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Financial globalization and the raising of public debt

By Marina Azzimonti, Eva de Francisco and Vincenzo Quadrini

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Marina Azzimonti
Federal Reserve Bank of Philadelphia

Eva de Francisco
Towson University

Vincenzo Quadrini
University of Southern California

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Abstract

During the last three decades the stock of government debt has increased in most developed countries. During the same period international capital markets have been liberalized. In this paper we develop a two-country political economy model with incomplete markets and endogenous government borrowing and show that countries choose higher levels of public debt when financial markets are internationally integrated.

1 Introduction

During the last three decades we have observed an increase in the stock of public debt in most of the developed countries. As shown in the top panel of Figure 1, the stock of public debt in OECD countries has increased from around 30 percent of GDP in the early 1980s to about 50 percent in 2005. Similar increases are observed in the US and Europe.

Historically, the dynamics of public debt has been closely connected to war financing and business cycle fluctuations, where budget deficits and surpluses were instrumental to minimizing the distortionary effects of taxation. The tax-smoothing theory developed by Barro (1979) provides a rationale for such dynamics. However, when we look at the upward trend in public debt that started in the early 1980s, it becomes difficult to rationalize it with tax-smoothing arguments since the period has been characterized by relatively peaceful times and low volatility of output.

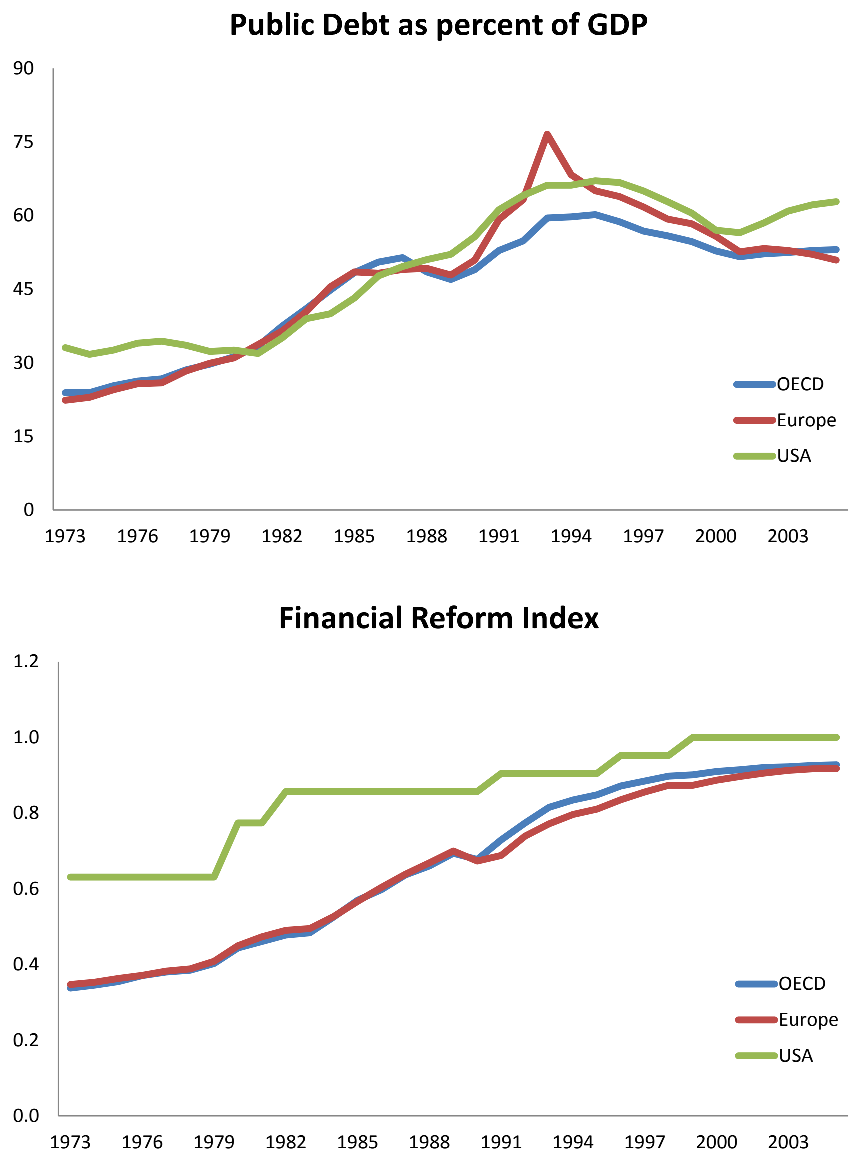

Figure 1: Public debt and financial liberalization in advanced economies.

The last three decades are also characterized by a significant process of financial liberalization. The second panel of Figure 1 plots the index of financial liberalization constructed by Abiad, Detragiache and Tressel (2008) for the group of OECD countries, the US and Europe. As can be seen from the figure, the world financial markets have become much less regulated starting in the early 1980s. A fact also confirmed by other indicators of international capital mobility as shown in Obstfeld and Taylor (2005).

In this paper we propose a theory where financial globalization leads to higher government borrowing. We study a two-country model where agents face uninsurable idiosyncratic risks and public debt can be held by private agents to smooth consumption. To keep tractability, we assume that there are two types of agents: those who face idiosyncratic risks (entrepreneurs) and those who are insulated from these risks (workers). Government policies are determined through the aggregation of agents' preferences based on probabilistic voting. The goal is to show how the choice of government debt changes when we move from a regime with financial autarky to a regime with international capital mobility.

Both agents have preferences for some public debt. Agents who face idiosyncratic risks (entrepreneurs) benefit from public debt because it provides an additional instrument to smooth consumption. This is the same reason why in Aiyagari and McGrattan (1998) and Shin (2006) public debt improves welfare. Agents who do not face idiosyncratic risks (workers) also benefit from government borrowing because the equilibrium interest rate is lower than the intertemporal discount rate. The benefits from public debt, however, fade away as the stock of debt increases. Once the debt has reached a certain level, further increases provide only small gains to entrepreneurs since they already hold large amounts of wealth. On the other hand, workers internalize that raising the stock of debt increases the interest rate, and therefore, the repayment cost. Thus, once debt has reached a certain level, workers do not support further increases in government borrowing. It is the internalization of the raising cost of debt that limits its growth.

How does financial integration affect the preferences for public debt? The central mechanism is the elasticity of the interest rate to the supply of public debt. In a globalized world, the demand for government debt comes not only from domestic investors but also from foreign investors. Therefore, each individual country faces a lower elasticity of the interest rate to the supply of 'their own' debt. Since the interest rate is less responsive to the country debt, governments have more incentives to expand their borrowing. This is the mechanism through which financial globalization induces higher public debt.

A recent literature has explored the importance of market incompleteness for international financial flows. Caballero, Farhi and Gourinchas (2008), Mendoza, Quadrini and Rios-Rull (2009), Angeletos and Panousi (2010), have all emphasized the importance of heterogeneity in financial markets for global imbalances. Our study differs from these contributions in three dimensions. First, our finding that capital markets liberalization leads to higher government borrowing does not rely on country heterogeneity. In fact, we present our results with perfectly symmetric countries. Second, our focus is on public debt while the above contributions have focused on private debt. With private borrowing atomistic agents do not internalize the impact that the issuance of debt has on the interest rate. But governments do. Therefore, the fact that borrowing takes place through governments may lead to very different outcomes. Third, the goal of our study is to explain the global volumes of (public) debt while the contributions mentioned above focus on net volumes. In these models financial liberalization leads to higher liabilities in one country but lower liabilities in others, with the difference defining the imbalance. The global volume of credit, however, does not change significantly. In contrast, in our model capital liberalization generates an increase in the global stock of debt. Therefore, we can explain why government debt has increased globally during the last thirty years.

The paper is also related to the theoretical literature on optimal debt management pioneered by Barro (1979), Lucas and Stokey (1983), and subsequent work that builds on these contributions such as Aiyagari, Marcet, Sargent, and Seppala (2002), Angeletos (2002), Chari, Christiano, and Kehoe (1994), and Marcet and Scott (2008). However, we depart from the tax-smoothing mechanism because we abstract from aggregate fluctuations and distortionary taxation. Instead, we focus on the role of heterogeneity within a country which is assumed away in the above papers.

