Austerity Plans and Tax Evasion : Theory and Evidence from Greece

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PRELIMINARY DRAFT

Abstract

In countries with low financial development and weak tax monitoring, austerity plans may have dramatic recessionary effects and affect the degree of informality of the economy. We analyze the short-term effect of an austerity plan in a stylized model where firms face an arbitrage between access to credit and tax evasion. In our framework, a tax hike has a direct effect on the degree of tax evasion but also an indirect one through credit markets. A tax increase tightens the credit constraints of firms and depresses even further their incentives to be transparent. We calibrate the model to the austerity measures adopted in Greece in 2010 using a dataset of about 30000 firms. We show that the leakages in tax receipts due to tax evasion generate a lower than expected fiscal adjustment. The evidence show that the investment slack is the result of a contracting demand for credit by small and medium size firms magnified by tax evasion.

JEL Classification Codes: E44, O17, H26.

Key words: tax evasion, austerity plans, credit frictions.

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1. Introduction

Following the sovereign crisis in late 2009, Greece has plunged into a deep recession and a political crisis. In Greece and in other Southern European countries like Portugal, Italy and Spain, the response to the sovereign debt crisis has consisted in large fiscal adjustments in order to reduce immediate deficits and ultimately, get further from the threatening debt ceiling. These austerity plans were the key condition for having access to bail-out programs of international financial institutions (this was the case for the two financial packages delivered to Greece in 2010 and 2012).[1]

The argument that we develop in this paper is that a very high incidence of tax evasion threatens the viability of those austerity plans, particularly when they rely heavily on tax increases rather cuts in government spendings.[2] We consider that, in presence of imperfect tax enforcement, the decision to declare activity results from an arbitrage between improved access to credit and a lower tax burden. An austerity plan distorts this arbitrage through (i) an increased tax burden and (ii) lower gains from transparency. The behavioral response of the economy to raising tax rates has two components.[3] First, for a given level of transparency, a higher tax burden reduces future pledgeable cash flows and tightens credit constraints (taxes are senior to debt). Second, this direct effect may make the access to credit markets less profitable and disincentivize firms to be transparent. To understand the decomposition of these behavioral responses, consider the following accounting exercise. Denote τ the tax rate payed by firms on the reported value added $(1-\gamma)v$, where $(1-\gamma)$ is the share of declared value added v. Suppose that the government wants to generate a fiscal surplus through an increase of value added tax rate (VAT) and ultimately tax revenue dTR. The impact of this fiscal policy is :

$$dTR = \underbrace{(1-\gamma)vd\tau}_{dM} + \underbrace{(1-\gamma)\tau dv}_{dB} + \underbrace{\tau v d\gamma}_{dE}$$

We argue that the behavioral response (dB, dE) can alleviate half of the mechanical response

[1] In the long-term, austerity plans may build the basis for fiscal reforms favoring the debt sustainability and continued access to international credit markets.

[2] For many reasons (some of them political), over-indebted countries among the GIIPS like Portugal, Greece or Italy implemented fiscal reforms based mainly on tax increases rather than on cuts in government spendings.

[3] In addition, the marginal tax revenue generated by a marginal tax increase is low when the declared tax base is low. This mechanical consequence of tax evasion induces government of such countries to climb even further the Laffer curve to extract a surplus, exposing themselves to large behavioral responses.

dM. These estimations are in line with declarations from the greek authorities[4] and with the discrepancies between the targeted and actual tax revenues collected by the greek authorities during this period. For instance, Greece planned a fiscal adjustment of 6 points of GDP in 2010 (from 15.4 in 2009 to 9.4), decomposed into expenditure cuts (2.9 points of GDP) and an increase in tax revenue (3.1 points of GDP). Greek authorities increased VAT accordingly (from 9 to 11 percent for the basic rate and from 19 to 23 percent for the high rate) but only collected a surplus of 1.5 points of GDP. As a consequence, the decrease of primary fiscal deficit of 8% of GDP over the last two years has required the adoption of draconian fiscal measures leading to a very large GDP drop.

In this paper, we analyze theoretically and empirically the costs associated with austerity plans in a small open economy plagued by tax evasion. We explore the mechanisms sketched above in a simple model with heterogeneous credit-constrained firms and a passive government using VAT taxes as its only instrument of adjustment. In order to account for the entrepreneur's trade-off between credit and tax burden, we assume that the choice of transparency, i.e. the proportion of declared plants, determines both the tax receipts and the cash flows that can be pledged to investors. In our model, we will have two effects following a tax increase. First, some small firms will not find it profitable anymore to be transparent and get access to credit. The reason is that there is a modern technology that necessitates a fixed investment. When credit constraints tighten, small firms cannot borrow enough and make this fixed investment profitable. Their response is to hide their activity completely (extensive margin formal/informal). Second, medium-size firms will still find it profitable to have access to credit but they will need to loosen the constraints and be more transparent. We show that, under mild conditions on the distribution of firms (verified in the data), the first effect tends to be larger than the second one. The implication of our model is that the aggregate transparency of the economy decreases adding to the direct recessionary effect of higher taxes.

We then calibrate the model using a dataset (balance sheets) of 30'000 Greek firms and show how costly it is for the government to stabilize its debt burden as a function of institutional parameters, such as the protection of lenders and the tax monitoring. We provide a measure

[4]The Greek prime minister Lucas Papademos declared in an interview to *Il Sole 24 Ore* on March 30th 2012 that "the fight against tax evasion has yielded limited results partly because of the greater than previously forecast contraction of the economy".

of the performance of austerity plans through their direct and indirect effects : (i) direct losses from poor enforcement (the internal revenue service is unable to collect tax receipts), (ii) indirect effects through the distortion induced by taxes and the incentives of informality when financial development is low.

To our knowledge, this project is the first one which identifies the cost of an austerity plan in the presence of tax avoidance and threatening debt burden. Nonetheless, both the impact of default risk and the value of fiscal multipliers have been extensively studied. Among others, Romer and Romer (2010), Ilzetzki et al. (2010), Favero et al. (2011), Christiano et al. (2011), Auerbach and Gorodnichenko (2010), Alesina and Ardagna (2009) have tried to estimate a fiscal multiplier, some articles focusing on the identification of differences across countries, some other on how these multipliers might vary depending on the type of fiscal shock considered. On the default side, Gennaioli et al. (2011) and Sandleris (2010) have analyzed the impact of defaults or default risk on the domestic economy. Our paper borrows some features from the model of default developed in Bolton and Jeanne (2011). Finally, Mendoza and Yue (2011) and Arellano (2008) have studied the interaction between business cycles and sovereign defaults.

The paper is organized as follows: in section 2, we present some stylized facts on credit and tax reports in Greece that motivate the theoretical framework. In section 3, we introduce a model of transparency choice and credit access, where we detail the arbitrage faced by firms when declaring their activity. In section 4, we calibrate our model using the empirical evidence from Hellastat, and we conduct counterfactual exercices to assess the impact of tax evasion and credit market frictions on the effectiveness of austerity plans. Section 5 discusses some extensions of the basic analysis and concludes.

