

# Secondary Markets in Turbulent Times: Distortions, Disruptions and Bailouts

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VERY PRELIMINARY AND INCOMPLETE

## Abstract

Countries in the Euro periphery have gone from zero sovereign spreads and healthy economic growth in 2006 to sovereign debt problems and deep recessions by 2010. This has been accompanied by a transfer of sovereign debts from foreigners to domestic residents and a shift in domestic portfolios from credit to firms and consumers to credit to the public sector. In this paper, we propose a growth model with sovereign debts in the presence of secondary markets that accounts for these observations. The model displays self-fulfilling rollover crises: if foreigners start worrying about default they sell sovereign debts to domestic residents; this crowds out investment and lowers growth; this reduces the cost of default and increases its probability, validating foreigners' fears. The maturity structure of sovereign debts is irrelevant, as secondary markets allow the reallocation of both maturing and non-maturing debts. In other words, secondary markets make long-term debts effectively short-term with regards to the existence of rollover crises.

*Keywords:* sovereign debt, rollover crises, secondary markets, economic growth.

*JEL Classification:* F32, F34, F36, F41, F43, F44, F65, G15

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In 2006 the economies of Portugal, Ireland, Italy, Greece, and Spain were growing fast (3.7% on average versus 2.8% in Germany and France), their fiscal deficits were low (1.8% of GDP on average versus 2.0% in Germany and France), their sovereign spreads were close to zero (0.15% on average), their public debts were not particularly large (77.3% of GDP on average versus 70.5% in Germany and France), and the maturity of their public debts was long (6.4 years on average versus 6.7 years in Germany and France).<sup>1</sup> By 2010 all five so called PIIGS economies were facing major sovereign debt problems and in the midst of deep recessions. What happened?

[FIGURE 1 WITH SOVEREIGN SPREADS]

One explanation is that these economies had serious vulnerabilities that had been ignored by market participants. The fiscal situation in Greece was worse than people understood at the time. Italy and Portugal had sclerotic economies that had been growing slowly for a long time. Spain and Ireland had large real estate bubbles and banking systems heavily exposed to them. These factors are surely important, but they seem too much like ex-post rationalizations. If they are so obvious ex-post, why had they been ignored for so long? Another type of explanation emphasizes multiple equilibria in sovereign debt markets. The standard story is as follows. Consider a government that would be willing to repay its debts slowly over time, but not at the high speed at which debts are maturing. In this case, a refusal by foreigners to rollover maturing debts could lead to a self-fulfilling default.<sup>2</sup> One problem with this story is that the maturity of sovereign debts in PIIGS countries was long. This, together with the existence of emergency funding from various official creditors, should have made these countries somewhat immune to this type of roll-over crisis.

In this paper we propose a novel and complementary explanation for the crisis. Although it also emphasizes self-fulfilling crises in sovereign debt markets, the nature of the multiplicity of equilibria is very different from that in existing models. We propose a model with three crucial ingredients: (i) governments sometimes discriminate ex-post in favor of domestic residents; (ii) the cost of default depends on the size of the economy; and (iii) secondary markets prevent governments from controlling the transfer of sovereign debts between foreigners and domestic residents. A crisis starts with a sudden worsening of expectations regarding the probability of debt repayment. This reduces foreigners' demand for domestic sovereign debt. Domestic residents are willing to purchase the debt as they are more likely to be repaid. This crowds out domestic investment and leads to

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<sup>1</sup>Of course, there was more heterogeneity among PIIGS economies than this description suggests. In particular, Portugal and Italy were growing more slowly, Portugal and Greece had larger deficits, and Italy and Greece had larger public debts.

<sup>2</sup>See Calvo (1988), Cole and Kehoe (2000), and Aguiar et al. (2013).

lower growth. In turn, the lower growth reduces the cost of default on foreigners and makes default more likely. This validates the pessimistic expectations.

Secondary markets play an important role in the mechanism we propose. The existence of well functioning secondary markets at the time sovereign debts mature increases the probability that foreigners will be repaid. This is because if foreigners fear that they will be defaulted on they have the option of reselling sovereign debts to domestic residents in secondary markets.<sup>3</sup> But this means that governments might try to prevent domestic purchases of sovereign debt, for example by imposing capital controls right before defaulting. If foreigners expect this to happen, they might want to liquidate their holdings of domestic sovereign debt before maturity. The existence of secondary markets before debts mature helps the transfer of sovereign debts from foreigners to domestic residents and might actually make default more likely. This happens regardless of debt maturity. If sovereign debts are short term, secondary markets make it difficult to segment domestic and foreign creditors. In particular, even if governments are willing to pay a higher interest rate so that foreigners buy their debts in primary markets, governments cannot force foreigners to hold on to their debts. If sovereign debts are long term, secondary markets allow foreigners to sell to domestic residents all debts, even those that mature well in the future. In other words, secondary markets make long-term debts effectively short-term with regards to the existence of liquidity or rollover crises.<sup>4,5</sup>

The mechanism we propose is consistent with several characteristics of the sovereign debt crises in PIIGS countries. First, at the time sovereign spreads started increasing in each of the PIIGS countries sovereign bonds started being transferred from foreigners to domestic residents.<sup>6</sup> Existing models of self-fulfilling debt crises do not make any predictions regarding trading in secondary mar-

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<sup>3</sup>This result is emphasized in Broner et al. (2010), who show that when secondary markets work well their presence improves repayment. In this paper we show that when governments can strategically shut down secondary markets their presence can actually make default more likely.

<sup>4</sup>In the absence of frictions, the trade that is required to maximize repayment takes place at maturity and thus does not interfere with other functions of financial markets. In the presence of frictions, this trade might take place earlier and lead to distortions. The reason is that the allocation of bonds that maximizes repayment does not in general coincide with the allocation of bonds that maximizes the efficiency of investment.

<sup>5</sup>BAILOUTS (to be written): Trading sovereign debts in secondary markets can improve repayment, but not only from the issuer of the debts but also from other governments, leading to international bailouts and excessive borrowing. We show that ex-post transfers across governments might generate inefficient borrowing. The reason is that trade in secondary markets maximizes repayment “to bondholders” rather than repayment “by the government that issued the bonds.” In particular, this trade redistributes bond holdings not only towards residents of the issuing country, but also towards residents of those countries that are more likely to provide international bailouts. Secondary markets maximize bailouts and worsens the problem of excessive borrowing.

<sup>6</sup>This has already been pointed out by Brutti and Saure (2013), who also argue that this has been the case especially for foreign creditors from outside the Euro area. More generally, Broner et al. (2013) show that periods of financial turbulence are often accompanied by a reduction in gross capital flows, in which foreign agents reduce their purchases of domestic assets and domestic agents reduce their purchases of foreign assets.

kets. Moreover, this observation seems to go against the logic of optimal diversification. However, this observation is a natural prediction of our model. Second, at the time domestic banks started increasing their holdings of domestic sovereign debt, their lending to other sectors in the economy started shrinking. And third, an analysis of the debt dynamics in PIIGS countries reveals that the fast deterioration in their fiscal outlook has been the result of the deep recession and the high spreads they face, as opposed to irresponsible fiscal policy.<sup>7</sup>

The paper is closely related to previous work that analyzes the role of secondary markets in international financial markets when governments lack the commitment to repay their own debts or to enforce repayment by private agents. In Broner et al. (2008 and 2010) we show that, when creditors can freely retrade debts just before maturity, repayment and enforcement improve as debts are transferred to those creditors that are more likely to be repaid. Similarly, Lanau (2011) shows that, even when defaults cannot be avoided, renegotiations lead to smaller haircuts when debts can be retraded since secondary markets transfer debts to those agents that can extract more repayment.<sup>8</sup> In Broner and Ventura (2010 and 2011) we analyze the effects of secondary markets when they do not prevent default but rather restrict the ability of governments to discriminate between domestic and foreign creditors. In this case secondary markets create interactions between domestic and foreign financial markets and can improve repayment to foreigners and worsen repayment among domestic residents. In all these papers secondary markets restrict the actions of governments ex post and, since governments face a time inconsistency problem, they can be either beneficial or damaging from an ex-ante point view. In this paper, we also emphasize how secondary markets restrict the actions of governments ex ante. In particular, secondary markets make it difficult for governments to segment domestic and foreign markets when debts are issued and to control the re-trading of non-maturing debts. Since governments are assumed to be benevolent, such restrictions on their ex-ante actions are damaging to welfare.<sup>9</sup>

The paper is also related to a recent literature that analyzes how the possibility of sovereign defaults can affect private investment and growth. Aguiar et al. (2009) and Aguiar and Amador

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<sup>7</sup>In fact, structural fiscal deficits have been reduced enormously in all PIIGS economies. Since their peak in 2009 until 2012, structural deficits have been reduced by 7.7% of GDP in PIIGS versus 2.2% in Germany and France.