Our model is closer to the models studied in Aiyagari and McGrattan (1998) and Shin (2006). In these papers the role of government debt is to partially complete the asset market in an incomplete market economy where agents are subject to idiosyncratic risks. The government accumulates debt in order to crowd out private capital, which is inefficiently high due to precautionary savings. In our model we abstract from capital accumulation. Therefore, the government choice to issue debt is independent of production efficiency considerations but it is based on redistributive concerns. Because of this, our paper is also related to the literature on optimal redistributive policy in heterogeneous agent economies such as Golosov, Kocherlakota, and Tsyvinski (2003), Albanesi and Sleet (2008), and Farhi and Werning (2008).

Finally, the paper is related to the literature on the political economy of debt initiated by the original work of Alesina and Tabellini (1990), Persson and Svensson (1989), and further developed by Battaglini and Coate (2008), Caballero and Yared (2008), Ilzetzki (2008), and Song, Storesletten and Zilibotti (2007) among others. The key common feature in these papers is the strategic use of public debt in economies where the interest rate is exogenous and governments with different preferences over public spending and distortionary taxation alternate in power. We abstract from political turnover and consider instead how the supply of government bonds endogenously affects interest rates and redistribution. The 'interest rate manipulation' channel is also present in Azzimonti, de Francisco, and Krusell (2009) but it relies on the existence of distortionary taxation, which we assume away here.

An important difference between our study and most of the literature on optimal government policies is that we address the issue of policy competition in an open economy environment while most of the literature studies closed economies. In particular, our goal is to study how the international liberalization of capital markets affect the government policies (specifically public debt). An exception is Quadrini (2005) who studies how capital liberalization affects the structure of capital taxation. However, there is no government debt in that model since governments have to balance their budgets every period.

The organization of the paper is as follows. In Section 2 we present the general model with repeated voting and characterize the equilibrium under two trading regimes: financial autarky and financial integration. Section 3 explores a simplified version of the model with only two periods, providing simple analytical intuition for the key results of the paper. Section 4 conducts a quantitative analysis with the infinite horizon model and repeated voting. This allows us to study the transition dynamics from the autarkic steady state to the steady state with capital mobility. Section 5 provides concluding remarks. All technical proofs are relegated to the Appendix.

2 Model

Consider an economy composed of two symmetric countries indexed by $j \in \{1, 2\}$. Markets are incomplete in the sense that agents face uninsurable idiosyncratic shocks. However, not all agents face exactly the same exposure to risk. To capture the possible heterogeneity in risk exposure in a tractable manner, we assume that there are two types of agents: a continuum of workers and entrepreneurs. Workers do not face any idiosyncratic uncertainty while entrepreneurs are subject to investment risks. In modeling entrepreneurs we adopt a similar approach as in Angeletos (2007), which allows us to aggregate and work with a representative entrepreneur. Therefore, we are able to limit the complexity of the model by focusing on only two agents: a representative worker and a representative entrepreneur. The presence of two representative agents is also a feature of the model studied in Judd (1985). In our model, however, risk is central to the analysis and government policies are over the choice of public debt.

Although we focus on heterogeneity between workers and entrepreneurs and make the extreme assumption that workers do not face any risk, the model should be interpreted more generally as an environment in which some agents face more risk than others. Because of the different exposure, they have different preferences over government debt. These preferences determine government borrowing through democratic elections of political representatives. In characterizing the government policies and associated allocation, we proceed in two steps. We first derive the competitive equilibrium for given policies and then we study the determination of policies.

2.1 Economic Environment

Both types of agents maximize the expected lifetime utility

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t\log(c_t), \tag{1}$$

where c_t denotes consumption and $\beta \in (0,1)$ is the intertemporal discount factor. Each country is endowed with one unit of land, an international immobile asset traded at price $p_{j,t}$.

Entrepreneurs are individual owners of private firms, each producing output with technology

$$f(z_t, k_t, l_t) = (z_t k_t)^{\theta} l_t^{1-\theta},$$

where k_t is the input of land, l_t the input of labor supplied by workers, and $\theta \in (0,1)$. The variable z_t is an idiosyncratic productivity shock that is observed after the input of land. We assume that z_t is independently and identically distributed among agents and over time, and takes value in the set $\{z_1, ..., z_n\}$ with probabilities $\{\mu_1, ..., \mu_n\}$. There are not aggregate shocks.

Entrepreneur i in country j hires workers in a competitive labor market at wage $w_{j,t}$ and the profits are given by

$$\pi(z_{i,j,t}, k_{i,j,t}, l_{i,j,t}, w_{j,t}) = f(z_{i,j,t}, k_{i,j,t}, l_{i,j,t}) - w_{j,t} l_{i,j,t}.$$

The budget constraint is

$$c_{i,j,t} + p_{j,t}k_{i,j,t+1} + \frac{b_{i,j,t+1}}{R_{j,t}} = \pi(z_{i,j,t}, k_{i,j,t}, l_{i,j,t}, w_{j,t}) + p_{j,t}k_{i,j,t} + b_{i,j,t}, \quad (2)$$

where $b_{i,j,t}$ is the holding of riskless bonds with current unit price $1/R_{j,t}$.

Workers are endowed with one unit of time supplied inelastically in the domestic market (labor is internationally immobile). Their consumption in period t is financed by labor income and lump-sum government transfers, that is,

$$c^w_{j,t} = w_{j,t} + T_{j,t}. \quad (3)$$

For simplicity we assume that workers do not hold government bonds or borrow. This is without loss of generality. As we will see, since the equilibrium interest rate is smaller than the intertemporal discount rate ($R_{j,t} < 1/\beta$) and workers do not face uncertainty, they will not hold bonds in the long-run. The inability to borrow is justified by a limited enforcement argument, leading to an upper bound to the amount of borrowing. Again, since $R_{j,t} < 1/\beta$ and workers do not face uncertainty, in the long run they will borrow up to the limit which for simplicity we set to zero.

The government raises revenues by issuing one-period bonds. The proceeds are redistributed as lump-sum transfers to workers and used to pay outstanding debt. We assume that entrepreneurs do not receive lump-sum transfers because this would break the aggregation result that we derive below. However, we conjecture that the qualitative results of the paper should not be affected in important ways by this assumption. The government budget constraint is

$$T_{j,t} + B_{j,t} = \frac{B_{j,t+1}}{R_{j,t}}, \quad (4)$$

where $B_{j,t}$ are the bonds issued in the previous period and due in the current period t, and $B_{j,t+1}$ the new bonds.

2.2 Competitive Equilibrium

We consider two trading arrangements. In the first arrangement each country is under financial autarky, where riskless bonds cannot be traded in international markets. In the second arrangement countries are financially integrated, so the governments can sell bonds to (borrow from) domestic and foreign entrepreneurs.

The decision problem of workers is trivial because transfers are taken as given and the supply of labor is inelastic. Given the initial holdings of land

and bonds, entrepreneurs choose the input of labor, consumption and asset holdings (land and bonds) to maximize their lifetime utility. These choices will be a function of their individual states, that is, $s_{i,j,t} = (k_{i,j,t}, b_{i,j,t}, z_{i,j,t})$. A competitive equilibrium with given government policies is defined as:

Definition 2.1 (Autarkic competitive equilibrium) *Given a sequence of government debt* $\{B_{j,t+1}\}$*, a Competitive Equilibrium without mobility of capital is defined as a sequence of prices* $\{w_{j,t}, p_{j,t}, R_{j,t}\}$*, entrepreneurs' policies* $\{c_{i,j,t}(s_{i,j,t}), l_{i,j,t}(s_{i,j,t}), k_{i,j,t}(s_{i,j,t}), b_{i,j,t}(s_{i,j,t})\}$*, workers' consumption* $\{c^w_{j,t}\}$*, transfers* $\{T_{j,t}\}$ *for* $j \in \{1, 2\}$ *such that:*

i. Entrepreneurs choose $\{c_{i,j,t}(s_{i,j,t}), l_{i,j,t}(s_{i,j,t}), k_{i,j,t+1}(s_{i,j,t}), b_{i,j,t+1}(s_{i,j,t})\}$ *to maximize their utility (1) subject to the budget constraint (2). Workers' consumption* $\{c^w_t\}$ *satisfies the budget constraint (3).*

ii. Prices $\{w_{j,t}, p_{j,t}, R_{j,t}\}$ *clear the domestic markets for labor, land, and bonds,*

$$\int_i l_{i,j,t}(s_{i,j,t}) = 1,$$
$$\int_i k_{i,j,t+1}(s_{i,j,t}) = 1,$$
$$\int_i b_{i,j,t+1}(s_{i,j,t}) = B_{j,t+1}.$$

iii. Domestic bonds and transfers satisfy the budget constraint (4).

