asymmetric, left tail, and default is predominantly observed towards the lower end of this distribution. The staggered technological adjustment of entrepreneurs implies that the dynamics of informality exhibits stickiness—a key property of the calibrated economy: high informality today induces low returns to taxation in the medium run, thereby giving strong incentives to default.

The response to shocks The complex dynamics followed by our economy as a function of exogenous fluctuations cannot be captured by the previous evidence. To shed some light on these dynamics, we produce impulse response functions following an ex-

Figure 5. Impulse response functions—an illustration of dynamics in the simulated economy.



(a) Initial shock (exp.)

(b) Debt

(c) Tax rate

(d) Formality

(e) Consumption

(f) Default

Notes: This Figure displays the median response of 10,000 simulated economies to an expenditure shock over a period of 16 years. Panel (a) provides an illustration of the direct effect of the shock on average expenditures: in period 1, we set the level of expenditure to be 1 percentage point of output above its long-term value (see period 0), which corresponds to a (log) deviation of 6% relative to the mean. We then simulate the stochastic, exogenous processes from period 1 onward across the 10,000 simulated economies. Panels (b), (c), (d), and (e) display the median response (plain line) and the 25-75% quantiles (dashed lines) for the following variables: debt (as normalized by *average* output), the tax rate (τ), the incidence of the formal sector (γ), and consumption (c). In these panels, we compute these quantities while only including repayment periods; we provide a robustness check also including defaulting economies in Appendix B.2. Finally, panel (f) displays the likelihood to observe a default across the 10,000 simulated economies. The initial conditions are $\gamma_{-1} = 0.720$, and $b_0 = 0.41$ as a share of output. In panels (c) to (e), the dashed lines indicate long-term averages. Panel (b) reports instead the initial conditions.

penditure shock within our dynamic system.[23] A limit of this exercise is that it depends on initial conditions and extracting an average response across those is not easy; for this reason, we use it as an illustration of the model dynamics rather than a proper validation against the data (as more explicitly done in Table 2).

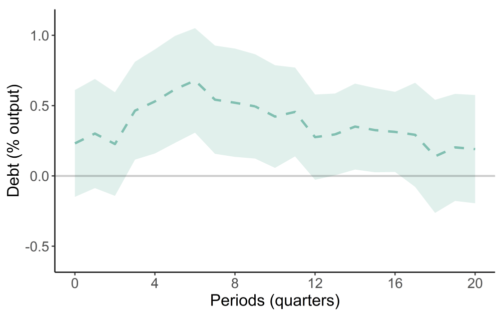
The outcome of this exercise is reported in Figure 5. Panel (a) displays the evolution of the shocked, exogenous variable in (log) deviation from its mean. Panels (b) and (c) show the response of debt and taxation: the median simulated economy (plain line) fills the large gap in the government budget by incurring more debt *and* by increasing taxation. Along the median trajectory, the former covers about 0.5 percentage points of output on impact (or about 50% of the gap), while the latter accounts for the remaining gap.[24] Tax

[23]We first simulate our economy over many periods and use the mode of the state variables ($\bar{\mathbf{s}}$) as initial conditions ($\gamma_{-1} = 0.720$, and $b_0 = 0.41$ as a share of output). We then deviate from this "steady-state" by setting exogenous expenditures above their long-term average by 1 percentage point of output. Finally, we simulate 10,000 economies affected by subsequent shocks and starting from this initial shock in period 1, and we report the distribution of their responses over a period of 16 years.