<sup>8</sup>Pitchford and Wright (forthcoming) show that secondary markets can increase repayment during renegotiations by concentrating debts on the optimal number of creditors. Bai and Zhang (2012) show that secondary markets can reduce delay during renegotiations by providing information on creditors' reservation values.

<sup>9</sup>In Broner and Ventura (2010) we also argued that secondary markets prevent the segmentation of domestic and foreign markets and explored a number of optimal ex-ante policies under this constraint. In that model, crowding out of private investment did not play any role and governments sometimes would have liked to prevent sales of domestic debts by domestic residents to foreigners. In the current paper, crowding out of private investment is crucial and governments sometimes have incentives to prevent sales of domestic debts by foreigners to domestic residents.

(2011) show that high levels of public debts can reduce private investment and growth by increasing governments' incentives to default and expropriate private capital. Gennaioli et al. (forthcoming), Brutti (2011), Erce (2012), and Mengus (2012) show that public defaults can reduce investment and growth due to their effects on private balance sheets. This cost, in turn can make defaults less likely in financially developed countries.

The paper is organized in five sections. Section 1 provides a description of recent events in sovereign debt markets in Europe. Section 2 develops a model to study the effects of sovereign debt on investment and growth in the presence of secondary markets. Section 3 introduces endogenous costs of default and self-fulfilling debt crises. It discusses the role of debt maturity. Section 4 [to be written] studies the role of bailouts. Section 5 concludes.

## 1 A bird's-eye view of the European debt crisis

In this section, we present four sets of stylized facts focused on the following countries: Portugal, Ireland, Italy, Greece, Spain, Germany, and France. The analysis is performed using data from 2000 to end-2012. First, we compiled information on public debt and deficits in order to be able to decompose the debt path. Then, we gathered data on borrowing by both the domestic non-financial private sector and the public sector. Third, we constructed series collecting information on the residence of public debt holders. In addition, in order to gauge the distinct relevance of primary and secondary markets in driving portfolio reallocation between creditor types, we obtained information on net and gross public debt issuance. Finally, we put together time series on the average maturity of public debt.

### 1.1 Debt dynamics

Our strategy to understand the dynamics of the debt-to-GDP ratio is to decompose its changes on several components. Figure 2 presents this decomposition together with the debt-to-GDP ratio. We explain next how this decomposition was carried out.

There are three elements explaining the evolution of debt: interest payments, the primary balance, and the stock-flow adjustment.<sup>10</sup> Defining the stock of debt by  $D$ , the nominal interest

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<sup>10</sup>The last factor corrects by the fact that there are operations that while not generating costs today (and, therefore, excluded from the deficit) increase the level of debt. Within this category fall adjustments such as those implied by the Government borrowing to finance bank recapitalization programs or by the revenues obtained from privatization programs.

rate by  $i$ , the primary balance by  $PB$  and the stock-flow adjustment by  $SFA$ , the debt stock evolves as follows

$$D_t = D_{t-1}(1 + i_t) + PB_t + SFA_t$$

As our object of interest is the debt-to-GDP ratio, we need to consider also the evolution of GDP. Dividing the expression above by the GDP and rearranging

$$d_t = d_{t-1} \frac{(1 + i_t)}{(1 + g_t)} + pb_t + sfa_t,$$

where lower-case denotes variables normalized by GDP and  $g_t$  denotes the growth rate of nominal output at time  $t$ .

We follow Boussard et al. (2012) and decompose the changes in the debt-to-GDP ration in four factors: primary balance, interest payments, growth and the stock-flow adjustment factor. Subtracting  $d_{t-1}$  from both sides of the expression above and rearranging delivers the four factors mentioned.

$$\Delta d_t = \frac{i_t}{(1 + g_t)} d_{t-1} - \frac{g_t}{(1 + g_t)} d_{t-1} + pb_t + sfa_t$$

Once this is done, we further decompose the primary balance in three subcomponents: a structural component ( $spb_t$ ), a cyclical component ( $cpb_t$ ) and a one-off adjustment ( $one\_off_t$ ). The structural (or cyclically-adjusted) balance represents what government revenues and expenditure would be if output were at its potential level. In turn, one-offs are derived as the deviations from trend in net capital transfers, special one-offs not related to capital transfers and one-off revenues such as those arising from the sale of the third generation mobile telephone licenses.<sup>11</sup>

Adding up both decompositions delivers the following expression

$$\Delta d_t = \frac{i_t}{(1 + g_t)} d_{t-1} - \frac{g_t}{(1 + g_t)} d_{t-1} + spb_t + cpb_t + other\_adjustments_t$$

where  $other\_adjustments_t = sfa_t + one\_off_t$ .

We carry out the decomposition using information from the OECD's Economic Outlook Database. More specifically, from this source we gathered data on General Government financial balance,

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<sup>11</sup>For a methodological discussion see <http://www.oecd.org/eo/outlook/eosources-notestostatisticalannextables25-33fiscalbalancesandpublicindebtedness.htm>

General Government cyclically-adjusted balance, General government underlying balance, General Government underlying primary balance and General Government net debt interest payments. The data on nominal GDP growth was obtained from *Eurostat*.

From Figure 2 it is clear that the drivers of debt accumulation in PIIGS countries and in Germany and France are very different. In the run up to the crisis, growth was particularly important in helping reduce debt-to-GDP ratios in PIIGS countries. As the crisis hit, the lack of economic growth was a major factor behind the rapid increase in debt-to-GDP ratios in PIIGS countries, particularly in Greece. The cyclical deficit also saw a rapid increase in PIIGS countries since the beginning of the crisis. The structural deficit, on the other hand, increased at first in PIIGS countries but over the last three years has been reduced enormously reflecting extreme fiscal adjustments. Interest payments have also increased in PIIGS countries, which helps explain the increase in debt-to-GDP ratios. In Germany and France the debt-to-GDP ratios increased substantially less than in PIIGS countries, as their growth rates were less affected, their cyclical deficits increased less, and the interest rates they face actually decreased. Finally, other adjustments have increased debt-to-GDP ratios in those countries that spent resources recapitalizing their banks, and have decreased it in Greece reflecting its partial default. Overall, the debt-to-GDP ratios in PIIGS countries have increased as a result of the economic crisis and high borrowing costs they face.

## 1.2 Credit allocation across domestic sectors

To understand the behavior of private and public investment during fiscal stress we have put together information on credit allocation among the institutional sectors of our sample countries. We collected the data from National Central Banks Monetary Surveys and Financial Accounts. More specifically, using those sources, we gathered information on the exposure of domestic banks, either through loans or securities holdings, to the following sectors: General Government (GG), Non-Financial Corporations (NFCs) and Households (HH).<sup>12</sup>

In order to understand the extent to which fiscal stress can affect the patterns of public and private borrowing we present two closely related measures. On the one hand, in Figure 3 we show the behavior of bank credit relative to GDP in three sectors: non financial corporations, households and the public sector. The figure shows how until the onset of the crisis both households and corporations received an increasing amount of funds. This pattern is most clear in Spain and

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<sup>12</sup>Our dataset also includes information on the credit provided to the financial sector and to non-residents (distinguish between EA residents and the rest of the world). For some countries, the dataset separate the exposure to other EA countries bilaterally.

Ireland, but is also present in Portugal, Italy and Greece. Instead, in France and Germany both sectors' borrowing has remained stable with the exception of household borrowing in France, which also increased since 2005 until the start of the crisis. This behavior contrasts with that of public borrowing, which barely increased and, for Spain and Germany, even presented a declining trend prior to the crisis. These patterns changed markedly with the crisis, which led to an increase in public borrowing for all PIIGS countries, while credit to households and firms either stopped growing or began contracting. In contrast, in Germany and France there is hardly any change in the level of borrowing for all three sectors.