The definition of equilibrium in the globally integrated economy is similar, with the exception that the bond market clears internationally instead of country by country, that is,

$$\int_i b_{i,1,t+1}(s_{i,1,t}) + \int_i b_{i,2,t+1}(s_{i,2,t}) = B_{1,t+1} + B_{2,t+1}.$$

As a result, interest rates are equalized across countries, $R_{1,t} = R_{2,t} = R_t$.

2.3 Characterization of a competitive equilibrium

Entrepreneurs' labor decisions are independent of any dynamic considerations since they only affect current profits. Given the shock realization and the stock of land, the optimal labor demand and the level of profits are linear in $k_{i,j,t}$,

$$l_{i,j,t}(z_{i,j,t}, k_{i,j,t}, w_{j,t}) = \left(\frac{1-\theta}{w_{j,t}}\right)^{\frac{1}{\theta}} z_{i,j,t}k_{i,j,t}, \tag{5}$$

$$\pi(z_{i,j,t}, k_{i,j,t}, w_{j,t}) = A(z_{i,j,t}, w_{j,t})k_{i,j,t}, \tag{6}$$

where $A(z_{i,j,t}, w_{j,t}) = \theta \left(\frac{1-\theta}{w_{j,t}}\right)^{\frac{1-\theta}{\theta}} z_{i,j,t}$.

As in Angeletos (2007) we can prove that the decision rules are linear in beginning-of-period wealth $a_{i,j,t} = A(z_{i,j,t}, w_{j,t})k_{i,j,t} + p_{j,t}k_{i,j,t} + b_{i,j,t}$.

Lemma 2.1 *Given prices, the entrepreneur's consumption and asset holdings are linear in wealth $a_{i,j,t}$, that is,*

$$\begin{aligned} k_{i,j,t+1} &= \frac{\beta\phi_{j,t}}{p_{j,t}}a_{i,j,t}, \\ b_{i,j,t+1} &= R_{j,t}\beta(1-\phi_{j,t})a_{i,j,t}, \\ c_{i,j,t} &= (1-\beta)a_{i,j,t}, \end{aligned}$$

where $\phi_{j,t}$ satisfies $\mathbb{E}\left[\frac{R_{j,t}}{\left(\frac{A(z_{i,j,t+1}, w_{j,t+1})+p_{j,t+1}}{p_{j,t}}\right)\phi_{j,t}+R_{j,t}(1-\phi_{j,t})}\right] = 1.$

Proof 2.1 *Appendix A.1.*

Aggregating agents' decision rules using the lemma and imposing market clearing conditions we can establish our first result.

Proposition 2.1 *Given the sequences of government policies in both countries, $\{B_{1,t+1}, B_{2,t+1}\}_{t=0}^{\infty}$, the competitive equilibrium admits aggregation regardless of the trade arrangement. That is, prices and aggregate allocations* *are independent of the distribution of individual wealth and are given by*

$$w_{j,t} = (1-\theta)\bar{z}^{1-\theta}, \tag{7}$$

$$c^w_{j,t} = w_{j,t} + \frac{B_{j,t+1}}{R_{j,t}} - B_{j,t}, \tag{8}$$

$$\phi_{j,t} = \mathbb{E}\left[\frac{A(z_{i,j,t+1}) + p_{j,t+1}}{A(z_{i,j,t+1}) + p_{j,t+1} + D_{j,t+1}}\right], \tag{9}$$

$$p_{j,t} = \frac{\beta\phi_{j,t}[A(\bar{z}) + D_{j,t}]}{(1-\beta\phi_{j,t})}, \tag{10}$$

$$R_{j,t} = \frac{(1-\beta\phi_{j,t})D_{j,t+1}}{\beta(1-\phi_{j,t})[A(\bar{z}) + D_{j,t}]}, \tag{11}$$

$$c_{j,t} = \frac{1-\beta}{\beta}\left(p_{j,t} + \frac{D_{j,t+1}}{R_{j,t}}\right), \tag{12}$$

where $\bar{z} = \int_i z_{i,j}$, $A(z_{i,j,t}) = \theta\frac{z_{i,j,t}}{\bar{z}^{1-\theta}}$, $c_{j,t}$ *is aggregate entrepreneurs' consumption, and* $D_{j,t+1} = \int_i b_{i,j,t+1}(s_{i,j,t})$ *is the demand of bonds from entrepreneurs in country* j*. In the autarkic regime we have*

$$D_{j,t+1} = B_{j,t+1}, \quad \forall j. \tag{13}$$

In the regime with capital mobility the bond market clears worldwide

$$D_{1,t+1} + D_{2,t+1} = B_{1,t+1} + B_{2,t+1}, \tag{14}$$

and the interest rates are equalized worldwide, that is, $R_{1,t} = R_{2,t} = R_t$.

Condition (8) is obtained by replacing transfers from the government's budget constraint into the workers' consumption. Equation (9) determines the propensity to hold the risky asset (land) as a function of expected future returns, while equation (11) implicitly defines the domestic demand for risk-free bonds. Conditions (13) and (14) determine interest rates under each financial regime. With financial autarky, the supply and demand of government bonds must be equalized country by country. As a result, interest rates are not necessarily equalized across countries. With international financial mobility it is the global demand and supply of bonds that are equalized and the law of one price applies (single worldwide interest rate).

As evident from the expressions above, if the sequence of government policies were identical in both countries, that is, $B_{1,t} = B_{2,t}$ for all t, and in both regimes with and without mobility of capital, the autarkic and financially integrated equilibrium would coincide. This results from the symmetry of technology and preferences across countries. However, as we show next, the sequences of public debt under autarky will differ from those in the integrated economy once policies are chosen endogenously by each government. Therefore, the allocation in the autarkic equilibrium will be different from the allocation in the economy with integrated financial markets.

2.4 Determination of government policy

In this section we discuss how a government optimally chooses its supply of bonds and how this is affected by the process of financial integration. We start by analyzing the autarkic case.

2.4.1 Politico-economic equilibrium with financial autarky

We focus on Markov-Perfect equilibria where government policies are a function of the only aggregate state variable of the economy, the stock of public debt. We denote future variables with primes and drop the country subindex j to simplify notation. Let the equilibrium policy rule governing the supply of bonds be $\mathcal{B}(B)$. Each government selects the current period supply of bonds B' taking future policies as given, that is, it assumes that future policies are determined by the function $\mathcal{B}(B')$.

Before deriving how the political process aggregates preferences for B' (i.e. the government's objective function), it is useful to write agents' indirect utilities recursively. The next proposition establishes that entrepreneurs' welfare is independent of their individual land and bond holdings. The reason being that only the ratio between debt and land, $b_{i,t}/k_{i,t}$, matters. As shown in Lemma 2.1, this ratio coincides with the aggregate demand for bonds $D_t = \int_i b_{i,t}$ because the aggregate supply of land is 1. Moreover, since we are restricting the analysis to a closed economy, we have that $D_t = B_t$.