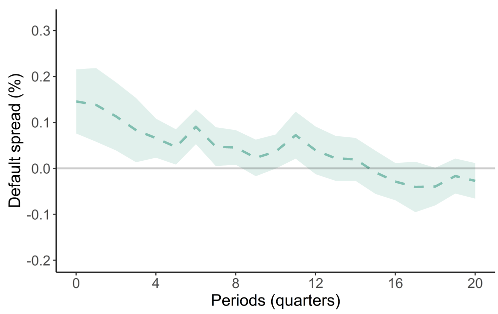
[24]Note that debt appears to increase in the longer run—an effect explained by composition (we are only including repayment scenarios here); we thus provide a robustness check also including defaulting economies in Appendix B.2.

rates increase by 20% (or 0.06 in levels); given the elasticity of formality to tax rate, the tax base decreases by 8% (or 0.05 in levels). The shrinking tax base explains why these costly fiscal adjustments generate moderate fiscal surpluses. The two fiscal instruments are used differently over time: while debt reverts to the mean in about 3-4 years, taxes remain high in most cases, even after 5-6 years—which can be thought of as an informality-driven "overhang". This overhang is also visible when looking at technological choices (panel d, showing the incidence of the formal sector): formality remains persistently low—1 percent below its average value after 5 years in the majority of cases. Through this sluggish adjustment in (in)formality, the government remains susceptible to default in the medium run (see panel f, where default remains very likely 5-6 years after the initial shock). Ultimately, what matters to welfare is consumption. Its evolution lies between the less sluggish debt response and the more sluggish technological response: there is a large decrease in private consumption on impact, which slowly reverts to the mean.

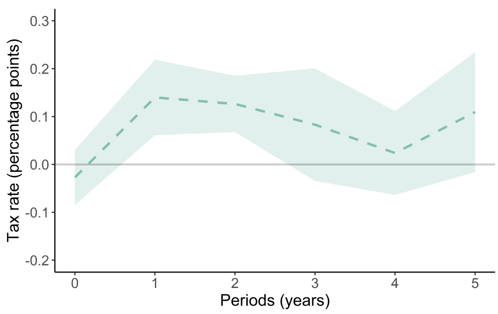
Figure 6. Impulse response functions—data.



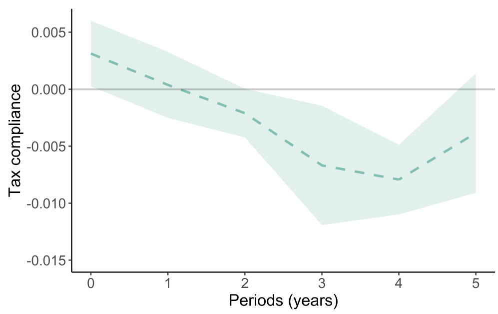
(a) Debt



(b) Default spread



(c) Tax rate



(d) Tax compliance

Notes: This Figure displays the estimated impulse response function to an increase of one percent of output in government expenditures (as in Born et al., 2020). Panels (a), (b), (c) and (d) display the estimated response (dashed line) and the 10-90% confidence interval for the following variables: debt as a percentage of output, the default spread on sovereign bonds, the average tax rate, and tax compliance. The estimation procedure is done at a quarterly level for debt and the default spread (panels a and b) and at a yearly level for the average tax rate and tax compliance (panels c and d).

We provide an empirical counterpart for selected variables in Figure 6 where we replicate the approach of Born et al. (2020) on our sample of countries across years.[25] The approach builds upon local projections (Jordà, 2005) and exogenous expenditure shocks: forecast errors in government consumption. More specifically, we consider the following empirical specification,

$$y_{ct+h} = \Psi_h z^g_{ict} + \gamma_h \mathbf{x}_{ct} + \alpha_{ch} + \eta_{th} + \varepsilon_{ct+h}, \tag{12}$$