Figure 4 compares the ratio of General Government borrowing to private domestic borrowing (the sum of borrowing by households and firms) with the corresponding country spread.<sup>13</sup> As regards the allocation of credit the message comes even more strikingly than before. For all countries but France and Germany there is a marked increase on the relative weight of public borrowing starting in 2008. Indeed, even for Germany there was such an increase in 2008 (due to the need to recapitalize banks after the subprime crisis) although it reversed soon afterwards. In Greece the raise in the ratio came to halt with the sovereign debt restructuring in 2012, but the evidence shows that it is already picking up again.

Even more relevant for the message in this paper, the shift in the relative importance of private and public credit comes with the marked increase in the spread to be paid by the corresponding sovereigns. In France, where the increase in the spread has been contained, there is no such pattern.

### 1.3 Sovereign debt holdings

Some recent attempts at analyzing the changing patterns of sovereign debt holdings include the IMF's Global Financial Stability Report (2011), Arslanalp and Tsuda (2013), and Brutti and Saure (2013). They combine data from the IMF's International Financial Statistics on domestic sovereign debt holdings with data from the BIS on public debt holdings by non-resident banks. Unfortunately, the stocks of debt holdings in IFS's and BIS's datasets are valued at market prices, making it difficult to disentangle active portfolio management from the price swings usually accompanying periods of stress. As just argued, changes in the portfolio as reported by these sources can be due to valuation changes, without involving transactions in neither primary nor secondary markets.

Instead, we rely on national sources as in Andritzky (2013) and Merler and Pisani-Ferry (2012). We use the data from these papers, replacing those series that were still at market prices with

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<sup>13</sup>Spreads are measured relative to the 10-year German Bund as obtained from Datastream.



updated face-value data from national sources, particularly Treasuries and Central Banks.<sup>14</sup> Although our dataset does not deliver bilateral relations, it collects information regarding the holdings of non-residents, official creditors, and domestic agents, the latter distinguishing between the public, private non-financial, and private financial sectors.

Figure 5 separates public debt holdings according to the residence of the holders. It presents two lines describing the proportion of debt held by residents and by foreigners. It also contains the corresponding country spread against the 10-year German Bund. It clearly shows how the increase in spreads was accompanied by a marked shift in the fraction of public debt held by domestic residents and foreigners. Prior to the crisis the proportion of sovereign debt in the hands of foreigners increased markedly for all countries but Portugal. As spreads increased, foreigners started reducing their shares while domestic residents filled the gap and increased significantly their exposure to their own sovereign debt. The shift in PIIGS debt holdings is clear in all PIIGS countries. Instead, in Germany the fraction of sovereign debt held by foreigners has kept increasing throughout the crisis, most likely reflecting the safe-haven status of the German bond market.

Figure 6 [TO BE DONE], in turn, decomposes the resident holdings in three types of holders: public, private non-financial and private financial. We do not observe a differential behavior of across these groups, which we interpret as evidence that, at least until now, increases in public debt holdings by resident banks are not due to coercion.

#### 1.4 Portfolio reallocation and secondary markets

To what extent do these shifts in bond holdings reflect the effects of secondary markets? Are countries constrained in their ability to segment domestic and foreign markets at the time bonds are issued? Have there been sales of sovereign bonds by foreigners to domestic residents in secondary markets? These questions are difficult to answer given available data.<sup>15</sup> Here, we will try to determine the extent to which shifting debt holdings are due to activity in secondary markets or the higher participation of domestic residents in primary markets.

To control for the potential for primary market activity to account for the changes in debt positions, we have collected information on gross and net debt issuance, which can help us proxy the amount of public debt which could have changed hands in primary markets. The data comes

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<sup>14</sup>Unfortunately, for Greece the only data available mixes nominal and market prices.

<sup>15</sup>See Brutti and Saure (2013) for a discussion. Note that even if we had data on primary markets, given that foreigners (other than Central Banks) use domestic banks as agents on primary markets there would be no way to assign debt purchases to them.

from the various Central Banks in our sample countries. Our strategy is to choose a participation rule for the different creditor groups on the primary market and then obtain secondary market activity as a residual.

Define an investor's stock of debt  $B_t$ . The change in the investor's nominal exposure to the sovereign behaves according to the following identity

$$B_t = B_{t-1} + \text{Net Purchases}_t = B_{t-1} + NPP_t + NPS_t,$$

where  $NPP_t$  and  $NPS_t$  denote net purchases in primary and secondary markets. The most natural rule is to allocate  $NPP_t$  between domestic residents and foreigners assuming that both groups participate in primary markets in proportion to their holdings of outstanding debt.<sup>16</sup> Another option is to construct bounds on secondary market activity. To do this, we first assume that all gross issuance is absorbed by domestic residents and all repayments are to foreigners. This minimizes purchases in secondary markets by domestic residents from foreigners. We then assume that all gross issuance is absorbed by foreigners and all repayments are to domestic residents. This maximizes purchases in secondary markets by domestic residents from foreigners. Figure 7 [TO BE DONE] presents the results from implementing these three rules.

## 1.5 Sovereign debt maturity

Finally, in order to understand the relevance of the debt maturity structure of the various sovereigns on their ongoing fiscal woes, we compiled information on the average maturity of public debt in our sample countries. The data, obtained from the OECD, reports the average term to maturity of total debt. Figure 8 presents the time series for Germany, France and the average of the PIIGS.

The figure shows how since the inception of the Euro PIIGS countries increased their average debt maturity. As a result, by 2005, they had brought it in line with the maturity observed in France and Germany. This pattern likely reflected the governments' incentives to benefit from the lower borrowing costs that accompanied the first years of the Euro. As a result, when the crisis hit the European periphery there was no significant difference in debt maturity between PIIGS countries and Germany and France. Indeed, the maturity of German debt remains below that of the PIIGS even though with the crisis there has been a slight reduction on the average maturity of sovereign debt in Ireland and Portugal.

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<sup>16</sup>This is the procedure followed in Gamez and Segura-Cayuela (2013).

## 2 A model of sovereign debt, investment and risk premia

In this section we develop a model to study the interactions between sovereign debt, investment and risk premia. This model emphasizes the role of secondary debt markets. It shows that, in the presence of default risk, the Diamond model has two steady states. As it is well known, under standard assumptions this model features a concave law of motion and a single steady state. The presence of default risk modifies the law of motion and makes it convex for a range of capital stocks. This gives rise to multiple steady states. The model allows us to study the effects of risk premia on investment, consumption and welfare.

### 2.1 The baseline model

Consider a country with a private sector and a government. The private sector consists of generations that live for two periods. All generations contain a measure  $\mu$  of patient individuals that maximize expected consumption during old age, and a measure  $1 - \mu$  of impatient individuals that maximize consumption during youth. All generations receive one unit of labor when young, and have access to a Cobb-Douglas technology to produce goods:  $f(k_t) = k_t^\alpha$ ; where  $k_t$  is the capital stock and  $\alpha \in (0, 1)$ . The production of one unit of capital in period  $t + 1$  requires the investment of one unit of the consumption good at time  $t$ . We assume that capital depreciates at a rate  $\delta \in (0, 1)$ .

Factor markets are competitive and, as a result, factors are paid their marginal products:

$$w_t = (1 - \alpha) \cdot k_t^\alpha \tag{1}$$

$$r_t = \alpha \cdot k_t^{\alpha-1} + 1 - \delta \tag{2}$$

where  $w_t$  and  $r_t$  are the wage and the return to investment, respectively. The latter consists of the rental rate plus the value of undepreciated capital.

We turn next to the financial market. There is a risk-neutral international financial market willing to borrow or lend at a riskless (gross) interest rate of  $\rho > 1$ . Here we introduce the first friction: the private sector can pledge to its creditors only a return of  $\phi \in (0, \rho)$  per unit of investment. As a result, it faces the following credit constraint:<sup>17</sup>

$$f_t \leq \frac{\phi \cdot k_{t+1}}{\rho} \tag{3}$$

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<sup>17</sup>For instance, the private sector cannot pledge future output, but it can pledge undepreciated capital. Under this interpretation, we have that  $\phi \in [0, 1 - \delta]$ .

where  $f_t$  is the creditor financing that the private sector receives from the international financial market. Equation (3) simply says that the amount of financing that the private sector can obtain from the international financial market cannot exceed the net present value of pledgeable funds. Since these funds are known as of period  $t$ , the credit obtained by the private sector is riskless and yields the riskless rate  $\rho$ .