Proposition 2.2 *Given current policy B' and the policy rule $\mathcal{B}(B)$ determining future policies, we have:*

i. Prices are

$$R(B;B') = \frac{[1-\beta\phi(B')]B'}{\beta[1-\phi(B')][A(\bar{z})+B]}, \quad (15)$$

$$p(B;B') = \frac{\phi(B')B'}{[1-\phi(B')]R(B;B')}, \quad (16)$$

where $\phi(B) = \mathbb{E}\left[\frac{A(z)+p(B;\mathcal{B}(B))}{A(z)+p(B;\mathcal{B}(B))+B}\right]$.

ii. The indirect utility of an entrepreneur with productivity z is

$$\begin{aligned} V(B,z;B') &= \kappa + \frac{1}{1-\beta}\log\left[A(z)+B+p(B;B')\right] \quad (17) \\ &- \frac{\beta}{1-\beta}\log\left(\frac{p(B;B')}{\phi(B')}\right) + \beta\mathbb{E}V(B',z';\mathcal{B}(B')), \end{aligned}$$

where $\kappa = \log(1-\beta) + [\beta/(1-\beta)]\log\beta$.

iii. The indirect utility of workers is

$$W(B;B') = \log c^w(B;B') + \beta W(B';\mathcal{B}(B')), \quad (18)$$

where $c^w(B;B') = (1-\theta)\bar{z}^{1-\theta} + \frac{B'}{R(B;B')} - B$.

Proof 2.1 *Appendix A.2.*

As we can see from equations (17) and (18), public debt B' affects differently the welfare of entrepreneurs and workers. Therefore, they disagree on the optimal level of B'. The existence of risk-free bonds benefits entrepreneurs since it allows them to hedge against income risk, partially completing assets markets. Workers on the other hand trade-off the benefits of borrowing in an economy where the equilibrium interest rate is lower than the intertemporal discount rate, with the increasing repayment costs which will reduce future transfers from the government. When computing their most preferred value for B', every agent fully internalizes the impact that the issuance of debt has on the interest rate. The aggregate supply of government bonds will ultimately depend on how these preferences are aggregated.

In this model government policies are implemented by representatives who are elected through a democratic process. Consider an election between two opportunistic candidates that only care about being in power and have commitment to platforms. Under standard assumptions made in the probabilistic voting literature, political competition leads to convergence in policy proposals. As shown in Persson and Tabellini (2001), government policies maximize a weighted sum of agents' welfare. In our framework it will be a weighted sum of workers' and entrepreneurs' welfare with relative weight Φ assigned to workers. Therefore, the optimization problem solved by the government can be written as

$$\max_{B'} \left\{ (1-\Phi) \sum_{i=1}^{n} \mu_i V(B, z_i; B') + \Phi W(B; B') \right\},$$

where the indirect utilities $V(B, z_i; B')$ and $W(B; B')$ were derived in Proposition 2.2.

Because elections are held every period and candidates are identical, it must be the case that $B' = \mathcal{B}(B)$ in the politico-economic equilibrium. The government behaves de-facto as a benevolent planner (with a particular set of weights) who does not have a commitment technology to future policies. Since there is no distortionary taxation, the level of debt does not affect aggregate production. Thus, changes in the relative weight Φ do not generate efficiency losses but only redistributional consequences.[1]

We assume that countries are symmetric also in the political representation, that is, $\Phi_1 = \Phi_2$. From the maximization problem above it is clear that if both countries start with the same levels of public debt, they will choose the same future debt, inducing the same cross-country allocations.

2.4.2 Politico-economic equilibrium with financial integration

With capital mobility the relevant state space is augmented since the domestic supply and demand for government bonds are no necessarily equalized, that is, D_j may be different from B_j. Given the initial states and the prices, workers' consumption is only affected by the domestic supply of bonds B'_j while entrepreneurs' consumption depends on its domestic demand D'_j (recall eqs. (8) and (12)). In addition, the interest rate is now determined by the worldwide market clearing condition $D'_1 + D'_2 = B'_1 + B'_2$, implying

[1] If the government was financing transfers with distortionary taxes and the supply of labor was endogenous, the taxes would affect the demand and supply of labor and hence the level of production. In an earlier version of the paper we allowed for endogenous supply of labor and distortionary taxes. Since the effect of taxes on debt resulting from changes in the relative weights were not quantitatively important, we decided to abstract from distortionary taxes (and endogenous labor supply) to keep the model simple.

that agents in one country need to form expectations about the foreign demand and supply of bonds. This creates a strategic interaction between the government policies of the two countries.

We restrict attention to Nash equilibria where public borrowing decisions are made simultaneously and independently (i.e. there is no coordination among countries). The government in country 1 solves

$$\max_{B_1'} \left\{ (1-\Phi)\sum_{i=1}^{n} \mu_i V(z_i, D_1, B_1, B_2; B_1', B_2') + \Phi W(D_1, B_1, B_2; B_1', B_2') \right\},$$

where the indirect utilities are derived in a similar fashion as in the autarky regime. The sufficient set of state variables are D_1, B_1 and B_2. Once we know these three variables we also know $D_2 = B_1 + B_2 - D_1$. In choosing the next period debt B_1', the government of country 1 takes as given the debt chosen by country 2.

Because of the symmetry, if we start with $D_1 = D_2 = B_1 = B_2 = B$, in equilibrium we have $D_1' = D_2' = \frac{B_1'+B_2'}{2} \equiv B'$. The worldwide interest rate can then be derived from eq. (11) as

$$R = \frac{(1-\beta\phi)B'}{\beta(1-\phi)[A(\bar{z}) + B]}.$$

The main difference between this expression and equation (15) is that in the Nash equilibrium the world wide interest rate is perceived by country 1's decision maker as being less elastic to its own supply of bonds B_1'. This increases the incentive to issue more debt because the marginal increase in the repayment costs R is lower when B_2' is taken as given.

This channel is new in the literature. Most studies focus either on closed economy models or on open economies but with private debt. However, private issuers do not internalize the impact of their choices on the equilibrium interest rate since each individual agent is too small to affect aggregate prices. Furthermore, the changes induced by capital markets liberalization arise because countries are heterogeneous in some important dimension. In our framework, instead, countries are homogeneous and the impact of liberalization arises because the debt issuers—the governments—internalize the impact that their choices have on the equilibrium interest rate.

Because of the complexity of the model, we are unable to derive a closed-form solution where the properties described above can be established analytically. Therefore, we will characterize these properties numerically. Before proceeding to the quantitative exercise, however, it would be convenient to focus on a simplified version of the model with only two periods with which we can provide analytical intuition for the properties of the general model.

3 Two-period model

Suppose that the economy lasts only two periods. In the first period all entrepreneurs start with the same stock of land, $k_{i,j,1} = 1$, and they do not face idiosyncratic shocks, that is, $z_{i,j,1} = \bar{z}$. We further assume that they do not hold bonds, that is, $b_{i,j,1} = 0$. The entrepreneurs' wealth, including current production is $a = A(\bar{z})+p$, where $A(\bar{z}) = \theta\bar{z}^{\theta}$. They chose to allocate wealth between consumption and savings in the form of bonds, b_2, and land, k_2. The second period output, however, is stochastic since it depends on the realization of the idiosyncratic shock z_2. Therefore, the entrepreneurial wealth in the second period is $A(z_2) + b_2$, where $A(z_2) = \theta\frac{z_2}{\bar{z}^{1-\theta}}$ and z_2 is the idiosyncratic realization of the shock. Since this is the last period, land has no value and all wealth will be consumed. We first characterize the equilibrium in the autarky regime and then compare it to the environment with capital mobility.

3.1 Politico-economic equilibrium with autarky

To simplify notation ignore time subscripts and denote by k and b the individual land and the individual bonds purchased at time 1. Also, we denote by R and B the gross interest rate and the bonds issued by the government in period 1. Finally, the idiosyncratic shock realized in period 2 is denoted by z.