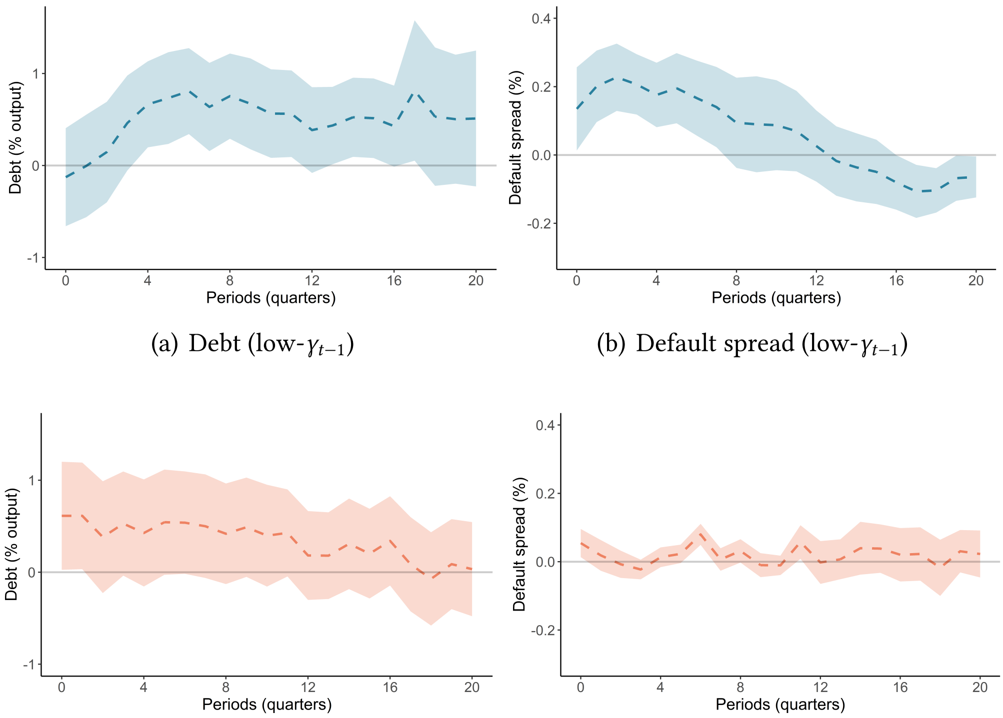
where c is a country, t is the time of the fiscal shock, z^g_{ict}, and h is the number of years/quarters after the initial shock. The fiscal shock, z^g_{ict}, is defined as the gap between actual government consumption and its forecast by Oxford Economics. In the specification, we also condition for control variables and their lags ($\mathbf{x}_{ct}$: corporate and income tax rates, year of entry into the UE), country fixed effects (α_{ch}) and year fixed effects (η_{th}). The coefficients of interest are the estimated Ψ_h at different horizons: $h \in \{1, 2, 3, 4, 5\}$ for yearly specifications and $h \in \{1, \dots, 20\}$ for quarterly specifications.

Figure 6 shows the estimated effects, Ψ_h, of exogenous shocks in government expenditures over a 5-year horizon on: debt levels (b, quarterly), the default spread on sovereign debt (as a proxy for debt prices, q, quarterly), tax rate (VAT rate, as a proxy for τ, yearly), and tax compliance (VAT compliance, as a proxy for the incidence of the formal sector, γ, yearly). The initial shock is partly mitigated by higher debt levels (between 30% and 50% of the initial budget gap is covered by debt), but also by higher taxes. There is a significant tax overhang: fiscal policy remains contractionary in the medium run, leading to a persistent, delayed drop in VAT compliance. Five years after the initial expenditure shock (1% of GDP), tax compliance is still 0.6 percentage points below its average value—a persistence close to the quantitative moments. These findings provide a counterpart to the model-based response derived in Figure 5.

The previous empirical response is an average across different economies in different states of nature. In Figure 7, we provide a conditional impulse response based on two regimes: a low-γ_{t-1} regime, and a high-γ_{t-1} regime (calculated by the position of γ_{t-1} relative to its median value within each country). The responses to the expenditure shock markedly differ across the two regimes. In the low-γ_{t-1} regime, both debt and the default premium increase, while debt increases without being associated to higher default risk in the high-γ_{t-1} regime—in line with the forces at play in our quantitative

[25] In effect, we cannot apply the selection implemented in Section 4.1 to our empirical computation of impulse responses: once we match our full sample of economies (S2) to the fiscal shocks used in Born et al. (2020), we are left with only 18 economies, and half of them are outside of our baseline sample (S1). Implementing local projections requires sufficient variation, especially when estimated on annual data (Jordà, 2005). For this reason, we estimate Equation (12) on the largest possible sample (thus including countries with lower incidence of informality or low default risk). One needs to keep this limitation in mind when contrasting Figures 5 and 6.