The government inherits an amount of debt  $d$  and follows these rules of behavior: (i) it issues only one-period debt; (ii) it taxes the old just enough to keep the debt burden constant over time, i.e.  $d_t = d$  for all  $t \geq 0$ ; (iii) it never defaults on debt held by the domestic private sector. The key question to understand the evolution of this economy, of course, is who buys this debt. And this, in turn, depends on whether foreigners expect to be repaid or not.

## 2.2 Crowding-out effects

Suppose first that the government never defaults on debts held by foreigners. In this case, the contractual interest rate on government debt, which we denote by  $R_{t+1}$ , must equal  $\rho$ . Given this interest rate on debt, the law of motion of the capital stock is given by:

$$k_{t+1} = \min \left\{ \frac{\rho}{\rho - \phi} \cdot s \cdot k_t^\alpha, \left( \frac{\alpha}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}} \right\} \quad (4)$$

where  $s \equiv \mu \cdot (1 - \alpha)$  is the gross saving rate. Equation (4) shows that government debt does not affect capital accumulation. In the absence of any financial friction, the domestic private sector would invest until the marginal return to capital were equal to the international interest rate, i.e. until  $k_{t+1} = \left( \frac{\alpha}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}}$ . But this investment might be unattainable if the financial constraint binds: in this case, the private sector will invest as much as possible and  $k_{t+1} = \frac{\rho}{\rho - \phi} \cdot s \cdot k_t^\alpha$ . This law of motion therefore has an upward-sloping section, in which the financial constraint binds, and a horizontal section, as depicted by the solid line in Figure 9 below. The figure is drawn for the case in which the investment of the private sector is constrained in the steady state.

What happens instead if the government always defaults on the debt held by foreigners? In this case, foreigners will never demand any debt regardless of the contractual interest rate that is offered. Hence, the entire stock of debt has to be absorbed by the domestic private sector, which naturally crowds out investment. Moreover, the contractual interest rate on the debt must be high enough to compensate the domestic private sector for the foregone return to investment. Thus,

we have that  $R_{t+1} = [\max\{\alpha \cdot k_{t+1}^{\alpha-1} + 1 - \delta, \rho\} - \phi] \cdot \frac{\rho}{\rho - \phi}$ . The return to investment, in turn, takes into account that each unit of capital can be leveraged to further expand borrowing and investment. Given this interest rate on debt, the law of motion of the capital stock is therefore given by

$$k_{t+1} = \min \left\{ \frac{\rho}{\rho - \phi} \cdot (s \cdot k_t^\alpha - d), \left( \frac{\alpha}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}} \right\}. \quad (5)$$

Equation (5) is very intuitive: when all the debt is purchased by the domestic private sector, it crowds out private investment. This is why the law of motion is weakly lower than before, as depicted by the dashed line in Figure 9. Comparing Equations (4) and (5) we see that default risk crowds out investment and lowers the capital stock. This is a main theme of this paper. This has negative implications for consumption and welfare.

The previous cases correspond to two extremes, in which the government either defaults or repays fully the debt held by foreigners. Which assumption is most appropriate? The literature on sovereign risk has long dealt with this question: as long as governments value the welfare of domestic residents but do not care about foreigners, it argues, they will be tempted to default on all debt held by the latter. What prevents governments from doing so? The conventional view is that debts will be repaid only if foreign creditors can effectively threaten to impose penalties on the country. In past research, however, we have argued that foreign creditors can also use secondary markets to get repaid: by selling their maturing debt holdings to domestic residents, they can collect on their debt indirectly through the secondary market.<sup>18</sup> We can therefore interpret the previous cases (of full and no repayment to foreigners) as representing the two benchmarks of perfect and nonexisting secondary markets. When secondary markets work perfectly, foreigners face no risk of default: in each period, they can collect fully on maturing debt by selling it to domestic residents, who are then repaid by the government. In this case, foreigners are willing to purchase domestic debt and the law of motion of the capital stock is given by Equation (4). When secondary markets are instead nonexistent, foreigners never get repaid on their debt: in this case, the entire stock of debt must be absorbed by domestic residents and the law of motion of the capital stock is therefore given by Equation (5). These are, of course, two extremes. We now consider the intermediate case

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<sup>18</sup>Broner et al. (2010) show that trading in secondary markets allows foreign creditors to successfully circumvent the opportunistic behavior of the government, ‘de facto’ averting default and therefore eliminating sovereign risk. The proof of this result is based on two observations: (i) once the private sector has bought back the debt, not enforcing domestic debts can at most redistribute wealth within the private sector but cannot increase its level of wealth; and (ii) trading in the secondary market always ensures that the redistribution that would result from not enforcing domestic debts is undesirable for the government.

in which secondary markets exist but may not work perfectly.

### 2.3 Risk premia

To do so, we maintain the assumption that the government starts with a given amount of debt  $d$  and follows rules of behavior (i)-(iii) outlined above. Regarding the enforcement of debt held by foreigners, we assume instead that the government pays the debt held by the international financial market with probability  $\pi_t$ . We think of this probability as reflecting the likelihood that the secondary market opens and foreigners are able to sell their debt holdings to the domestic private sector before the government decides on repayment. With probability  $1 - \pi_t$ , the secondary market does not open (because, for instance, the government prevents it from opening by imposing capital controls) and foreigners are not able to collect.

Before describing the equilibrium of this economy, we make two preliminary observations. First, the contractual interest rate on this economy depends on the identity of the marginal buyer. When default on foreigners is possible but not certain, foreigners may be willing to hold the debt as long as they are appropriately compensated for the risk of default. Likewise, the domestic private sector may also be willing to hold debt as long as it is appropriately compensated, not for the risk of default (which is zero in this case) but rather for the foregone return on investment. If foreigners are buying the debt at the margin, the contractual interest rate on the debt must equal  $\frac{\rho}{\pi_t}$ . If domestic residents are buying debt at the margin, the contractual interest rate must equal  $[\max\{\alpha \cdot k_{t+1}^{\alpha-1} + 1 - \delta, \rho\} - \phi] \cdot \frac{\rho}{\rho - \phi}$ . Second, the government cannot segment foreigners and domestic residents, i.e. it cannot control who buys its debt. The reason is that once debts have been sold they can be traded in secondary markets. In particular, even if the government were willing to pay a higher contractual interest rate so that foreigners buy all the debts in primary markets, it cannot force foreigners to hold on to its debt.

The previous observations suggest that the identity of the marginal buyer of debt, and hence the effects of debt on capital accumulation and growth, depends on the economy's capital stock. Indeed, the law of motion of the capital stock in this economy can be divided into four distinct regions:

I:  $\frac{\rho}{\pi_{t+1}} \leq \left[ \alpha \cdot \left( \frac{\rho}{\rho - \phi} \cdot s \cdot k_t^\alpha \right)^{\alpha-1} + 1 - \delta - \phi \right] \cdot \frac{\rho}{\rho - \phi}$ . In this region, the capital stock is sufficiently low, and its return sufficiently high, that the domestic private sector invests only in capital and all the debt is purchased by the international financial market. Thus, the

contractual interest rate on the debt is given by  $R_{t+1} = \frac{\rho}{\pi_t}$ , and the law of motion of the capital stock is

$$k_{t+1} = \frac{\rho}{\rho - \phi} \cdot s \cdot k_t^\alpha. \quad (6)$$

II:  $\left[ \alpha \cdot \left( \frac{\rho}{\rho - \phi} \cdot s \cdot k_t^\alpha \right)^{\alpha-1} + 1 - \delta - \phi \right] \cdot \frac{\rho}{\rho - \phi} < \frac{\rho}{\pi_{t+1}} \leq \left[ \alpha \cdot \left( \frac{\rho}{\rho - \phi} \cdot (s \cdot k_t^\alpha - d) \right)^{\alpha-1} + 1 - \delta - \phi \right] \cdot \frac{\rho}{\rho - \phi}$ . In this region, the capital stock is sufficiently high, and its return sufficiently low, as to induce the domestic private sector to purchase some debt. At the same time, however,

the capital stock is not so high as to allow all debt to be purchased domestically. Hence, foreigners are still marginal buyers of debt and the contractual interest rate on the debt is still given by  $R_{t+1} = \frac{\rho}{\pi_t}$ . But the law of motion of the capital stock is now

$$k_{t+1} = \left( \alpha \cdot \left( \frac{\rho - \phi}{\pi_{t+1}} + \phi + \delta - 1 \right)^{-1} \right)^{\frac{1}{1-\alpha}}, \quad (7)$$

so that the marginal return to capital accumulation equals the contractual interest rate on the debt.