2. Motivation

The recent greek crisis has crystallized a lot of criticisms toward austerity plans and the organizations that promoted them, i.e. the European Union and the IMF. This reject of austerity policies has led to political crisis in affected countries. This political instability is the result of a strong antagonism between those being governed and those who govern. On the one hand, the governments, pressured by the IMF and the European Commission, implemented tax hikes and spending cuts in order to quickly resorb deficits. On the other hand, political parties arguing

that austerity is not adequate have gained a lot of attention and a sentiment grew on the idea that austerity measures were implemented as a punishment and not as a cure. In this paper, we analyze one channel through which austerity plans may prove inefficient (even as a way to reduce government deficits) and we think of Greece as the perfect guinea pig. To understand why this crisis is a good benchmark, let us describe quickly the course of events from 2000 to 2013.

A. The drastic austerity plan in Greece 2010

During the beginning of the 2000, Greece experienced a credit boom fostered by the Euro... At this time, there were already some concerns about (i) the flexibility of labor markets and (ii) the high indebtedness but they were attenuated by globally positive perspectives on output growth. In the aftermath of the global crisis of 2008, the spreads peaked and Greece was obliged to restructure its debt. A troika (European Commission, European Central Bank and International Monetary Fund) took over and imposed some conditions to the greek government for them to roll-over the greek debt.[5] under some conditions. The government had to resorb the deficit through the adoption of severe austerity plans.[6] The austerity plans and the resorption of deficit has been a more difficult process than expected because of constant mismatchs between the forecasts and the actual outcomes of each reform. In short, the effects on tax receipts were always over-estimated. This over-estimation came both from a larger drop than expected of GDP and a reduction of the tax base (independent of the degree of economic activity). The greek economy responded to the austerity plan by concealing more of its activity to the government. We detail in the following lines the amplitude of the misalignment.

The expected increase in tax revenues between 2009 and 2010 was estimated at 15.5%, of which 7.4% was actually realized. This shortfall was compensated by additional expenditures cuts: -9.5% instead of -5.3%.

Those readjustments point to behavioral responses as being very large. The measures to rebal-

[5] Cyprus, Ireland and Portugal also rescheduled their debt under the control of this troika.

[6] Francesco: I think that, indeed, it was impossible to devaluate but this measure is a bit orthogonal to the debt problem. Greece would have needed to reimburse the debt anyway. In addition, they would probably need to make the country competitive again. The question is more: do we ask for an effort now, or do we wait for the recovery? In the end, there are two adjustments: 1. a need for debt adjustment (austerity or recovery), 2. a structural reform of labor markets, competitivity...which may also be a way to foster the recovery.

ance the government account had very strong contracting effects. In 2010, Greece has experienced a GDP contraction of 4.5% explained by the fall of private consumption (contributing for -3.3%), the reduction of government consumption (-1.3%), a fall of investment (-3.1%, gross capital formation), partially compensated by a rebalancing of the external account. This contraction can be related to a reduction of leverage for firms, and a general tightening of credit constraints. In the following subsection, we analyze the evolution of leverage using the information from our database on Greek balance sheets.

B. Data and stylized facts

Our panel data consist in comprehensive balance sheet information over the period 2001-2011 from Greek firms publishing their accounts according to Greek law[7]. After dropping out firms at the bottom percentile, we are left with more than 20'000 firms per year (see figure 4).

To summarize, data in figures 1-6 show that :

- in the aftermath of the Greek sovereign debt crisis in 2009 there has been a global decrease of leverage (bank loans/total assets), that has been more pronounced for small firms (total assets below 10 M euro) than large firms (total assets above 10 M euro). Indeed the leverage for large firms slightly decreased after 2009.
- before 2009, the leverage was raising even for firms with negative profits, thus suggesting an overall expansion in credit as shown in the left panel of figure 3.
- taxes over total assets have been decreasing over the entire period as shown in figure 2. For both small and large firms, the tax ratio stopped its fall in 2010, when the first austerity plan has been implemented before decreasing again right after.
- the distribution of leverage before (2007) and after (2011) the Greek sovereign debt crisis and the adoption of austerity plans shows that there has been a shift of credit towards larger firms (cf. figure 5). For given firm size (in terms of total assets), in 2011 small firms with total assets ranging from 1 to 10 M euro had a leverage substantially lower

[7]Firms have to publish their balance sheets whether two of the following three criteria are fulfilled : (i) Turnover: 3 million, (ii) Total Assets: 1.5 million, (iii) Average staff: 50 people.

than the one the same firms had in 2007. We interpret this shift in the distribution of leverage as the key indicator that the credit crunch occurred for small and medium size firms more than for larger firms.

- as a consequence of the impressive recession after 2009, both the distributions of taxes over total assets (figure 6) and net income before taxes over total assets (figure 7) in 2011 lay below the same distributions in 2007. This shift in the distribution may encounter for the behavioral response (tax evasion driven) of the economy in addition to the mechanical response due to the recession.

3. A model of firm transparency and access to credit

The empirical evidence provided in the previous section point to an heterogenous effect of the austerity plan. The decrease in leverage is essentially borne by smaller firms, indicating more stringent credit constraints.

A. Environment

In this closed economy, there is a unit mass of entrepreneurs running firms. Entrepreneurs are heterogeneous in terms of their initial endowment w (denote $G(w)$ the wealth distribution of firms).

Each firm is organized in a unit mass of homogeneous plants. The plants or establishments are homogenous in the sense that entrepreneurs cannot use a different technology or a different investment across her plants. We assume however that entrepreneurs can choose the fraction of plants whose value added is concealed. Each plant is either fully declared or informal. Denote γ (transparency) the fraction of declared plants.

Firms produce final goods using capital as unique factor, which they borrow each period from a competitive financial intermediary sector. The entrepreneurs can have access to two technologies: a traditional one and a modern one. The access to the modern technology is conditional on an idiosyncratic draw (an *innovation*). With probability μ, the entrepreneur is granted access to the modern technology. She can pay a fixed cost c and produce with a Cobb-Douglas

function: $y = Ak^{\alpha}$. Otherwise, the traditional technology provide returns R and is available to all entrepreneurs.

The timing is the following. We assume that entrepreneurs choose first a level of transparency, which is going to jointly determine how much value added can be pledged to lenders and how much will be directly taxed by the government (without further monitoring). The entrepreneurs who have access to credit markets borrow capital k at the international interest rate $\underline{R}$. Then, entrepreneurs discover an innovation with probability μ and decide to use the modern technology (if available) or the traditional one. Once production has taken place, firms pay a tax rate τ on the reported value added, i.e. the value added generated by the declared establishments.

Tax authorities have access to an audit technology which allows them to detect an informal plant with probability z. In case of auditing, firms pay the tax $\theta\tau$ on the concealed value added. The punishment for being detected consists in the payment of an extra tax $\theta \geq 1$, which is set by the government. In order to get rid of idiosyncratic risk due to the random monitoring process, we assume that each establishment can be monitored with a random probability z by the tax police. The punishment implied by tax enforcement is then deterministic: a proportion of activities z is always audited. The total amount of taxes paid by firms is equal to the taxes on declared value added $\tau(1-\gamma)v$, and the amount $z\theta\tau\gamma v$ paid to tax authorities after controls.

Credit constraints arise from the imperfect pledgeability of firms' cash flows. We assume that creditors can only seize cash flows yield by production in transparent plants. In addition, taxes are senior to this recovery process. Consequently, entrepreneurs can only pledge a fraction λ of the future cash flows net of taxes and generated by their declared establishments.