Figure 7. State-dependent impulse response functions—data.



(a) Debt (low-γ_{t-1}) (b) Default spread (low-γ_{t-1})

(c) Debt (high-γ_{t-1}) (d) Default spread (high-γ_{t-1})

Notes: This Figure displays the estimated impulse response function to an increase of one percent of output in government expenditures (as in Born et al., 2020). Panels (a/c) and (b/d) display the estimated response (dashed line) and the 10-90% confidence interval for debt as a percentage of output and the default spread. The estimation procedure allows for regime switching between two regimes: low and high tax compliance in the previous period. For a qualitative comparison, we provide a further illustration of dynamics in the *simulated economy* in Appendix B.2 and Appendix Figure B3, where we derive state-dependent impulse response functions in the model.

model. The dynamics of informality do not only respond to fiscal policy; it also alters its impact on the economy. These interactions between fiscal policy and the dynamics of formality may have non-negligible welfare consequences. We now quantify the impact of such interactions through the lens of our quantitative model.

4.3 The dynamic distortionary effect of fiscal policy and its welfare cost

To quantify the welfare consequences of dynamic fiscal distortions and imperfect commitment, we compare our baseline economy ([i. Baseline], calibrated in Section 4.1) to four alternative economies: [ii. Rigidity] an economy where entrepreneurs can freely reset their technology ($\theta = 0$); [iii. Complementarity] an economy where entrepreneurial decisions are not strategic complements ($\phi = 1$), neutralizing spillovers within the formal sector; [iv. Informal returns] an economy with a marginally less compressed distribution of informal returns ($a_1 = 0.35, a_2 = 1.90$), yielding a thinner density of entrepreneurs near the indifference threshold, but a similar expected output within the informal sector; and [v. No default with borrowing constraint] a commitment economy, otherwise parametrized as the baseline, but allowing the government to borrow up to a fixed constraint with perfect commitment to repay.[26] For each scenario, we simulate 10,000 stochastic processes and their associated responses over 100 periods (years) for which we focus on the last 50 years, using the same shock structure as in the baseline economy.

Table 3 reports key moments about fiscal policy, the distribution of debt, and default across these different economies. Focusing first on scenarios [ii]-[iv], we find that these less rigid [ii] and less responsive economies [iii, iv] typically exhibit lower fluctuations in the incidence of the formal sector, as partly induced by a lower volatility of taxation (and a lower elasticity of formality to those fluctuations in the case of scenario iv). In theory, fluctuations in fiscal policy might either stabilize consumption (when fiscal policy is counter-cyclical) or amplify consumption volatility (when fiscal policy is pro-cyclical); we will discuss the consequences of muted fluctuations in fiscal policy in the counterfactual economies next. Relative to the baseline, scenarios [ii], [iii], and [iv] also feature different debt levels and default: In line with our qualitative insight of Section 3, the debt distribution shifts upward when domestic production is less responsive to taxes (see columns [iii] and [iv]), and a similar adjustment—for the right tail of the debt distribution—is observed in the less rigid economy (see column [ii]). In a less responsive or less rigid economy, fiscal policy indeed has a smaller impact on *future* returns to taxes, and high tax rates are less likely to discourage future repayment. The related effect on default is, however, ambiguous: on the one hand, economies with flexible choices [ii], no strategic complementarities in technological choices [iii], or more limited behavioral responses to taxes [iv] have more commitment to repay; on the other hand, they accumulate more debt. In [iii] and [iv], the former effect dominates, reducing default risk; in [ii], the latter dominates, leading to slightly more frequent defaults.

Toning down the behavioral response of the economy to taxation, as in [iii]—in which the estimated fiscal multiplier is much closer to 1 at around 1.13—or in [iv]—in which the elasticity of formality falls to -0.317 for a similar degree of persistence—has meaningful welfare implications. So does lowering the rigidity of technological choices, as in [ii]—where the persistence of formality falls to 0.769, only disciplined by the auto-correlated structure of shocks. In the baseline, welfare losses stem from a combination of factors.