III.  $\rho \leq \left[ \alpha \cdot \left( \frac{\rho}{\rho - \phi} \cdot (s \cdot k_t^\alpha - d) \right)^{\alpha-1} + 1 - \delta - \phi \right] \cdot \frac{\rho}{\rho - \phi} < \frac{\rho}{\pi_{t+1}}$ . In this region, the capital stock is sufficiently high to make the domestic private sector both willing and able to purchase the entire stock of outstanding debt, but it is not high enough to sustain the efficient level of investment. This region thus corresponds to the case of autarky analyzed in the previous section, in which the contractual interest rate in debt is given by  $R_{t+1} = \left[ \alpha \cdot k_{t+1}^{\alpha-1} + 1 - \delta - \phi \right] \cdot \frac{\rho}{\rho - \phi}$  and the law of motion is given by

$$k_{t+1} = \frac{\rho}{\rho - \phi} \cdot (s \cdot k_t^\alpha - d). \quad (8)$$

IV:  $\left[ \alpha \cdot \left( \frac{\rho}{\rho - \phi} \cdot (s \cdot k_t^\alpha - d) \right)^{\alpha-1} + 1 - \delta - \phi \right] \cdot \frac{\rho}{\rho - \phi} < \rho$ . In this region, the capital stock is sufficiently high to enable the domestic private sector to purchase the entire stock of outstanding debt and to attain the efficient level of investment. Hence, the contractual interest rate in debt is given by  $R_{t+1} = \rho$  and the law of motion is given by

$$k_{t+1} = \left( \frac{\alpha}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}}. \quad (9)$$

In order to interpret the different regions of this law of motion, in Figure 10 we have again plotted as a solid line the case in which  $\pi_t = 1$  for all  $t$  and foreigners face no risk of default. Recall that in Figure 9, the dashed line represented the case in which  $\pi_t = 0$  for all  $t$  and foreigners are always defaulted upon. Now the dashed line in Figure 10 represents the case in which  $\pi_t = \pi \in (0, 1)$  and foreigners are defaulted upon with probability  $1 - \pi$ .

As can be seen from the figure, the presence of default risk lowers investment and capital accumulation. Why does this happen, given that the risk of default affects only foreigners? The answer is precisely that, *because it affects only foreigners*, default risk crowds out domestic investment. When  $\pi_t < 1$ , the contractual interest rate promised by the debt must rise above  $\rho$  in order for it to be purchased by the international financial market. But this raises the appeal of debt for the domestic private sector, which can obtain the high contractual interest rate even though it does not face any risk of default. Whether the debt becomes attractive enough to crowd out investment depends on the region in which the economy finds itself. When the economy is in Region I, the return to capital is so high that the domestic private sector prefers to invest in capital despite the high interest rate promised by the debt. When the economy is in Regions II and III, however, this is no longer the case and the high return on debt crowds out domestic investment. In Region IV, once the domestic private sector has enough resources to simultaneously attain the efficient level of capital and purchase the entire stock of debt, both laws of motion coincide once again.

One implication of the introduction of default risk is that, as can be seen in Figure 10, it may give rise to multiple steady states. This requires the debt to be neither too small nor too large. To see this, consider first what happens when the level of debt is too high. Note from Equation (8) that increases in the stock of debt  $d$  imply a downward shift in the law of motion within Region III: eventually, once debt surpasses a threshold  $\bar{d}$ , the law of motion within this region lies everywhere below the forty-five degree line.<sup>19</sup> At this point, it is clear that there can be no steady states in Regions III or IV, and standard concavity arguments imply that the economy displays a unique steady state in Regions I or II.

What happens instead when the debt level is low? Once again, Equation (8) implies that reductions in the level of debt lead to an upward shift in the law of motion in Region III. Eventually, once debt falls below a threshold  $\underline{d}(\pi)$ , Regions I and II lie completely above the forty-five degree line

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<sup>19</sup>Formally, it can be shown that

$$\bar{d} = s \cdot (1 - \alpha) \cdot \left( \frac{\rho}{\rho - \phi} \cdot s \cdot \alpha \right)^{\frac{\alpha}{1-\alpha}} .$$



and they cannot contain any steady states. Note that, differently from the threshold  $\bar{d}$ , this lower threshold  $\underline{d}(\pi)$  depends on the probability of default  $1 - \pi$ .<sup>20</sup> The reason is that, as we have seen, reductions in  $\pi$  raise the appeal of debt for the domestic private sector: for any given stock of debt, this makes it more likely that the economy displays a steady state in Region II, thereby reducing  $\underline{d}(\pi)$ . Thus, the economy displays multiple steady states for all debt levels  $d \in \{d' : \underline{d}(\pi) \leq d' \leq \bar{d}\}$ : this set can be shown to be nonempty as long as the probability of default exceeds a given lower bound.<sup>21</sup>

## 2.4 Back to Europe

How can we use this model to think about the unfolding of the European debt crisis as outlined in Section 1? One interpretation is that the crisis was the direct outcome of the buildup in debt that started in 2007-08, which crowded out domestic investment in Europe's troubled economies and reduced their steady-state levels of capital and output. This situation is depicted in Figure 11. The Figure illustrates an economy with an initial debt level of  $d$ : for this debt level, the law of motion of the capital stock is represented by the solid line. Suppose that, in period  $T$ , the debt level increases to  $d'$ : because this higher debt crowds out domestic investment, the law of motion of the capital stock shifts to the right as depicted by the dashed line. In all cases, this is going to reduce the capital stock on impact. If the capital stock is high enough, the economy will converge towards the high steady state and recover partially. If the capital stock is low enough, the economy will converge towards the low steady state and will go down even further. According to this simple interpretation, the troubled economies in Europe have stagnated because the higher debt burden has crowded out investment and put them in path that leads to a low steady-state level of capital.

Although the general narrative behind the previous example appears compelling, it cannot be the whole story. After all, the levels of debt of some of these European economies are not larger than those of other countries that are not experiencing the same sort of problems. As we have

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<sup>20</sup>Formally, it can be shown that

$$\underline{d}(\pi) = \left( \alpha \cdot \left( \frac{\rho - \phi \cdot \pi}{1 - \pi} + \delta - 1 \right)^{-1} \right)^{\frac{\alpha}{1-\alpha}} \cdot \left[ s - \alpha \cdot \left( \frac{\rho - \phi \cdot \pi}{1 - \pi} + \delta - 1 \right)^{-1} \right].$$

<sup>21</sup>Formally, this set is nonempty as long as

$$\pi > \frac{\frac{\rho - \phi}{\rho \cdot s} + 1 - \delta - \rho}{\frac{\rho - \phi}{\rho \cdot s} + 1 - \delta - \phi}.$$

shown in Section 1, however, spreads for these economies have increased dramatically especially since 2010. What are the effects of an increase in the perceived likelihood of default?

Figure 12 below shows the effects of a reduction in  $\pi_t$ . The Figure illustrates an economy with a debt level of  $d'$  and an initial probability of default  $1 - \pi$ : the law of motion of the capital stock corresponding to this situation is represented by the solid line. It is assumed that  $\pi$  is relatively high, so that even relatively high values of  $d'$  will have a minor impact on investment and growth. Suppose that, in period  $T$ , the probability of default rises so that  $\pi$  increases to  $\pi'$ . This raises the contractual interest rate on the debt and, thus, its appeal for the domestic private sector: as a consequence, the crowding-out effect of debt becomes stronger and the law of motion of the capital stock shifts to the right as depicted by the solid line. The dashed line of Figure 12 illustrates this case. The increase in the risk premium reduces the capital stock on impact. If the capital stock is high enough, the economy will converge towards the high steady state and recover partially. If the capital stock is low enough, the economy will converge towards the low steady state and will go down even further. According to this alternative interpretation of the crisis, the troubled economies in Europe have stagnated not because of their high debt levels, but because of a shift in their perceived likelihood of default.

The evidence of Section 1 suggests that both increases in debt and increases in the risk premium have been at play in recent years. The model presented here shows how this two shocks lower investment and lead to a recession. But these two shocks might not be independent. Ultimately, the view presented here boils down to assuming that European countries suffered a negative shock to their enforcement technology precisely when they were accumulating debt. This does not seem plausible. A more natural interpretation of the facts is that the buildup of debt has, in itself, led to an increase in the perceived risk of default. As we now show, this interpretation arises naturally in our framework once the model is modified along a simple dimension.