Finally, since entrepreneurs may not have access to the modern technology, they can force reimbursment even in the worst case in which the entrepreneur could not benefit from an innovation.

$$\lambda\gamma(1-\tau)\underline{R}k \geq \underline{R}(k-\omega)$$

We will assume that the modern technology saving rate is equal to the international interest rate, i.e.

$$\underline{R} = R$$

B. Choice of tranparency

Absent credit frictions, entrepreneurs would conceal all their production and borrow such as to maximize $Ak^\alpha - Rk$. Denote $k^* = (A\alpha/R)^{\frac{1}{1-\alpha}}$ the unconstrained solution.

Another quantity will be important to determine the optimal choice of transparency. Denote $\bar{k}$ the minimal level of investment upon which entrepreneurs prefer to use their innovation, i.e. the smallest solution to the equation

$$Ak^\alpha - c = Rk$$

and define $\bar{\omega} = \bar{k}(1 - \lambda(1-\tau))$ the minimum endowment that allows agents to borrow up to $\bar{k}$. Those two quantities allow us to isolate tow zones in which the entrepreneur decision is simple. If $\omega < \bar{\omega}$, even a full transparency would not allow the entrepreneur to generate any surplus from borrowing. Accordingly, entrepreneurs would be better off concealing their activity and renege on any loan. If $\omega \geq k^*$, then the entrepreneurs will be able to levy the optimal without relying on external creditors. Consequently, they conceal all their establishments.

As regard firms whose endowments are between $\bar{\omega}$ and k^*, their program can be written as follows:

$$\max_{\gamma,k} \{(1 - \tau\gamma)\left[\mu(Ak^\alpha - c) + (1-\mu)Rk\right] - Rk\}$$

subject to

$$\lambda\gamma(1-\tau)k \geq (k - \omega)$$

Define $\hat{k}$ the solution to

$$\left(1 - \frac{\tau}{\lambda(1-\tau)}\frac{k-\omega}{k}\right)\left(\mu A\alpha k^{\alpha-1} + (1-\mu)R\right) - \frac{\tau\omega}{\lambda(1-\tau)k^2}\left[\mu(Ak^\alpha - c) + (1-\mu)Rk\right] = R$$

and $\hat{\gamma} = \frac{\hat{k}-\omega}{\lambda(1-\tau)\hat{k}}$ the associated transparency. Then, the solution can be written as:

$$\begin{cases} k = \min\{\frac{\omega}{1-\lambda(1-\tau)}, \hat{k}\} \\ \gamma = \min\{1, \hat{\gamma}\} \end{cases}$$

As a conclusion, in the framework with credit constraints, some firms are rationed: their net worth is not sufficient to reach k^*. They are obliged to be transparent and even so, they do not invest up to k^*.

C. Aggregate transparency and aggregate taxes

In parallel, their production is:

$$f(k) = \begin{cases} f(w) & \text{if } w < w_{min} \\ f(\bar{k}) & \text{if } w_{min} \leq w \leq \bar{k} \\ f(w) & \text{if } w > \bar{k} \end{cases}$$

The aggregate production of credit-rationed firms is $\int_0^{w_{min}} f(w)dG(w)$ but the government does not manage to levy any aggregate taxes on them. Aggregate production in the economy is

$$Y = \int_0^{w_{min}} f(w)dG(w) + f(\bar{k})[G(\bar{k}) - G(w_{min})] + \int_{\bar{k}}^{\infty} f(w)dG(w)$$

and aggregate tax base is

$$Y_\tau = \int_{w_{min}}^{\infty} (1-\gamma)f(\bar{k})dG(w) = \int_{w_{min}}^{\bar{k}} \frac{\underline{R}(\bar{k}-w)}{(1-\tau)\lambda} dG(w)$$

The derivative of the aggregate tax base with respect to λ is

$$\frac{\partial Y_\tau}{\partial \lambda} = -\int_{w_{min}}^{\bar{k}} \frac{\underline{R}(\bar{k}-w)}{(1-\tau)\lambda^2} dG(w) + \frac{g(w_{min})}{\lambda} f(\bar{k})(\bar{k}-w_{min})$$

$$= \frac{\underline{R}}{\lambda^2(1-\tau)} \left[-\int_{w_{min}}^{\bar{k}} (\bar{k}-w)dG(w) + g(w_{min})(\bar{k}-w_{min})^2 \right]$$

where the positive term is greater than the negative one under mild conditions.[8] The aggregate tax base is therefore increasing in the level of financial development and decreasing in the level of tax rates.

A higher level of financial development (or a lower level of taxation) generates two effects at the extensive and the intensive margins. First, some firms benefit from the higher financial development as they are now able to borrow and reach the capital threshold $\bar{k}$. These firms switch their transparency from 0 to 1 (or almost) in order to have access to credit. Second, firms that had access to credit are now less constrained and can afford to borrow up to the capital threshold $\bar{k}$ with a lower level of transparency.

[8] A sufficient condition is $g(w_{min}) > \frac{max_{[\bar{k},w_{min}]}\{g\}}{2}$, a condition which is verified as long the density of firm sizes is decreasing.

4. Empirical analysis

To be written

5. The Greek Austerity Plan

In this section, we calibrate the model to the Greek Austerity Plan implemented in 2010. We solve the model numerically and provide some numerical estimates for the response of the underground economy to the austerity plan and the output cost related to it.

Our calibration strategy is the following. We first want to compute the initial equilibrium of our economy, i.e. before the implementation of the austerity measures. To do so, we set the underlying parameters such as to match few moments. A concern is that we need to capture the degree of heterogeneity of firms in the economy, and in particular the joint distribution of their size and productivity.

Using the benchmark calibration, we then analyze the effect of changes in the tax rate. We run three different experiments :

1. **Actual outcome of austerity measures**

   We set $\tau = 0.23$ and we match the observed increase in tax receipts equal to 7.4%. As a consequence, we use the condition for firm transparency and the credit constraint to get the new level of transparency γ associated to the new tax rate.

2. **Government objective**

   We set the increase in tax receipts equal to 15.5%, that is equal to the government's objective when launching the austerity measures. We then use the condition for firm transparency and the credit constraint to get the new level of transparency γ and the new tax rate τ yielding the target increase in tax receipts.

3. **Counterfactual**

   In this case, we assume that the level of transparency is not affected by changes in the tax rate and stay fixed at its initial level. We then set the increase in tax receipts equal to 15.5%, that is equal to the government's objective when launching the austerity measures. Using the matched increase in tax receipts with the credit constraint, we get the new level of tax rate τ yielding the target increase in tax receipts.

To be completed ...

6. Discussion and extensions

In our model, we have focused on the transparency decision of firms, and we highlight that the negative effect of higher tax evasion is magnified by the large number of small and medium size firms in Greece. There are additional potential mechanisms at play in the simple framework we have depicted so far. These mechanisms pertain to the role of the government and the financial intermediary sector, that we explicitly model in Appendix B.

In the extended model, we show that the increased debt burden may depress credit through two channels, (i) a contraction of credit demand from firms, (ii) a credit crunch provoked by the fragilization of the domestic banking sector. Since the threat of default increases the interest rate on sovereign bonds, the value of the collateral held by banks depreciate and tighten the credit constraint of firms. This situation leads to lower transparency as less firms are granted the access to credit. There is then a third possible effect, which is related to the implementation of the austerity measures. Because of the leakages in tax receipts due to tax evasion, the austerity measures deliver a lower than expected fiscal adjustment. As a consequence, the markets do not believe in the capacity of the country to implement its fiscal adjustment and the risk premia on the sovereign bonds raise up. Since the financial sector is exposed to sovereign debt default, there could be a further valuation loss for the banking sector leading to a larger credit crunch and more tax evasion from the firms side which make the required fiscal adjustment more difficult to happen.