Since all entrepreneurs start with the same wealth a, they choose the same land k and the same bond b holdings. Therefore, consumption in the current period equals $c_1 = a - b/R - kp$. Because $a = A(\bar{z}) + p$ and in equilibrium $k = 1$ and $b = B$, current consumption is $c_1 = A(\bar{z}) - B/R$. Next period consumption depends on the realization of the shock and can be written as $c_2 = A(z) + B$. Therefore, entrepreneurs' utility is

$$V_c(B) = \ln\left(A(\bar{z}) - \frac{B}{R}\right) + \beta\mathbb{E}\ln\Big(A(z) + B\Big). \tag{19}$$

Workers receive constant wages $w = (1-\theta)\bar{z}^{\theta}$ in both periods. In addition they receive transfers from the government. The transfer received in period 1 is equal to government borrowing B/R. The transfer received in period 2 is equal to the repayment of the debt, $-B$. Therefore, the workers's consumptions are $c_1 = w + B/R$ and $c_2 = w - B$, and the utility is

$$W_c(B) = \ln\left(w + \frac{B}{R}\right) + \beta \ln(w - B). \tag{20}$$

To determine how the utilities of entrepreneurs and workers depend on government borrowing we also need to determine how B affects the interest rate which is determined by the following expression

$$R = \frac{[1 + \beta(1 - \phi(B))]B}{\beta(1 - \phi(B))A(\bar{z})}, \tag{21}$$

where $\phi(B) = \mathbb{E}\left(\frac{A(z)}{A(z)+B}\right)$.

Lemma 3.1 *In an autarky equilibrium we have that*

i. The indirect utility of entrepreneurs (19) is strictly increasing in B,

$$\frac{\partial V_c(B)}{\partial B} = \beta\left[\frac{(\epsilon_c - 1)(1 - \phi)}{B} + \phi\right] > 0,$$

where $\epsilon_c = \frac{\partial R}{\partial B}\frac{B}{R} = 1 + \frac{\phi_B B}{(1-\phi)(1-\beta\phi+\beta)} > 0$ is the interest rate elasticity.

ii. The indirect utility of workers (20) is strictly concave in B. The unique maximum is interior to the interval $[0, (1-\theta)\bar{z}^\theta]$ and satisfies

$$c_2^w = \beta \frac{R}{1 - \epsilon_c} c_1^w. \tag{22}$$

Proof 3.1 *Appendix A.3.*

Entrepreneurs always prefer higher debt since higher debt increases the equilibrium interest rate, and therefore, it reduces the cost of holding risk-free assets to insure against the idiosyncratic risk. Workers would like to borrow initially since the interest rate is lower than the intertemporal discount rate. In fact, as B converges to zero, the interest rate converges to $R < 1/\beta$. However, as the stock of debt raises, the interest rate increases and this discourages workers from borrowing through the government.

Given the properties of the indirect utilities, entrepreneurs and workers disagree on the optimal level of debt above a certain level. Based on probabilistic voting, the optimal level of debt is chosen to maximize a weighted sum of entrepreneurs and workers' utilities,

$$\max_B \left\{(1 - \Phi)V_c(B) + \Phi W_c(B)\right\},$$

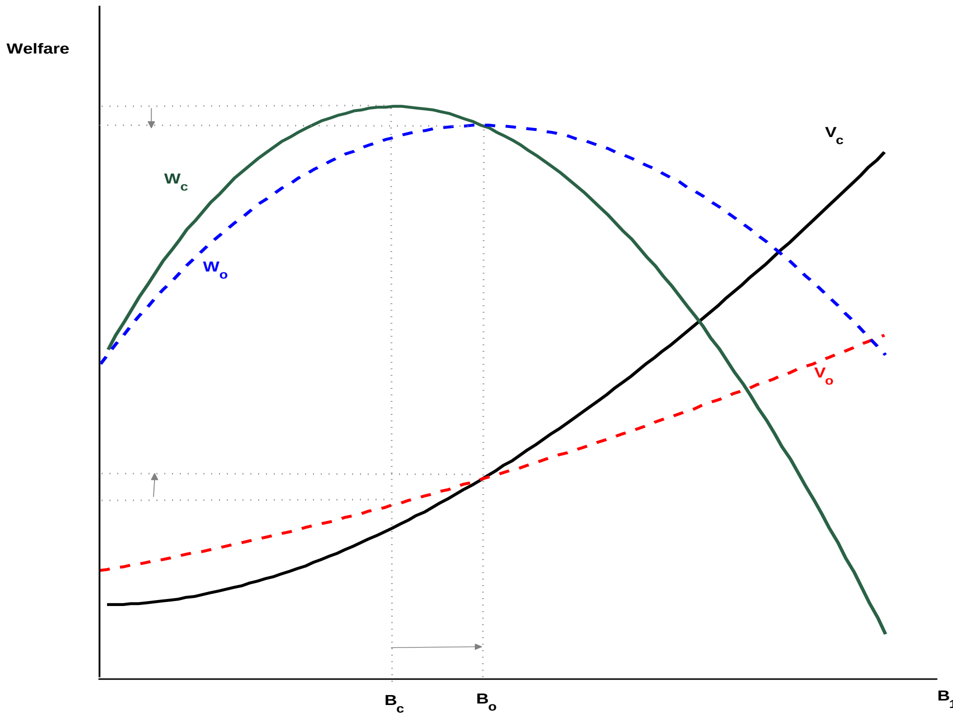

Figure 2: Public debt and financial liberalization in advanced economies.

where $V_c(B)$ and $W_c(B)$ are defined in (19) and (20).

Figure 2 depicts V_c (black solid line) and W_c (green solid line) under autarky for country 1. The actual level of debt observed in the politico equilibrium will depend on the weights that the government places on each type of agent. Societies where entrepreneurs' are more politically influential (i.e. Φ is small) would exhibit larger debt/GDP ratios than populist ones.

Since the function $W_c(B)$ converges to minus infinity as B converges to $(1-\theta)\bar{z}^{\theta}$, the optimal level of debt chosen by the government is bounded. Moreover, restricting the value of the weight assigned to entrepreneurs we can establish the following property of the government objective function.

Proposition 3.1 *If* $\Phi > 1 - \frac{\theta}{1+\beta}$*, the government's objective is strictly concave and there is a unique maximum interior to the interval* $[0, (1-\theta)\bar{z}^{\theta}]$.

Proof 3.1 *Appendix A.4.*

Two remarks are in order. First, the condition $\Phi > 1 - \frac{\theta}{1+\beta}$ is sufficient and not necessary for establishing the concavity of the government's objective. Therefore, it may be possible that the government's objective is still concave even if that condition is not satisfied. The second remark is that, even if the objective function of the government is not strictly concave, the maximum is still interior to the interval $[0, (1-\theta)\bar{z}^{\theta}]$ since the objective function is continuous. However in this case we can not establish uniqueness. Of course, for this simple model this can be checked numerically for any parameter values we wish to assign to the model as done in Figure 2.

3.2 Politico-economic equilibrium with mobility

Now consider the case in which there is capital mobility between two symmetric countries. We focus on a Nash equilibrium where governments choose their supply of bonds independently and simultaneously. When the economy is open, domestic entrepreneurs in country 1 can trade in foreign and domestic bonds and the domestic demands can be different from the supplies of domestic governments.

Proposition 3.2 summarizes the main differences between a closed economy and an economy where capital markets are integrated.

Proposition 3.2 *Consider $\Phi \simeq 1$. Relative to an autarkic equilibrium, a financially integrated economy exhibits*

i. larger government debt $B_o > B_c > 0$,

ii. higher interest rates $R_c < R_o < \beta$,

iii. lower welfare for workers $W_o(B_o) < W_c(B_c)$,

iv. larger welfare for entrepreneurs $V_o(B_o) > V_c(B_c)$.

The central finding is that governments issue more debt when the economy is financially integrated. The main intuition derives from the fact that the elasticity of the interest rate to one country debt is smaller relative to the autarkic case. When the government of country 1 chooses the optimal debt B_1 (or just B) taking as given the debt of country 2, B_2, it faces the world demand and the equilibrium condition is $D_1 + D_2 = B_1 + B_2$.

Moreover, since the problem we are solving is symmetric $D_1 = \frac{B+B_2}{2}$.