### 3 Default costs and self-fulfilling crises

Up to this point, we have assumed that the government never repays the debt that is in the hands of foreigners. If secondary markets open, this is inconsequential because foreigners need not collect directly from the government: instead, they can sell their maturing debt to the domestic private sector and collect indirectly through the secondary market. If secondary markets do not open, however, all debt in the hands of foreigners is defaulted upon by the government. This outcome

emerges naturally in our benchmark model because the government does not value the welfare of foreigners and there are no costs of default. In reality, however, defaults do seem to entail some costs, either through the loss of reputation, through sanctions, or through the disruption of domestic financial markets. These costs of default are in fact a customary assumption in the literature on sovereign risk. In this section, we explore the consequences of introducing this assumption in our benchmark model.

### 3.1 Adding default costs to the baseline model

Assume that, in the event of a default, the old generation that issued the debt suffers a loss. This loss could be thought of as the result of sanctions or penalties imposed by foreign creditors. We assume that it is a deadweight loss, which does not report any benefits to foreigners, and that it depends both on the size of the default and on the domestic output or capital stock. Intuitively, the size of the default determines the effort that creditors devote to hurting the country; moreover, the capital stock or output determines the size of the damage that they can do. Formally, if we use  $d_{t+1}^F$  to denote the stock of debt that is in the hands of foreigners at time  $t + 1$ , we assume that the cost of defaulting on this debt equals  $d_{t+1}^F \cdot \lambda \cdot k_{t+1}$ .

The main consequence of introducing this cost of default is that foreigners might be able to collect on the debt even when secondary markets remain closed. The reason is that the government will compare the costs of repaying foreigners with the costs of defaulting on them. If  $d_{t+1}^F \leq d_{t+1}^F \cdot \lambda \cdot k_{t+1}$ , the gain from defaulting on foreigners in period  $t + 1$  is lower than the costs of doing so, and the government will therefore choose to repay ex post. If instead  $d_{t+1}^F > d_{t+1}^F \cdot \lambda \cdot k_{t+1}$ , the government will find it optimal to repay on foreigners ex post. To see how repayment may be sustained in equilibrium, imagine that agents at time  $t$  expect the government to repay all debt at  $t + 1$ . Given these expectations, the domestic private sector will not demand any debt and  $d_{t+1}^F = d$ . Hence,  $k_{t+1}$  will be given by the law of motion of Equation (4), which we now refer to as the “optimistic” law of motion  $k^o(k_t)$ . To check whether these expectations are consistent with equilibrium, we just need to verify that the government actually wants to repay foreigners if the secondary markets close at  $t + 1$ : as long as  $k^o(k_t) > 1/\lambda$ , it does. This, in turn, happens for all  $k_t \geq k^o$ , where we define

$$k^o = \begin{cases} \{k : k^o(k) = 1/\lambda\} & \text{if } \lambda \geq \frac{1}{k^*} \\ \infty & \text{if } \lambda < \frac{1}{k^*} \end{cases}, \quad (10)$$

where  $k^* = \left( \frac{\alpha}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}}$ .

The intuition behind Equation (10) is clear. The government’s temptation to renege on its debt now depends on the capital stock, which shapes the costs of default. If  $\lambda \geq \frac{1}{k^*}$ , this determines a value  $k^o$  beyond which there is an optimistic equilibrium in which all debts are repaid. In such an equilibrium, everyone expects the government to repay its debt; because of this, the domestic private sector invests as much as possible, which in turn makes default costly ex-post thereby ratifying the original expectations. If  $\lambda < \frac{1}{k^*}$ , however, such an equilibrium cannot exist, for the simple reason that a government can always raise welfare by defaulting. In such an economy, each unit of default raises the consumption of the old at least by  $1 - \lambda \cdot k^*$ . The solid line of Figure 13 below illustrates the optimistic law of motion for the case in which  $\lambda \geq \frac{1}{k^*}$ .

The economy can also display pessimistic equilibria, in which the government defaults on the debt held by foreigners. In this case, the law of motion corresponds to the one analyzed in the previous section, which we will call the “pessimistic” law of motion and denote as  $k^p(k_t)$ . To check whether this is an equilibrium, we need to verify that the government actually wants to default on foreigners if the secondary markets close at  $t + 1$ : as long as  $k^p(k_t) < 1/\lambda$ , it does.<sup>22</sup> This, in turn, happens for all  $k_t \leq k^p$ , where we define

$$k^p = \begin{cases} \{k : k^p(k) = 1/\lambda\} & \text{if } \lambda \geq \frac{1}{k^*} \\ \infty & \text{if } \lambda < \frac{1}{k^*} \end{cases}. \quad (11)$$

The pessimistic law of motion is depicted by the dashed line in Figure 13. Note that, since  $k^p(k) \leq k^o(k)$  for all  $k$ , it always holds that  $k^p \geq k^o$ .

The previous section showed that, if costs of default are negligible, risk premia can give rise to multiple steady states. This section shows that, if costs of default are not negligible, risk premia can also give rise to self-fulfilling crises. This possibility arises whenever  $k_t \in [k^o, k^p]$ , which we can think of as the ‘crisis zone’. When the economy is within this zone, both the optimistic and the pessimistic equilibria exist, and the dynamics of the economy depend on expectations. As usual, we model these expectations with a sunspot variable that takes two values, optimism and pessimism.

This simple extension of the model allows us to rigorously interpret changes in the probability

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<sup>22</sup>Note that the pessimistic equilibrium might not exist even if  $k_t$  is so high that domestic residents hold all the sovereign debt. At first it might seem that, since the government is indifferent, defaulting on foreigners is always a best response in this case. Implicitly, we are restricting equilibria to survive to deviations by a positive but arbitrarily small mass of agents. The pessimistic equilibrium might not exist in this case because if a small group of foreigners expected repayment and purchased sovereign debt, the government would indeed prefer to repay them.

of default not as changes in the enforcement technology, but instead as changes in self-fulfilling expectations. There exists a range of capital stocks in which this is possible. If the international financial market expects the probability of default to be zero, investment is high, the costs of default are high and the probability of default it is indeed zero. If instead the international financial market expects the probability of default to be  $1 - \pi$ , investment is low, the costs of default are low and the probability of default is indeed  $1 - \pi$ .

This provides an additional interpretation of events in Europe. The decision to build up debt as a response to the financial crisis of 2007-08 made European economies vulnerable, in the sense that placed them in the crisis zone in which self-fulfilling debt crises are possible. Initially, the international financial market was optimistic and the accumulation of debt had small effects on investment and growth. At some point, the international financial market turned pessimistic and this led to a large drop in investment and growth. If the capital stock is high enough, the economy will converge towards the high steady state and recover partially. If the capital stock is low enough, the economy will converge towards the low steady state and will go down even further. According to this alternative interpretation of the crisis, the troubled economies in Europe have stagnated not only because of their high debt levels, but also because of a self-fulfilling change in expectations.

### **3.2 The (non-)role of debt maturity**

[PRELIMINARY DISCUSSION]

The type of self-fulfilling crises that we focus on here is different from the standard ones identified in the literature (e.g. Cole and Kehoe), which arise when foreigners expect a default and are therefore unwilling to roll-over the country's debt. This means that the country must use tax revenues to pay the maturing debt, which raises the cost of repayment and may therefore trigger the expected default. In our framework, the crisis arises instead because the expectation of default leads domestic residents to demand more debt, crowding-out domestic investment, reducing output and ultimately leading to a default. This type of crisis is brought about because, somewhat paradoxically, it is precisely the risk premium on domestic debt what makes it attractive to domestic residents.

In the traditional model of self-fulfilling crises, a careful handling of debt maturity can solve the problems. This is, unfortunately, not the case here. To see this, let us be more specific about the timing of events within each period. First, there is a sunspot that takes the value "pessimistic" with probability  $\eta$ . Second, the government decides repayment/capital controls. With probability

$\pi$  “institutions work” and the government repays maturing debt, issues new debt, and does not impose capital controls. With probability  $1 - \pi$  “institutions do not work” and the government behaves opportunistically. In this case, the government can do whatever it wants except that, by assumption, it does not default on domestic residents. The government can default on both maturing and non-maturing debt, in which case it suffers a penalty proportional to the market value of all defaulted debt at the end of the previous period (this is analogous to  $d^F$ , but extended to any maturity structure). Third, secondary markets open. It is easy to see that, if the government defaults on foreigners, it also imposes capital controls since otherwise foreigners will sell their bonds in the secondary market to domestic residents. The converse is not true since the government can impose capital controls to prevent domestic purchases of non-maturing bonds even if it does not default.