Quantitatively, the first effect (credit demand) dominates and is sufficient to generate an economic slack. This observation is in line with the aftermath of the 2010 crisis in Greece. The injection of capital in undercapitalized banks was programmed to offset the depreciation of collateral held by domestic banks and therefore promote access to credit. This injection of liquidity into the financial sector of a country implementing an austerity plan could counteract the incentive of firms to be less transparent. However, as illustrated in our model, this policy may be insufficient at fostering firms' credit demand. The issue of undercapitalisation of greek banks has indeed been rapidly tackled with large injections of capital ensured through the Hel-

lenic Financial Stability Fund (HFSF). It seems that this policy was only successful at saving some banks from liquidation but not at revitalizing credit. The investment slack is a result of a contracting demand, magnified by tax evasion.

The recapitalization of the financial sector avoids disruptive phenomena such as bank runs and the collapse of the credit market, but it is not the right measure to facilitate credit access of firms. In this respect, this measure does not provide the right incentives to firms to reduce tax evasion. In other words, it is not the credit supply which is binding (credit crunch) but it is rather the demand of credit which is binding.

References

Alesina, Alberto F. and Silvia Ardagna (2009), Large changes in fiscal policy: Taxes versus spending, Working Paper 15438, National Bureau of Economic Research.

Arellano, Cristina (2008), 'Default risk and income fluctuations in emerging economies', *American Economic Review* **98**(3), 690–712.

Auerbach, Alan J. and Yuriy Gorodnichenko (2010), Measuring the output responses to fiscal policy, Working Paper 16311, National Bureau of Economic Research.

Bolton, Patrick and Olivier Jeanne (2011), Sovereign default risk and bank fragility in financially integrated economies, Working Paper 16899, National Bureau of Economic Research.

Christiano, Lawrence, Martin Eichenbaum and Sergio Rebelo (2011), 'When is the government spending multiplier large?', *Journal of Political Economy* **119**(1), pp. 78–121.

Cuadra, Gabriel and Horacio Sapriza (2008), 'Sovereign default, interest rates and political uncertainty in emerging markets', *Journal of International Economics* **76**(1), 78–88.

Desai, Mihir A., Alexander Dyck and Luigi Zingales (2007), 'Theft and taxes', *Journal of Financial Economics* **84**(3), 591–623.

Favero, Carlo, Francesco Giavazzi and Jacopo Perego (2011), Country heterogeneity and the international evidence on the effects of fiscal policy, Working Paper 17272, National Bureau of Economic Research.

Gennaioli, Nicola, Alberto Martin and Stefano Rossi (2011), Sovereign default, domestic banks and financial institutions, Economics Working Papers 1170, Department of Economics and Business, Universitat Pompeu Fabra.

Ilzetzki, Ethan, Enrique G. Mendoza and Carlos A. Végh (2010), How big (small?) are fiscal multipliers?, Working Paper 16479, National Bureau of Economic Research.

Kleven, Henrik Jacobsen, Martin B. Knudsen, Claus Thustrup Kreiner, SÃ¸ren Pedersen and Emmanuel Saez (2011), 'Unwilling or unable to cheat? evidence from a tax audit experiment in denmark', *Econometrica* **79**(3).

Kwark, Noh-Sun (2002), 'Default risks, interest rate spreads, and business cycles: Explaining the interest rate spread as a leading indicator', *Journal of Economic Dynamics and Control* **26**(2), 271–302.

Longstaff, Francis A. (2011), 'How sovereign is sovereign credit risk?', *American Economic Journal: Macroeconomics* **3**(2), 75–103.

Mendoza, Enrique G. and Vivian Z. Yue (2011), A general equilibrium model of sovereign default and business cycles, Working Paper 17151, National Bureau of Economic Research.

Pan, Jun and Kenneth J. Singleton (2008), 'Default and recovery implicit in the term structure of sovereign cds spreads', *Journal of Finance* **63**(5), 2345–2384.

Romer, Christina D. and David H. Romer (2010), 'The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks', *American Economic Review* **100**(3), 763–801.

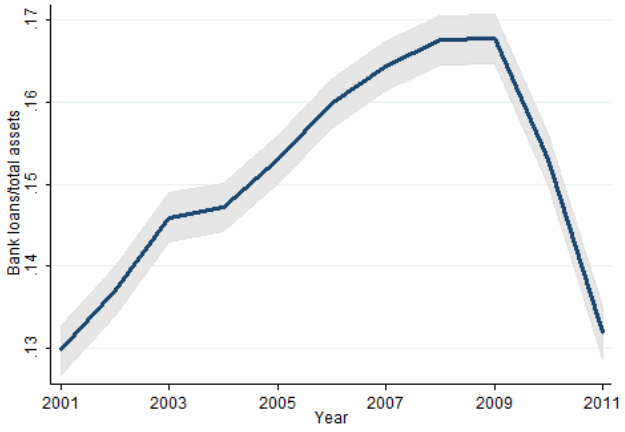
Sandleris, Guido (2010), Sovereign defaults, domestic credit market institutions and credit to the private sector, Technical report.

Slemrod, Joel and Shlomo Yitzhaki (2002), Tax avoidance, evasion, and administration, *in* A. J.Auerbach and M.Feldstein, eds, 'Handbook of Public Economics', Vol. 3 of *Handbook of Public Economics*, Elsevier, chapter 22, pp. 1423–1470.

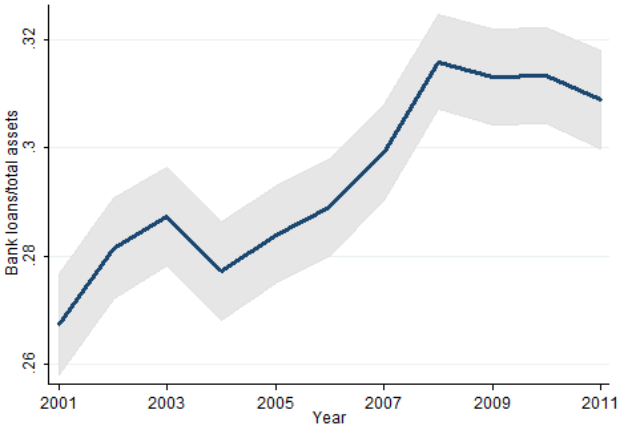
Yue, Vivian Z. (2010), 'Sovereign default and debt renegotiation', *Journal of International Economics* **80**(2), 176–187.

Figures and tables

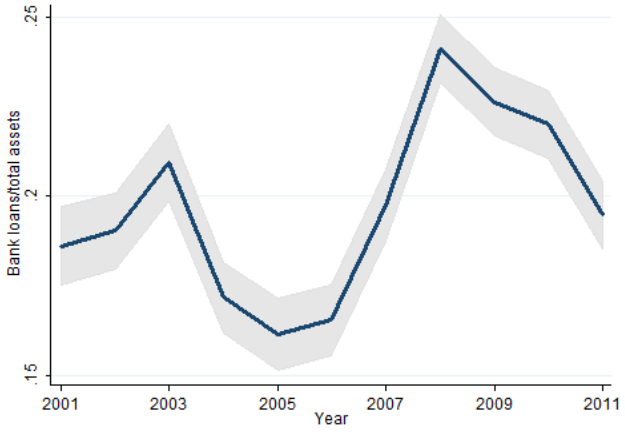
Figure 1: Evolution of bank loans over total assets, 2001-2011.