[26] For this economy, we forbid the government from accumulating debt above 43.3% of the average output—parametrized such as to span the same debt range as the baseline calibration (i.e., having similar median levels of debt). In Appendix B.3, we consider additional experiments varying other parameters of the baseline model, which also indirectly shows the sensitivity of our calibration to preference parameters, and to the default costs and debt structure.

Table 3. The welfare cost of dynamic fiscal distortions and imperfect commitment.

Parameter change	Baseline - [i]	Rigidity $\theta = 0$ [ii]	Complement. $\phi = 1$ [iii]	Inform. ret. $H(\cdot)$ [iv]	No default[†] - [v]
Formality					
Average	0.720	0.730	0.729	0.732	0.715
Volatility	0.039	0.030	0.035	0.029	0.041
Tax rate					
Average	0.290	0.283	0.287	0.287	0.296
Volatility	0.042	0.036	0.037	0.034	0.043
Debt					
25%-quantile	0.367	0.321	0.446	0.448	0.409
Median	0.410	0.439	0.467	0.460	0.410
75%-quantile	0.447	0.462	0.471	0.463	0.411
Default and exclusion					
Default frequency	0.0128	0.0163	0.0093	0.0092	0.0000
Market exclusion	0.1426	0.1786	0.1014	0.1004	0.0000
Welfare					
Cert. eq. consumption	0.834	0.863	0.846	0.869	0.849
Fluctuation cost (% cons.)	0.743%	0.674%	0.536%	0.523%	0.104%

Notes: For each specification [i-v], we simulate 10,000 stochastic processes and their associated responses over 50 periods (years), using the baseline shock structure. In practice, we run simulations across 100 years with similar initial conditions and only keep the last 50 years to limit the influence of these initial conditions. Specification [i] is our baseline model. Specification [ii] uses all parameters of specification [i], except that the probability for entrepreneurs to be unable to reset technology is set at a lower value, $\theta = 0$. Specification [iii] uses all parameters of specification [i], except that entrepreneurial choices are strategic substitutes, $\phi = 1$. Specification [iv] uses all parameters of specification [i], except for the parameters underlying the distribution of informal returns $H(\cdot)$, which are set to produce a less compressed distribution of informal returns ($a_1 = 0.35, a_2 = 1.90$), but a similar expected output in the limiting distribution. Specification [v] is the same as specification [i], but with: infinite default costs—thus providing perfect commitment to the government; and (†) a borrowing constraint forbidding the government to accumulate debt above 43.3% of the average output and set to match the median level of debt of specification [i]. For each specification, we report: the average and standard deviations of formality and tax rate; the 25%, 50%, and 75% percentiles for debt normalized by average output; the likelihood to observe a default across periods; the probability to be excluded from bond markets; and measures of welfare. The statistics about formality, the tax rate, and debt are computed using the subsample of repayment periods, as in Table 2. The *certainty equivalent consumption* is derived from the average value function, $1/S\sum_{s=1}^{S} v_{\tau,s}$, estimated across all the simulations $s \in \{1,\dots,S\}$ in period $\tau = 50$: $u^{-1}\left((1-\beta)/S\sum_{s=1}^{S} v_{\tau,s}\right)$. Given the low discount factor, the choice of an intermediate period $\tau = 50$ allows us to limit the influence of initial conditions. This quantity can be interpreted as the constant household consumption that would bring the same level of welfare as $1/S\sum_{s=1}^{S} v_{\tau,s}$. Finally, the inferred *fluctuation cost* is a second-order approximation based on Lucas (1987), i.e., $1/2\sigma\varphi^2$ where φ is the standard deviation of (log) consumption across all simulations and across all periods.