Therefore we can write the indirect utility of domestic entrepreneurs in the open economy as

$$V_o(B) = \ln\left(A(\bar{z}) - \frac{B + B_2}{2R_o}\right) + \beta\mathbb{E}\ln\left(A(z) + \frac{B + B_2}{2}\right), \tag{23}$$

with

$$R_o = \left(\frac{B + B_2}{2}\right)\frac{[1 + \beta(1 - \phi_o)]}{\beta(1 - \phi_o)A(\bar{z})}, \tag{24}$$

where $\phi_o = \mathbb{E}\left(\frac{A(z)}{A(z)+D_1}\right)$.

The properties of $V_o(B)$ are very similar to $V_c(B)$. Entrepreneurs still prefer higher levels of debt since higher debt increases the equilibrium interest rate, and therefore, it reduces the cost of holding risk-free assets to insure against the idiosyncratic risk. Now, however, the elasticity of the interest rate with respect to the issuance of domestic debt is lower. In particular, we have that $\epsilon_o = \frac{\epsilon_c}{2}$.

The indirect utility of domestic workers is still given by equation (20), but now evaluated at the new interest rate R_o. Let us denote this function by $W_o(B)$. Workers would like to borrow more since the interest rate increases more slowly when B increases ($\epsilon_o < \epsilon_c$), reducing the increase in the cost of borrowing and increasing the marginal benefit of domestic debt for workers.

Meanwhile the marginal benefit of domestic debt decreases for entrepreneurs in an open economy, since one can check that $\frac{\partial V_o(B)}{\partial B} = \frac{1}{2}\frac{\partial V_c(B)}{\partial B}$. This happens because now $\epsilon_o < \epsilon_c$, making entrepreneurs' return on the safe domestic bond increase more slowly than in the autarkic economy.

When $\Phi \simeq 1$ the government maximizes workers' utility at

$$c_2^w = \beta\frac{R}{1 - \frac{\epsilon_c}{2}}c_1^w$$

which takes exactly the same form as equation (22), but where the elasticity is reduced by half. In this case it is clear that $B_o > B_c$.

The dotted lines in Figure 2 illustrate the welfare of workers and entrepreneurs (V_o and W_o) in an open economy as a function of the domestic bond supply B_1 while keeping $B_2 = B_o$ fixed. Clearly W_c intersects W_o at the new equilibrium $B_1 = B_o$, since $W_c(B_o) = W_o(B_o)$ when $B_2 = B_o$ (and the same is true for entrepreneurs' welfare). Moreover, because $B_o > B_c$, the intersection occurs at a smaller value of W_c (consistent with point *iii* in Proposition 3.2), making workers worse off in the open economy. Entrepreneurs on the other hand, are better off since both the supply and the interest rate of the governments riskless bonds are higher than before.

To summarize, when the economy opens up each government perceives the interest rate as being less responsive (elastic) to its own debt. This reduces the cost of borrowing increasing the incentives to issue bonds. We conjecture that the larger the number of countries involved, the stronger the effect of financial integration on government debt.

4 Quantitative Analysis

In this section we solve the infinite horizon model numerically. The goal of the exercise is to provide a quantitative assessment of the importance of capital markets liberalization for the accumulation of public debt. Starting from a steady state equilibrium without mobility of capital, we assume that countries liberalize their foreign capital markets. Under the assumption that the international liberalization is not anticipated, we compute the transition dynamics to the new steady state. As we will see, the introduction of the new regime induces a gradual increase in government borrowing until the economy converges to a new steady state with higher worldwide stock of public debt. The numerical procedure used to solve the model is based on the discretization of the state space (the stocks of debt in the two countries). The details are described in the appendix.

4.1 Calibration

A period in the model is one year and the discount factor is set to $\beta = 0.95$. The parameter θ in the production function is set to 0.2 implying a capital income share of 20 percent. This is lower than the typical number used in the literature because in our model there is no depreciation. Therefore, θ represents the share of 'net' capital income in 'net' output.

Productivity is specified as

$$z_t = \bar{z} + \upsilon_t$$

where υ_t is uniformly distributed in the domain $[-5.5, 5.5]$ and $\bar{z}$ is the mean value normalized to 1. This parameterization implies a significant amount of risk, although one should think of risk in our model as entrepreneurial as opposed to aggregate risk. In particular, the maximum loss associated with the minimum value of z_t is about 30 percent the market value of land used in production.

The only remaining parameter to be calibrated is the political weight Φ assigned to workers. Starting from $\Phi = 1$, the steady state stock of public debt is inversely related to the workers' weight. We can then choose Φ to achieve the desired target for the stock of public debt. We choose the early 1980s as the initial calibration target since the a widespread view is that the process of international liberalization started in the 1980s and the pre-1980s period can be seen as closer to a regime of financial autarky. According to Figure 1, the stock of public debt in the OECD countries at the beginning of the 1980s was about 30 percent of GDP. Therefore, we choose Φ so that the steady state level of public debt in the autarky regime is 30 percent of output. This is obtained by setting the workers' weight to $\Phi = 0.855$. Notice that this value for Φ is smaller than the value obtained in Proposition 3.1 to assure the concavity of the government objective function in the two-period model. However, two points should be added here: on the one hand, the condition that $\Phi > 1 - \frac{\theta}{1+\beta}$ was sufficient but not necessary, and it was specific to the two-period case; and on the other hand, one can still check numerically that the government utility for the value of Φ used in the calibration is concave.

4.2 Results

Figure 3 plots the dynamics of public debt in response to capital markets liberalization (dashed line). We report only the debt for country 1 since the debt of country 2 follows the same path. We start from the steady state with financial autarky where the stock of public debt is about 30 percent of output. In year 1981 barriers to the mobility of capital are lifted and governments can borrow from domestic and foreign investors. Following the regime change, the stock of debt gradually increases and converges to a new level which is above 60 percent of output.

Figure 3 also reports the dynamics of public debt for the group of OECD countries, Europe and the United States. The empirical series are the same as those plotted in Figure 1. As can be seen, the path of public debt generated by the model (dashed line) is remarkably close to the dynamics observed in the data (continuous lines).

4.3 Public versus private debt

The issuance of government debt could be Pareto improving relative to an economy where government's budgets have to be balanced in every period. This is because entrepreneurs are willing to hold bonds even if they give a low return (lower than the intertemporal discount rate) in order to reduce the volatility of future consumption. Workers also gain since anticipating con-

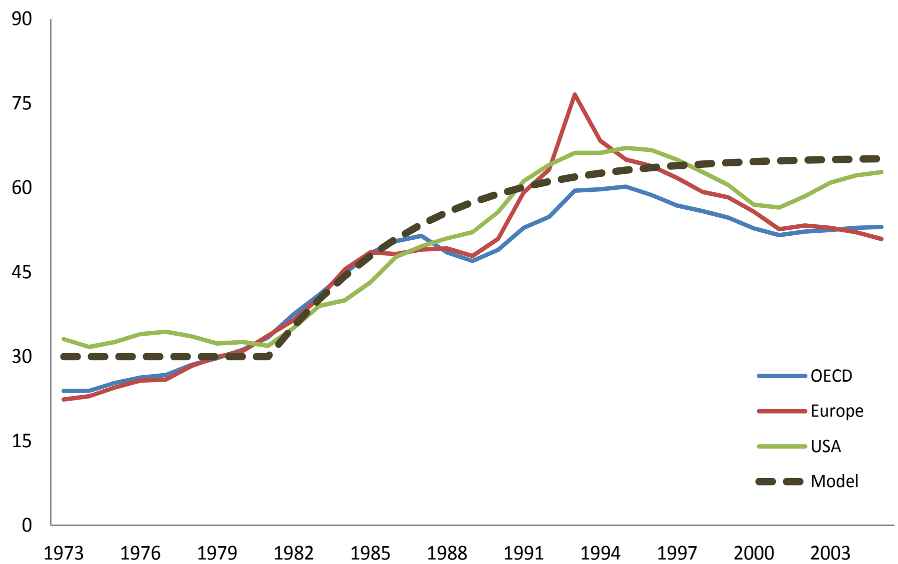

Figure 3: Dynamics of public debt: Data and Model.

sumption is cheap (the interest rate is lower than the intertemporal discount rate). Essentially, the losses from having a non-smooth path of consumption is more than compensated by the increase in lifetime consumption.