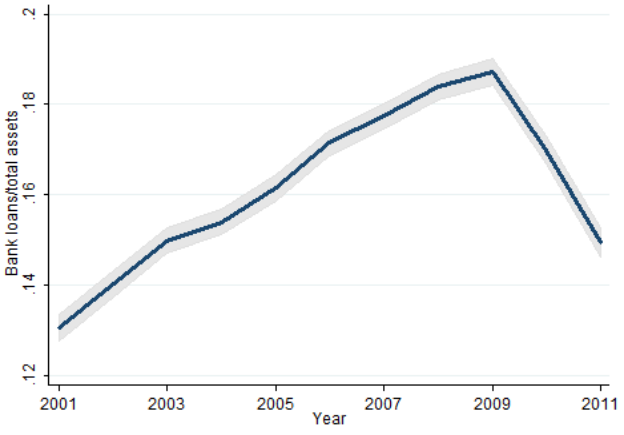
(a) Small firms, total assets less than 10 M euros



(b) Large firms, total assets more than 10 M euros



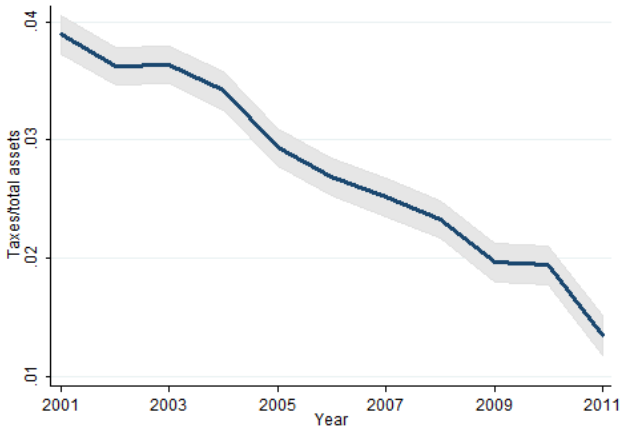
(c) Firms with negative profits



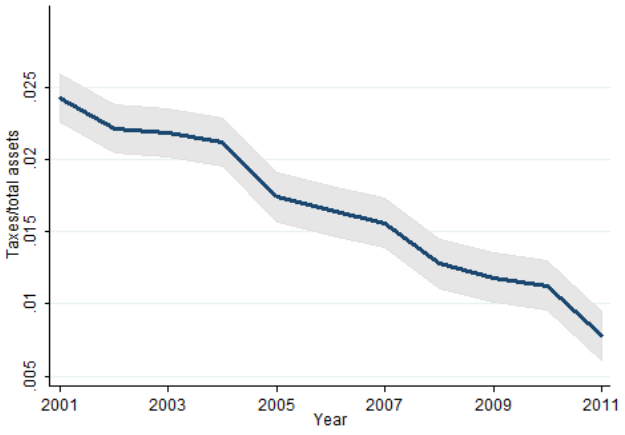
(d) Firms with positive profits

Source: Hellastat, 2001-2011. We use a panel estimation on the whole sample of firms (approximately 30'000 firms per year). The values reported in the figures above are the coefficients before the year dummies. We weight for the size of firms. Thus the evolution of each variable can be interpreted as its aggregate evolution. Shaded areas are 95% confidence intervals.

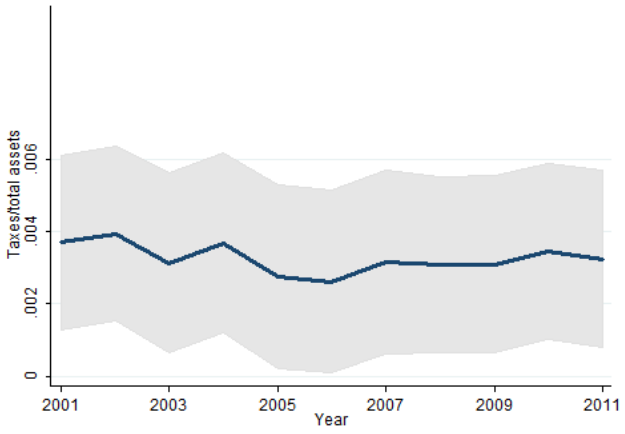
Figure 2: Evolution of taxes over total assets, 2001-2011.



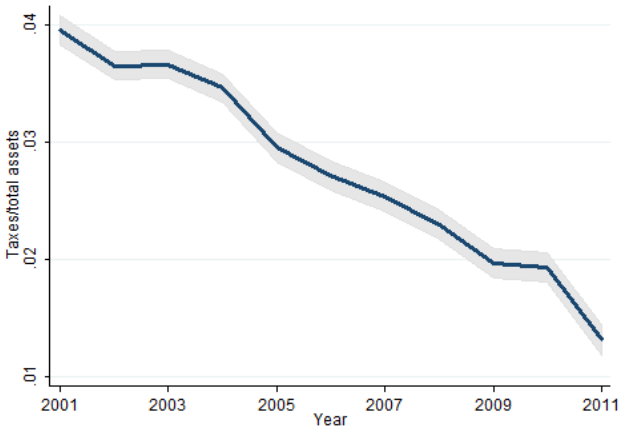
(a) Small firms, total assets less than 10 M euros



(b) Large firms, total assets more than 10 M euros



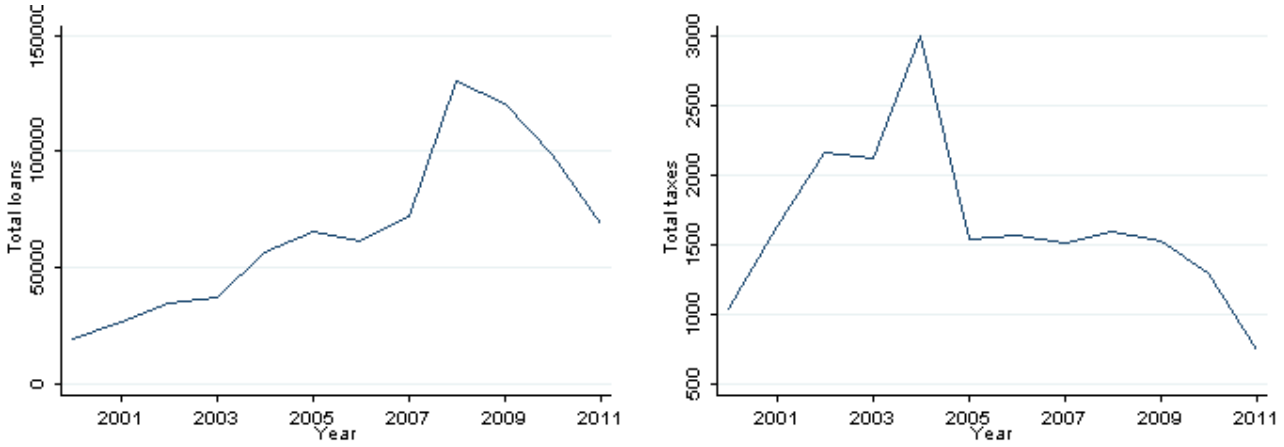
(c) Firms with negative profits



(d) Firms with positive profits

Source: Hellastat, 2001-2011. We use a panel estimation on the whole sample of firms (approximately 30'000 firms per year). The values reported in the figures above are the coefficients before the year dummies. We weight for the size of firms. Thus the evolution of each variable can be interpreted as its aggregate evolution. Shaded areas are 95% confidence intervals.