First, the distortions associated with the dynamics of informality have an impact on *average consumption* through: default risk and fluctuations in fiscal policy, which lower informality, output, and average consumption; and actual default, which has a mechanical effect on the average consumption throughout the period of market exclusion. Second, *consumption volatility* itself is costly. In Table 3, we first report an overall measure of welfare, which encompasses all previous effects: the constant consumption stream yielding the same average welfare as the simulated economy (the *certainty equivalent consumption*). We find significant differences in welfare across economies. Notably, reducing dynamic fiscal distortions through the separate effects of θ [ii], ϕ [iii], or $H(\cdot)$ [iv] would lead to large welfare gains, equivalent to a 3.5% [ii], 1.4% [iii], or 2.8% [iv] increases in certainty equivalent consumption. The larger effect of experiment [ii] comes from the fact that rigidities in technological choices lead to a misallocation of resources: entrepreneurs having decided to operate in the informal sector following a good draw might be locked into the informal technology, even when it then provides low returns.[27]

We now turn to the analysis of the fluctuations in fiscal policy across counterfactual economies. To isolate the cost of consumption *fluctuations* from that of lower average levels, we compute a second-order approximation in the spirit of Lucas (1987): $1/2\sigma\varphi^2$ is approximately the share of consumption that the government/household would accept to lose in order to get rid of all consumption fluctuations, where φ is the standard deviation of (log) consumption across all periods. In the baseline, this cost amounts to 0.743% of average consumption. These losses respectively fall to 0.674%, 0.536%, and 0.523% in economies with a more flexible adjustment of technology [ii], lower complementarity in the formal sector [iii], or marginally less responsive choices of technology [iv]. Such differences are only partly explained by default: the dynamics of informality also induces imperfect consumption smoothing outside of default episodes.

Contrasting the previous experiments [ii]-[iv] to the baseline experiment [i] sheds light on how the dynamics of informality—its elasticity combined with its sluggishness—affects fiscal policy and default risk. By contrast, the last experiment [v] captures how default risk shapes fiscal policy and the dynamics of informality: With full commitment and a fixed borrowing constraint, fiscal policy is more volatile and stabilizes consumption more effectively. The *certainty equivalent consumption* is about 1.8% higher than in the baseline, and the welfare cost of consumption volatility markedly drops to 0.104%.

These experiments highlight the central role of the interaction between dynamic distortions and imperfect commitment in shaping fiscal policy: toning down the impact of fiscal policy on future returns to taxation or tempering the threat of default would both lead to non-negligible welfare gains and to more muted consumption fluctuations.

5 Final remarks

In this paper, we study how dynamic fiscal distortions interact with default risk. To do so, we introduce imperfect tax enforcement and some rigidities in the choice of en-

[27]There is a similar mechanical effect in experiment [iv] whereby the fatter-tail distribution of informal returns allows more entrepreneurs to enter the formal sector while keeping informal production high.

trepreneurs to operate in formal/informal sectors in an otherwise standard model of sovereign debt with limited commitment. We show that the interaction of limited commitment and imperfect tax enforcement strongly influences the dynamics of fiscal policy during default crises: fiscal policy impacts the technological choice of entrepreneurs, this choice affects the future trade-off between repayment and default through its persistence over time, and these prospective incentives to default impact contemporary debt prices and thus the inclination to bring consumption forward. This channel is shown to strongly constrain the dynamics of optimal fiscal policies in a quantitative exercise where we carefully parametrize the elasticity and persistence of technological choices by local entrepreneurs.

A limitation of our study is to consider a stylized, theoretical representation of the economy. A more thorough quantitative exercise could consider: (i) a larger set of redistribution tools and/or endogenous government expenditures to better match the richness of actual fiscal policy; (ii) heterogeneous households with differential access to consumption-smoothing instruments; (iii) heterogeneous entrepreneurs and borrowing frictions; and (iv) a less stylized modeling of tax evasion (e.g., allowing for endogenous adjustments of tax enforcement), of the technological differences between the informal sector and the formal sector (e.g., with a more explicit modeling of strategic complementarities within the latter) and of the nature of sluggishness in entrepreneurial decisions. We leave these avenues for future research.

Data availability

Code replicating the tables and figures in this article can be found in Pappada and Zylberberg (2025) in the Harvard Dataverse, `https://doi.org/10.7910/DVN/LCSLHP`.

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