We would like to point out that this efficiency improvement could also be achieved with private bonds if we allow workers to borrow directly from entrepreneurs. This point has been made by Kocherlakota (2007). More specifically he shows that, under certain conditions, an economy with public debt can be replicated by an economy with private debt. In our environment however, the competitive equilibrium will be different from the equilibrium when the borrowing is chosen optimally by the government. This is because governments internalize the effect of introducing bonds on interest rates while individual agents take prices as given when they choose bond holdings. Even though this has implications for the relative share of bonds to risky assets in the economy, it creates no production inefficiencies (recall that production is $\bar{z}^{1-\theta}$, unaffected by policy). As a result, the distinction between public and private debt only implies movements along the Pareto frontier, where resources are redistributed from workers to entrepreneurs via interest rate manipulation as we decrease the value of Φ.

5 Conclusion

The stock of public debt has increased in most advanced economies during the last thirty years, a period also characterized by extensive liberalization of international capital markets. In this paper we study a two-country politico-economic model where the incentives of governments to borrow increase when financial markets become integrated. Through this mechanism we propose an explanation for the growing stocks of government debts observed in the data.

Even though we have focused on two symmetric countries—since our main goal was to explain the increase in public debt observed in developed countries—the model could be easily modified to study the effects of capital liberalization between developed and developing countries.

In fact, most of the existing literature has pursued this approach, since under a lack of a political economy mechanism as the one we introduced here, asymmetries of some sort are needed for capital liberalization to have any effect. In our model, the more populist governments commonly seen in developing countries could be represented by larger values of Φ in the government objective function. This extension (work in progress) will have implications not only on the total stock of debt, but also on capital flows across countries since developed economies will borrow from developing ones after financial liberalization occurs.

A Appendix

A.1 Proof of Lemma 2.1

Let's assume $k_{i,j,t+1} = \frac{\eta\phi_{j,t}}{p_{j,t}} a_{i,j,t}$, $d_{i,j,t+1} = R_{j,t}\eta(1-\phi_{j,t})a_{i,j,t}$, and $c_{i,j,t} = (1-\eta)a_{i,j,t}$.

Using these guesses, the law of motion for the next period wealth is

$$a_{i,j,t+1} = \eta\left[\left(\frac{A(z_{i,j,t+1}, w_{j,t+1}) + p_{j,t+1}}{p_{j,t}}\right)\phi_{j,t} + R_{j,t}(1-\phi_{j,t})\right] a_{i,j,t}.$$

The first order conditions for an entrepreneur are:

$$\begin{aligned}
\frac{\eta}{1-\eta} &= \beta\mathbb{E}\left\{\frac{R_{j,t}}{(1-\eta)\left[\left(\frac{A(z_{i,j,t+1},w_{j,t+1})+p_{j,t+1}}{p_{j,t}}\right)\phi_{j,t} + R_{j,t}(1-\phi_{j,t})\right]}\right\}, \\
\frac{\eta}{1-\eta} &= \beta\mathbb{E}\left\{\frac{\frac{A(z_{i,j,t+1},w_{j,t+1})+p_{j,t+1}}{p_{j,t}}}{(1-\eta)\left[\left(\frac{A(z_{i,j,t+1},w_{j,t+1})+p_{j,t+1}}{p_{j,t}}\right)\phi_{j,t} + R_{j,t}(1-\phi_{j,t})\right]}\right\}.
\end{aligned}$$

Multiplying these two conditions by $1-\phi_{j,t}$ and $\phi_{j,t}$ respectively and adding them we get:

$$\frac{\eta}{1-\eta} = \beta\mathbb{E}\left(\frac{1}{1-\eta}\right)$$

This condition is always satisfied when $\eta = \beta$. Using this result, the first optimality condition becomes $\mathbb{E}\left[\frac{R_{j,t}}{\left(\frac{A(z_{i,j,t+1},w_{j,t+1})+p_{j,t+1}}{p_{j,t}}\right)\phi_{j,t}+R_{j,t}(1-\phi_{j,t})}\right] = 1.$ *Q.E.D.*

A.2 Proof of Proposition 2.2

i. Price functions are directly computed from Proposition 2.1.

ii. From Lemma 2.1 (omitting i, j indexes),

$$\begin{aligned}
c &= (1-\beta)a, \\
k' &= \left(\frac{\beta\phi(B)}{p(B,B')}\right)a, \\
d' &= R(B,B')\beta(1-\phi(B))a.
\end{aligned}$$

The indirect utility of an entrepreneur can be written recursively as

$$V(k,d,z,B;B') = \log(c) + \beta\mathbb{E}V(k',d',z',B';\mathcal{B}(B'))$$

Substituting consumption $(1-\beta)a$ and using the definition of current wealth, $a = A(z,\tau)k + pk + d$, the value function becomes

$$V(k,d,z,B;B') = \log(1-\beta) + \log(k) + \log\left(A(z) + p(B,B') + \frac{d}{k}\right) +$$

$$\beta \mathbb{E} V(k',d',z',B';\mathcal{B}(B')),$$

which depends on d/k. Using the equilibrium conditions, $d/k = D/\bar{k} = B/\bar{k} = B$.

Subtracting $\frac{1}{1-\beta}\log(k)$ on both sides of the Bellman's equation, and adding and subtracting $\frac{\beta}{1-\beta}\mathbb{E}\log(k')$ in the right-hand-side, we have

$$\begin{aligned} \widetilde{V^e}(B,z;B') &= \log(1-\beta) + \log\left[A(z) + B + p(B;B')\right] \\ &+ \frac{\beta}{1-\beta}\log\left(\frac{k'}{k}\right) + \beta\mathbb{E}\widetilde{V^e}(B',z';\mathcal{B}(B')), \end{aligned} \tag{25}$$

where the new value function is 'normalized'

$$\widetilde{V^e}(B,z;B') = V^e(k,d,z,B;B') - \frac{1}{1-\beta}\log(k).$$

Noting that

$$\frac{k'}{k} = \frac{\beta p(B,B')}{\phi(B')}\left[A(z) + p(B,B') + B\right]$$

is independent of any individual state variable other than z, we can obtain expression (17) after some manipulations.

iii. The derivation of $V^w(B)$ is straightforward after replacing the government's budget constraint into workers' consumption.

Q.E.D.

A.3 Proof of Proposition 3.1

Let's first derive some preliminary properties. The function $\phi(B) = \mathbb{E}\frac{A(z)}{A(z)+B}$ satisfies

$$\begin{aligned} \frac{\partial \phi(B)}{\partial B} &= -\mathbb{E}\left[\frac{A(z)}{(A(z)+B)^2}\right] < 0 \\ \frac{\partial \phi(B)}{\partial B \partial B} &= \mathbb{E}\left[\frac{2(A(z)+B)A(z)}{(A(z)+B)^4}\right] > 0 \end{aligned}$$

We can now differentiate the indirect utility for entrepreneurs, equation (19), where the interest rate R has already been substituted for:

$$\frac{\partial V(B)}{\partial B} = \frac{\beta \phi'(B)}{1+\beta(1-\phi(B))} + \beta\mathbb{E}\left(\frac{1}{A(z)+B}\right) > 0,$$

where the inequality can be proved by showing that the first term, which is negative, is smaller in absolute value than the second term. To show this, consider these two terms separately. They satisfy

$$\begin{aligned}\frac{\beta\phi'(B)}{1+\beta(1-\phi(B))} &> \beta\phi'(B) = -\beta\mathbb{E}\left(\frac{A(z)}{A(z)+B}\right)^2\frac{1}{A(z)} \\ \beta\mathbb{E}\left(\frac{1}{A(z)+B}\right) &= \beta\mathbb{E}\left(\frac{A(z)}{A(z)+B}\right)\left(\frac{1}{A(z)}\right).\end{aligned}$$

The first inequality in the first equation comes from the fact that the left-hand-side term is negative and the denominator $1+\beta(1-\phi(B))$ is larger than 1. The last term is derived using the derivative of $\phi(B)$. The second equation is derived by multiplying and dividing by $A(z)$.