Figure 3: Total bank loans and taxes, 2001-2011.

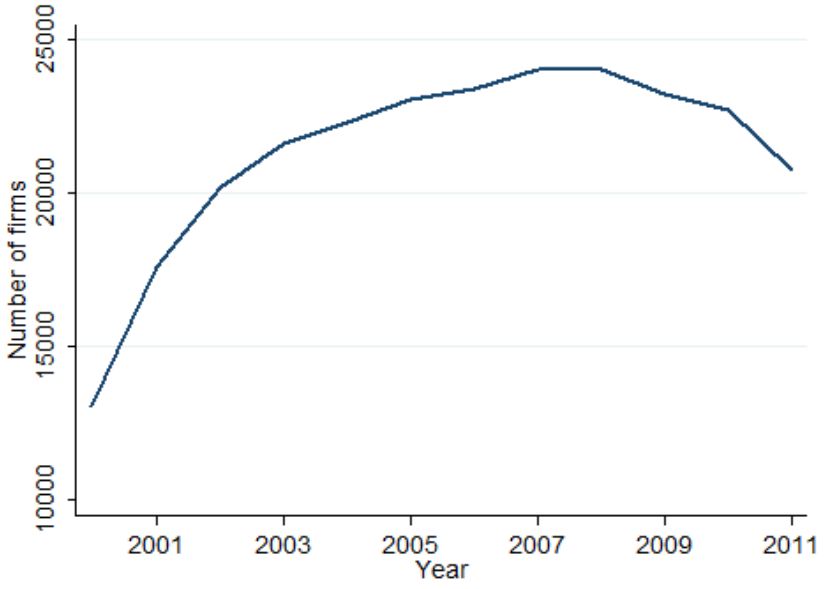


(a) Total loans (M euro)

(b) Total taxes (M euro)

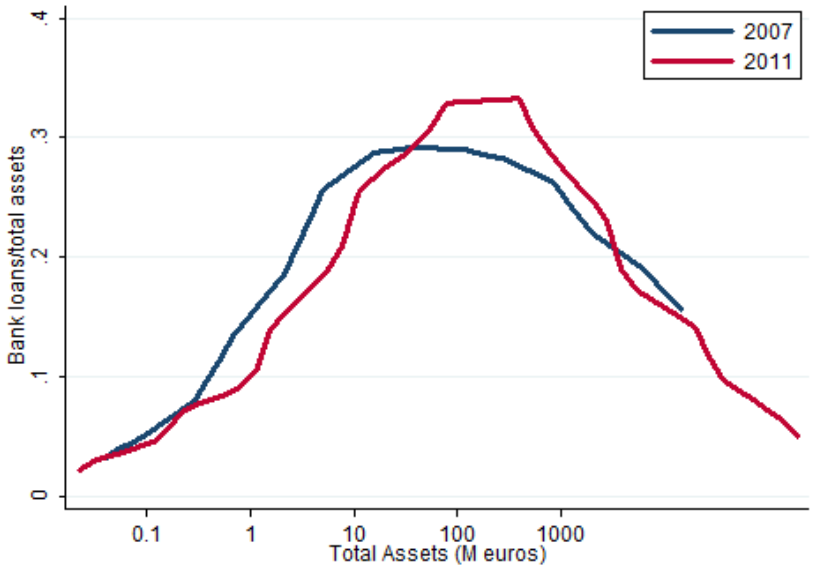
Source: Hellastat, 2001-2011. This graph displays the amount of total bank loans and total taxes paid by firms over the period 2001-2011. A tax reform on profit taxes has been introduced in 2004.

Figure 4: Number of firms, 2001-2011.



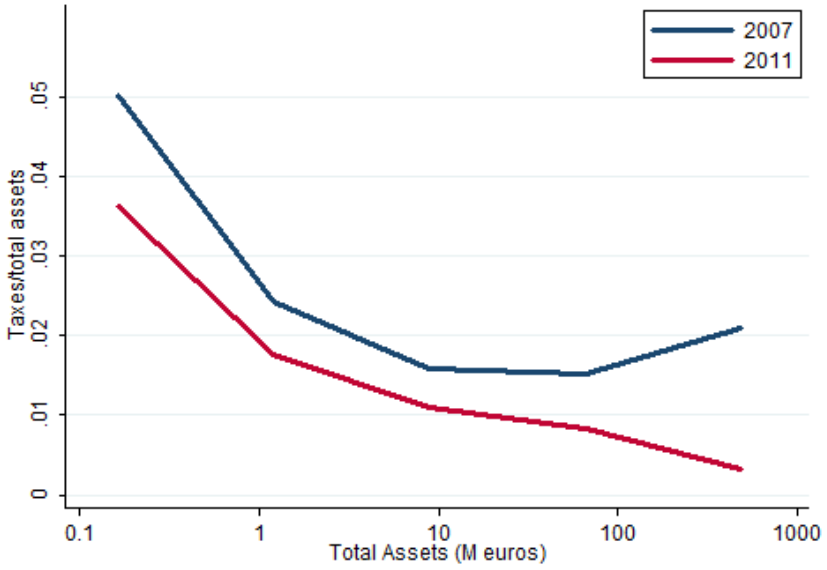
Source: Hellastat, 2001-2011. This graph reports the number of firms in the final database used.

Figure 5: Bank loans/Total assets and Total assets.



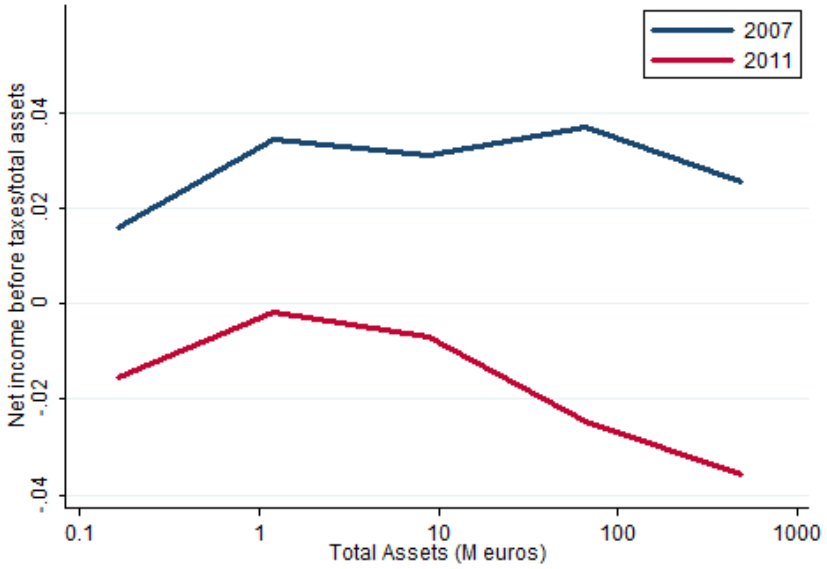
Source: Hellastat, 2001-2011. This graph displays the distribution of total bank loans over total assets before (2007) and after (2011) the austerity plan.

Figure 6: Taxes/Total assets and Total assets.