The analysis of the previous section in which we only allowed for one-period bonds is unaffected. The only difference is that the probability of playing the pessimistic equilibrium is  $\eta \cdot \pi$ . The reason is that, even the pessimistic sunspot is realized, with probability  $1 - \pi$  the government would impose capital controls and eliminate the pessimistic equilibrium. Intuitively, the government can segment domestic and foreign markets and keep domestic residents from purchasing the bonds from foreigners right after they have been issued.

Assume now that the country issues consols that promise to pay 1 in every period. The number of consols issued is adjusted every period so that their market value at the end of each period is  $d$ . What difference does this make relative to the case of one-period bonds? None whatsoever! This can be proved by showing that nobody wants to deviate from the previous equilibrium. If at any point the economy could transit to the pessimistic law of motion with one-period bonds, it could also do so with consols. The market value of purchased debt would be the same and so would be the resulting reduction in investment. The value to the government of defaulting and imposing capital controls is unaffected since debt payments are reduced by the same amount and the default cost is the same as with one-period debt. The government would have the same incentive to impose capital controls to avoid the pessimistic equilibrium as before.

Why does long-term debt not help here as it does in the Cole-Kehoe model? In that model foreigners can at most refuse to buy new debt, but they must hold on to their old debt. The longer debt maturity, the less new debt is issued in each period, the smaller the size of the run by foreign investors. In our model this is not the case. Even if debt is long term, foreigners can sell it to domestic residents. So the size of the run is unaffected by debt maturity.

## 4 Contagion and bailouts

An interesting aspect of the European crisis has been the role of European institutions and third countries. In this section, we extend the theory to study their role. We show how trading sovereign bonds in secondary markets leads to contagion to other countries. We analyze the role of bailouts and other systemic policies.

### 4.1 Contagion

*[...Here we do a multi-country version of the model. A subset of the countries are in a union. We can think, for instance, of Spain and Germany as a pair of small-open economies that trade assets with one another and with the international financial market. What is special about these economies is that their governments do not discriminate (or discriminate less) against each other's citizens, while they do discriminate against citizens of countries outside of the union. The exact reason for this lack of discrimination with the union lies outside of the model: one reasonable assumption is that the costs of default within the union are larger for the defaulting country, as it may imply exclusion from the union or some other form of punishment.*

*The main result of this is that, if one country in the union enters into the region in which discriminatory default is possible, investment falls in all other countries in the union. This is how shocks are transmitted across the union. This seems like contagion and it works even if there are no bailouts or anything else. This is an externality that requires some coordinated action and this is where we move next...]*

### 4.2 Bailouts

*[...Here we show that it is possible that the other members of the union want to bailout the country in trouble. An interesting observation is that, unlike current models, in our setup the bailout has good “ex-ante” effects and bad “ex-post” effects. Here we show how a system of bailouts can raise world efficiency...]*

## 5 Concluding remarks

[TO BE DONE]

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Figure 1: Sovereign Spreads

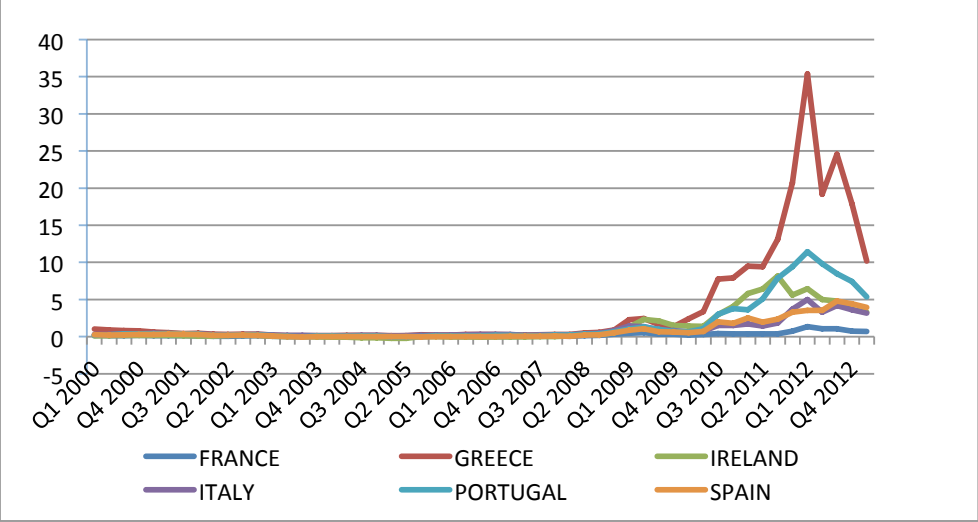
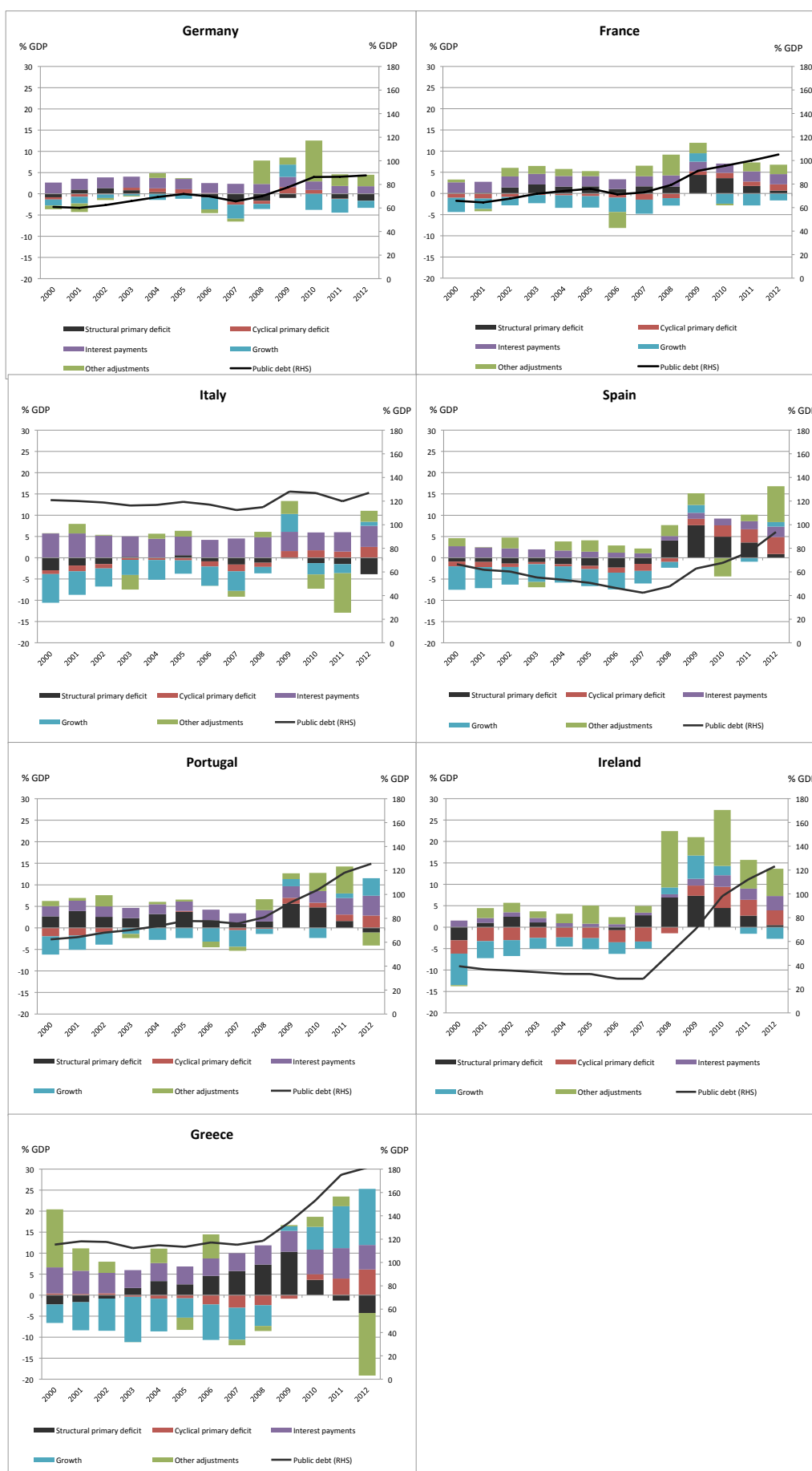
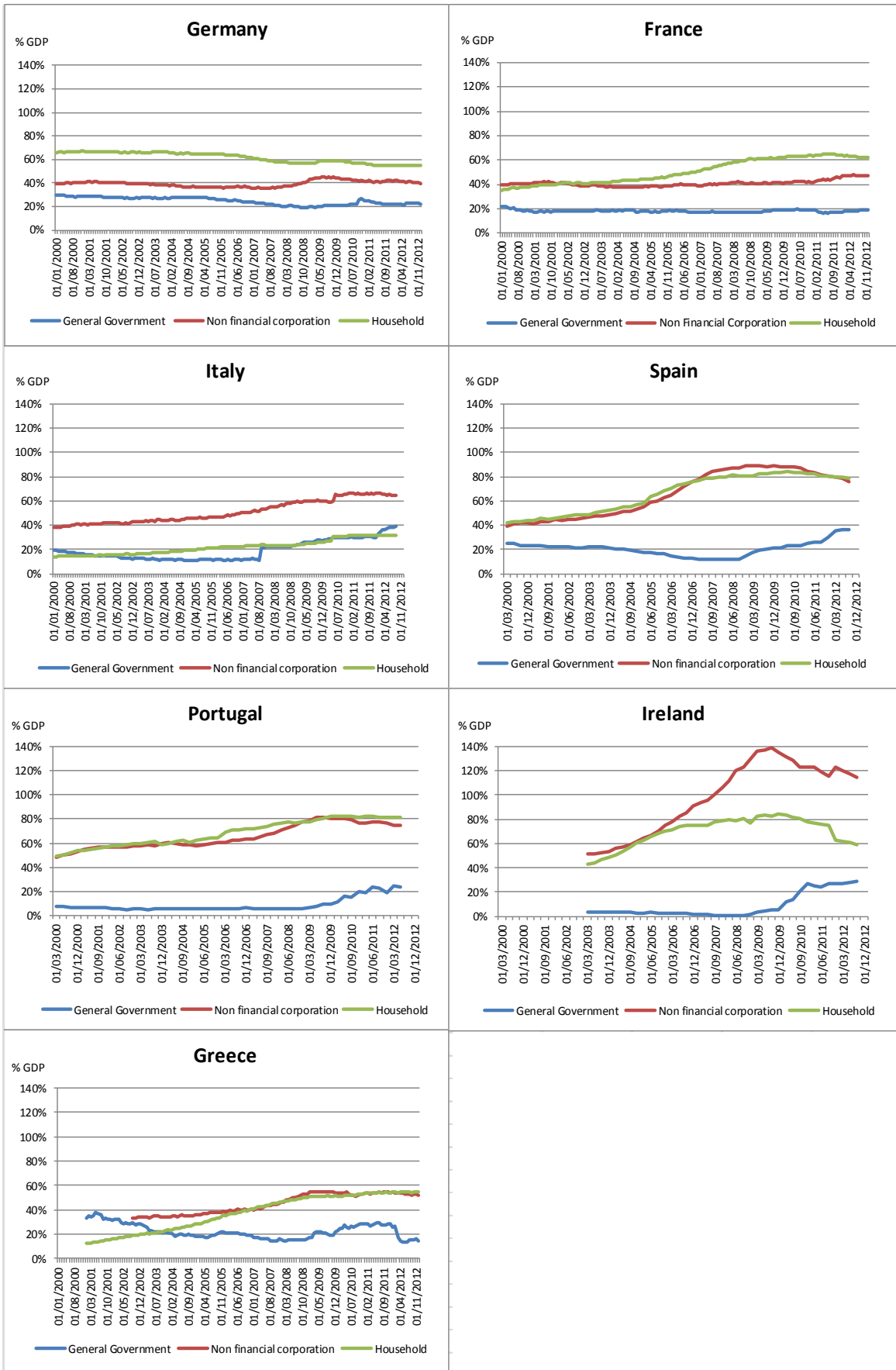