We can then go back to the derivative of the indirect utility,

$$\begin{aligned}\frac{\partial V(B)}{\partial B} &= \frac{\beta\phi'(B)}{1+\beta(1-\phi(B))}+\beta\mathbb{E}\left(\frac{1}{A(z)+B}\right) \\ &> -\beta\mathbb{E}\left(\frac{A(z)}{A(z)+B}\right)^2\frac{1}{A(z)}+\beta\mathbb{E}\left(\frac{A(z)}{A(z)+B}\right)\left(\frac{1}{A(z)}\right) \\ &= \beta\mathbb{E}\left[\left(\frac{A(z)}{A(z)+B}\right)-\left(\frac{A(z)}{A(z)+B}\right)^2\right]\left(\frac{1}{A(z)}\right) > 0,\end{aligned}$$

where the last inequality comes from the fact that $A(z)/(A(z)+B)$ is smaller than 1 for $B>0$. Therefore, we have established that the the entrepreneur's utility is strictly increasing for $B>0$.

Let's derive now the second derivative

$$\frac{\partial V(B)}{\partial B\partial B} = \frac{\beta\phi''(B)[1+\beta(1-\phi(B)]+\beta^2\phi'(B)^2}{[1+\beta(1-\phi(B))]^2}-\beta\mathbb{E}\left(\frac{1}{(A(z)+B)^2}\right).$$

Here we cannot establish a global sign for the second derivative. It is positive at $B=0$ and converges to to zero as B goes to infinity. Because the derivative computed above converges to zero as B converges to infinity, the indirect utility cannot be globally convex.

We move now to the indirect utility of workers, equation (20). For convenience we rewrite is as follows:

$$W(B)=\ln(C_1(B))+\beta\ln\Big(C_2(B)\Big),$$

where C_1 and C_2 are consumption in period 1 and 2 respectively and they are equal to

$$\begin{aligned}C_1(B) &= (1-\theta)\bar{z}^\theta+\frac{\beta(1-\phi(B))A(\bar{z})}{1+\beta(1-\phi(B))} \\ C_2(B) &= (1-\theta)\bar{z}^\theta-B\end{aligned}$$

Before continuing it will be convenient to establish some properties of consumption in period 1:

$$\frac{\partial C_1(B)}{\partial B} = -\frac{\beta\phi'(B)A(\bar{z})}{[1+\beta(1-\phi(B))]^2} > 0,$$

due to the sign of $\phi'(B)$. The second derivative reads:

$$\frac{\partial C_1(B)}{\partial B\partial B} = -\frac{\beta\phi''(B)A(\bar{z})(1+\beta(1-\phi(B))+2\beta^2\phi'(B)^2A(\bar{z})}{[1+\beta(1-\phi(B))]^3} < 0,$$

where the inequality derives from the sign of $\phi''(B)$.

We are now ready to derive the derivative of the indirect utility:

$$\frac{\partial W(B)}{\partial B} = \frac{\frac{\partial C_1(B)}{\partial B}}{C_1(B)} - \beta\frac{1}{C_2(B)}.$$

The derivative derives from the sum of two terms. The first term is positive while the second is negative. However, we can show that the derivative is positive at $B=0$ and converges to minus infinity as B converges to $(1-\theta)\bar{z}^\theta$ (since second period consumption for workers approaches zero).

Let's look now at the second derivative:

$$\frac{\partial W(B)}{\partial B\partial B} = \frac{C_1(B)\frac{\partial C_1(B)}{\partial B\partial B} - \left(\frac{\partial C_1(B)}{\partial B}\right)^2}{C_1(B)^2} - \beta\frac{1}{C_2(B)^2} < 0.$$

The inequality derives from the fact that the second derivative of $C_1(B)$ is negative as established above.

The elasticity of the interest rate with respect to the supply of bonds is

$$\epsilon = \frac{\partial R}{\partial B}\frac{B}{R} = 1 + \frac{\phi' B}{(1-\phi)(1-\beta\phi+\beta)}.$$

Since $\phi' < 0$, for ϵ to be positive, we need

$$|\phi' B| < (1-\phi)(1-\beta\phi+\beta)$$

Let us define $\hat{A} = \sum_i \mu_i A(z_i)$ and substitute it in ϕ and ϕ'. Since ϕ and $|\phi'|$ are convex in $A(z)$, $\phi \leq \hat{\phi}$ and $|\phi'| \leq \hat{\phi}'$.

Therefore, if we prove that

$$|\hat{\phi}' B| < (1-\hat{\phi})(1-\beta\hat{\phi}+\beta) \tag{26}$$

then

$$|\phi' B| < (1-\phi)(1-\beta\phi+\beta).$$

Substituting $\hat{A}$ in equation (26) we obtain that

$$|\hat{\phi}' B| = \frac{\hat{A}B}{(\hat{A}+B)^2} < \frac{\hat{A}B + (1-\beta)B^2}{(\hat{A}+B)^2} = (1-\hat{\phi})(1-\beta\hat{\phi}+\beta).$$

Q.E.D.

A.4 Proof of Proposition 3.1

We can write the government objective function $G(B) = (1 - \Phi)V(B) + \Phi W(B)$ as:

$$G(B) = (1-\Phi)\left(log(A(\bar{z})R - B) + \beta \mathbb{E} log(A(z) + B)\right) + \Phi \left(log(wR + B) + \beta log(w - B)\right) - logR.$$

Notice that for simplicity of notation, we are omitting the dependance of functions R and ϕ on B. Noting that after some algebra

$$A(\bar{z})R - B = \frac{B}{\beta(1-\phi)},$$

and

$$wR + B = \frac{B}{\beta(1-\phi)A(\bar{z})}[w[1 + \beta(1-\phi)] + \beta(1-\phi)A(\bar{z})].$$

Substituting and rearranging terms

$$G(B) = (1-\Phi)\beta \mathbb{E} log(A(z) + B) - log(1-\phi) + logB - logR$$
$$+\Phi \left(log(1 - \theta + \beta(1-\phi)) + \beta log(w - B)\right),$$

where constant terms has been omitted without consequences.
Now taking the first derivative of G(B) we obtain

$$\frac{\partial G(B)}{\partial B} = (1-\Phi)\mathbb{E}\left(\frac{1}{A(z) + B}\right) + \frac{\phi'}{1 + \beta(1-\phi)} - \Phi \frac{\partial \widetilde{W}(B)}{\partial B},$$

where

$$\frac{\partial \widetilde{W}(B)}{\partial B} = \frac{\phi'}{1 - \theta + \beta(1-\phi)} + \frac{1}{w - B}.$$

Taking the second derivative now

$$\frac{\partial G(B)}{\partial B \partial B} = (1-\Phi)\mathbb{E}\left(\frac{-1}{(A(z) + B)^2}\right) + \frac{\phi''[1 + \beta(1-\phi)] + \beta\phi'^2}{[1 + \beta(1-\phi)]^2}$$
$$-\Phi \frac{\partial \widetilde{W}(B)}{\partial B \partial B},$$

where

$$\frac{\partial \widetilde{W}(B)}{\partial B \partial B} = \frac{\phi''[1 - \theta + \beta(1-\phi)] + \beta\phi'^2}{[1 - \theta + \beta(1-\phi)]^2} + \frac{1}{(w - B)^2}.$$

Notice that all the terms are negative except $\frac{\phi''[1+\beta(1-\phi)]+\beta\phi'^2}{[1+\beta(1-\phi)]^2}$.
Working more in the algebra we can prove that if $\Phi \geq 1 - \frac{\theta}{1+\beta}$, then

$$\frac{\phi''[1+\beta(1-\phi)]+\beta\phi'^2}{[1+\beta(1-\phi)]^2} - \left(\frac{\phi''[1-\theta+\beta(1-\phi)]+\beta\phi'^2}{[1-\theta+\beta(1-\phi)]^2}\right) \leq 0,$$

and $\frac{\partial G(B)}{\partial B \partial B} < 0$.

Q.E.D.

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