Source: Hellastat, 2001-2011. This graph displays the distribution of taxes over sales before (2007) and after (2011) the austerity plan.

Figure 7: Net income before taxes/Total assets and Total assets.



Source: Hellastat, 2001-2011. This graph displays the distribution of net income before taxes over sales before (2007) and after (2011) the austerity plan.

Figure 8: Ex-post production function

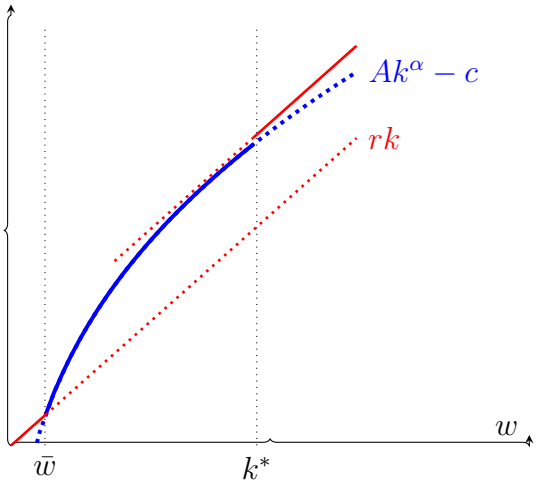
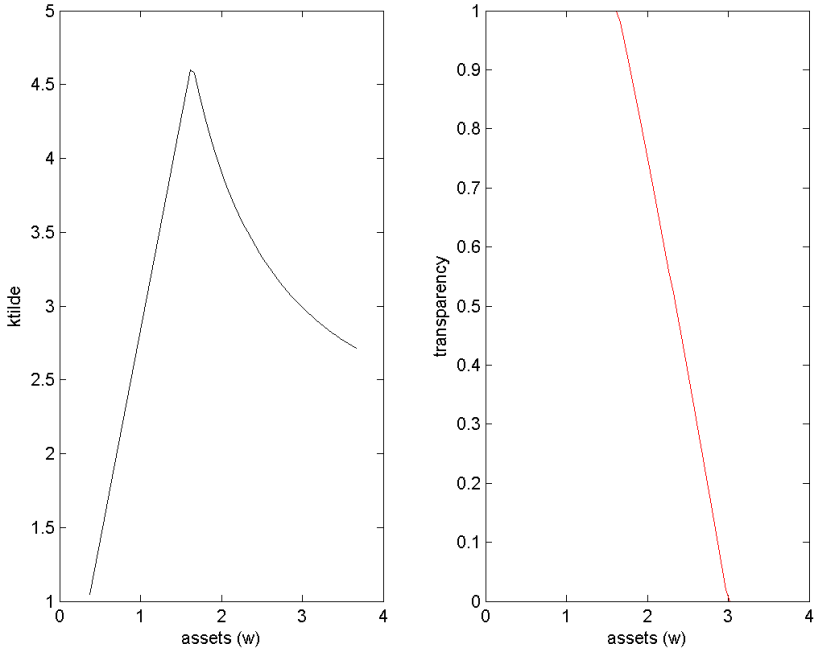


Figure 9: Optimal capital and transparency



Appendix

A Equilibrium

The following formula immediately derive from the theoretical framework:

$$S_{dom} = \int_{w^f_{min}}^{w_{min}} (\bar{k} - w) dG(w) = \bar{k} \left[(w^f_{min})^{-\psi} - w^{-\psi}_{min} \right] - \frac{\psi}{1-\psi} \left[w^{1-\psi}_{min} - (w^f_{min})^{1-\psi} \right]$$

$$S_{ext} = \int_{w_{min}}^{\bar{k}} (\bar{k} - w) dG(w) = \bar{k} \left[w^{-\psi}_{min} - \bar{k}^{-\psi} \right] - \frac{\psi}{1-\psi} \left[\bar{k}^{1-\psi} - w^{1-\psi}_{min} \right]$$

In addition,

$$w^f_{min} = \bar{k} - \frac{(1+\mu)\lambda(1-\tau)[\alpha\bar{k} + A]}{R}$$

$$w_{min} = \bar{k} - \frac{\lambda(1-\tau)[\alpha\bar{k} + A]}{\underline{R}}$$

where R and $\underline{R}$ account for the principal, i.e. are "equal to $1 + r$".

$$Y = \int_0^{w^f_{min}} f(w) dG(w) + f(\bar{k})[G(\bar{k}) - G(w^f_{min})] + \int_{\bar{k}}^{\infty} f(w) dG(w)$$

Which can be written as follows:

$$Y = \alpha \frac{\psi}{1-\psi} ((w^f_{min} - 1)^{1-\psi}) + (\alpha\bar{k} + A) \left[(w^f_{min})^{-\psi} - \bar{k}^{-\psi} \right] + Excess$$

B The model with the Government and the Financial intermediary sector

A. Government

The government issues debt B to finance government spendings $\bar{G}$ and collects tax revenues T in order to service its debt. We consider a framework where debt contracts are one-period contracts (the terms are renegotiated on a regular basis) and default risk is triggered by an exogenous shock. The government here is passive in the sense that default shocks are exogenous and there will be no strategic behaviors. In the no-default case, the government fully commits to (i) keep a fixed level of government spendings, (ii) fix taxes such as to ensure interest payments on the existing debt. In reality, decisions are related to the future access to markets and the vulnerability of the private sector to a sovereign default.

I. Uncertainty on default and timing of decisions

We are not interested in the impact of a sovereign debt default on financial intermediaries, but in the threat of default. We introduce in this section uncertainty on the future behavior of the government. The modeling of the timing of decisions is very close to Bolton and Jeanne (2011). We consider the following three stages:

1. Beginning of the period (stage 0). The government has a fixed expenditure $\bar{G}$ which is financed by issuing bonds B. There is an ex-ante probability π that at mid-period the government will default and pay a price 0 instead of $1 + s_0$ on the bonds issued.

2. Mid-period (stage 1). There is a signal on default, which yields a new probability of default π^c. The signal is known to everybody. If $\pi_c \neq \pi$, the government renegotiates its debt and issues new bonds which pay an interest rate s_1, according to the updated probability default π_c. The financial intermediary sector provides loans to firms and production takes place.

3. End of the period (stage 2). In case of no default, the government raises taxes such as to service its debt.

Henceforth, subscripts will denote the within-period stages.

II. Default vs. austerity plan decision.

The government austerity plan can be understood as a Taylor rule with full commitment. Accordingly, the government ensures that tax revenues are equal to debt service, with the VAT as the only adjustment variable. We consider the minimum plan which could ensure stability.[9] We assume that the auditing costs supported by tax authorities are included in government spendings. By assumption, $\bar{G}$ is fixed and represents the incompressible government spendings (as a share of GDP). Conditional on non-default, the government adopts an austerity plan by implementing the following Taylor fiscal rule:

$$T = (1 + s_1)B \tag{1}$$

We impose this simple rule to ensure that there is no room for strategic behaviors. Agents take this rule as given and act accordingly. The Taylor rule is designed such that the government is able to finance its given expenditure $\bar{G}$ by raising taxes equivalent to debt payment $(1 + s_1)B$. This is equivalent to saying that the government wants to generate a primary surplus equal to debt payment, or wants to keep the total amount of debt constant (avoiding a rollover on following periods).

B. Financial intermediary sector

In this closed economy, we will assume that domestic investors absorb completely the government bonds. Let us introduce a competitive intermediary financial sector. Banks collect deposits from households, purchase government bonds and supply loans to firms. Denote K the loans given by banks to the private sector, R the interest rate associated to these loans and $\bar{D}$ the deposits. Let us assume here that the amount of deposit is a fixed endowment. Banks keep a reserve of sovereign bonds as a liquidity buffer. In normal times, this reserve is constituted such as to guarantee deposits from households, while keeping an exposure to corporate defaults. Banks therefore pledge sovereign bonds and deposits to finance loans to firms.[10]

[9] We do not consider more stringent plan that the stabilization plan that we describe nor do we consider mixed plans where the ratio of debt over GDP continues to increase.

[10] There are several reasons to assume that this is the case. Among them, there are problems of information asymmetry, monitoring costs, increasing returns to scale, and risk diversification.

We will assume that the government issues two types of bonds of different maturities B_0^s, B_0^l at stage 0 with interest rate s_0^s, s_0^l respectively. The short-maturity bonds B_0^s mature at stage 1 and need to be rolled-over as the government does not generate any revenues before the last stage. Accordingly, bonds $B_1^s = (1 + s_0^s)B_0^s$ will be issued at stage 1 and we will denote s_1 the interest rate paid on it.

The financial intermediaries, henceforth called banks, hold assets (sovereign bonds and loans to firms S). At each stage, define N_0, N_1, N_2 the net worth of the bank, and D_0, D_1 the deposits from households. Those account respectively for equity and debt in the balance sheet of the bank. The asset side of the balance sheets will be composed of the bonds that are bought, and the projects that are financed. Denote π the ex-ante probability of a default at stage 2, and π^c the updated probability at the roll-over stage.

At stage 0, N_0 is given. Banks buy bonds $B_0^s + B_0^l = \bar{G}$, which pay the interest rate s_0^s, s_0^l in stages 1 and 2 respectively. Banks also collect deposits $D_0 = \bar{D}$ from households, which pay the exogenous rate r at each stage.

The balance sheet of banks is then:

$$B_0^s + B_0^l = N_0 + D_0$$

To put it simply, bonds have to be financed either with equity or debt. Potentially, there is also a capital requirement at this stage, i.e. bonds can not exceed a part of the equity capital of the firm N_0.

$$B_0^s + B_0^l \leq \chi N_0$$

We will assume however that at stage 0, even when the intermediaries absorb all the supply of bonds $B_0^s + B_0^l = \bar{G}$, the constraint does not bind, i.e. $\bar{G} < \chi N_0$.

The interest rate on sovereign bonds is thus determined such as to leave intermediaries indifferent between having debt or not.

$$(1 + s_0^l)(1 - \pi) = (1 + r) \quad 1 + s_0^s = (1 + r)$$

Let us compute the evolution of the equity capital under the assumption that there was no default before stage 1.

$$N_1 = (1 - \pi^c)(1 + s_0^l)B_0^l + (1 + s_0^s)B_0^s - (1 + r)D_0$$

After replacing by the balance sheet constraint, comes immediately

$$N_1 = (s_0^s - r)B_0^s + \left[(1-\pi^c)(1+s_0^l) - (1+r)\right] B_0^l + (1+r)N_0$$

Now, focus on stage 1. At stage 1, firms take deposits D_1 from households, rollover the bonds $B_1^s = (1+s_0)B_0^s$ (which pay the interest rate s_1 at the end of the period), and supply loans S (at the interest rate R). Banks commit to pay a non-contingent interest rate r on deposits D_1 at the end of the period. The balance sheet of banks at stage 1 is therefore :

$$B_1^s + B_0^l + S = N_1 + D_1$$

where N_1 is determined by the equation shown above. In addition, there is a capital requirement which imposes that banks' assets should not exceed a given fraction of their equity capital:

$$B_1^s + B_0^l + S \leq \chi N_1$$

At this stage, banks decide on the allocation between B_1^s and S of their assets by maximizing the expected equity capital in the last stage. The expected evolution of the equity capital of banks is the following:

$$N_2 = (1+R)S + (1-\pi^c)\left[(1+s_1)B_1^s + (1+s_0^l)B_0^l\right] - (1+r)D_1$$

As before, the equity capital evolves as there are returns on assets but deposits should also be paid. Plugging the balance sheet in this equation, we find that:

$$N_2 = (R-r)S + [(1-\pi^c)(1+s_1) - (1+r)]B_1^s + [(1-\pi^c)(1+s_0^l) - (1+r)]B_0^l + (1+r)N_1$$

The objective of banks is thus:

$$\max_{S,B_1^s}\{(R-r)S + [(1-\pi^c)(1+s_1) - (1+r)]B_1^s + [(1-\pi^c)(1+s_0^l) - (1+r)]B_0^l + (1+r)N_1\}$$

$$\text{s.t.} \quad B_1^s + B_0^l + S \leq \chi N_1$$

which gives a simple no-arbitrage condition between bonds and loans:

$$(1+R) = (1-\pi^c)(1+s_1)$$

The level of exposure depends on the value of R. When $R > r$ banks lend as much as they can and hit the capital requirement ceiling $B_1^s + B_0^l + S \leq \chi N_1$. If $R < r$, $S = B = 0$ as intermediaries

are unable to make any profit. Financial intermediaries are indifferent when $R = r$. In order to close the model, we just need to determine the supply of bonds $B_1^s = (1 + s_0^s)B_0^s$ and the demand of loans $K^d(R)$, which is determined by the firm optimization.

A positive shock on the probability of default intra-period ($\pi^c > \pi$) affects the balance sheet of the bank as its equity capital suffers from this revision. Accordingly, in addition to the upward adjustment of the interest rate on sovereign bonds and the increase in the service of debt, the capital requirement may change, leading to a shortage in the supply of loans.

C. Equilibrium in the model with Government and Financial intermediary sector

We are now able to compute the static competitive equilibrium of this economy. The equilibrium will be characterized by three conditions. First, (k, γ) is the solution of the firm maximization. Second, taxes are fixed following the Taylor fiscal rule. Third, the credit and sovereign bond markets clear.

Given the no-arbitrage condition at stage 0 : $(1 + s_0)(1 - \pi) = (1 + R)$, and the supply of government bonds at stage 0 : $B_0^s = \bar{G}$, the following four equations jointly determine Y, Y_τ, τ, R:

Aggregate production : $$Y = \int_0^{w_{min}^f} f(w)dG(w) + f(\bar{k})[G(\bar{k}) - G(w_{min}^f)] + \int_{\bar{k}}^{\infty} f(w)dG(w)$$

Aggregate tax base : $$Y_\tau = \frac{RS}{(1-\tau)\lambda(1+\mu)} + \int_{w_{min}}^{\bar{k}} \frac{R(\bar{k}-w)}{(1-\tau)\lambda} dG(w)$$

Credit market clearing condition : $$S = \int_{w_{min}^f}^{w_{min}} (\bar{k} - w)dG(w)$$

Taylor fiscal rule : $$\tau Y_\tau + z\theta\tau(Y - Y_\tau) = (1 + s_1)B_1$$

A shock on π^c induces a larger interest rate on sovereign bonds (no-arbitrage condition at stage 1). As a consequence, the government automatically increases taxes according to the Taylor fiscal rule. The increase in tax rates affects the decision of firms to hide their plants (firm transparency) and the overall demand of loans decreases. Both effects fuel again in the Taylor fiscal rule and induces the government to increase τ even further.