Figure 2: Decomposing Public debt and deficit



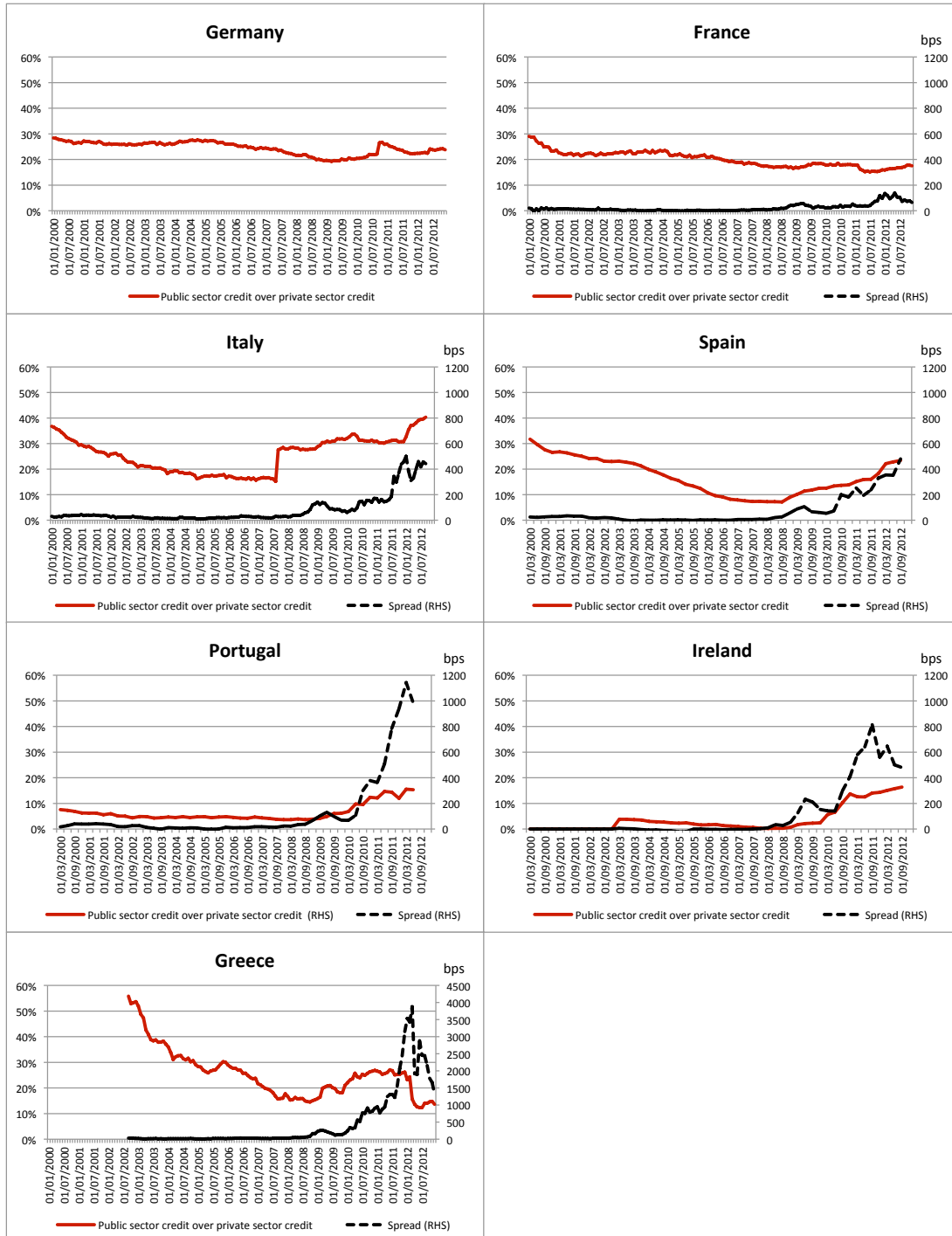
Sources: OECD, Eurostat and authors' calculations.

Figure 3. Bank credit to domestic non-financial sectors



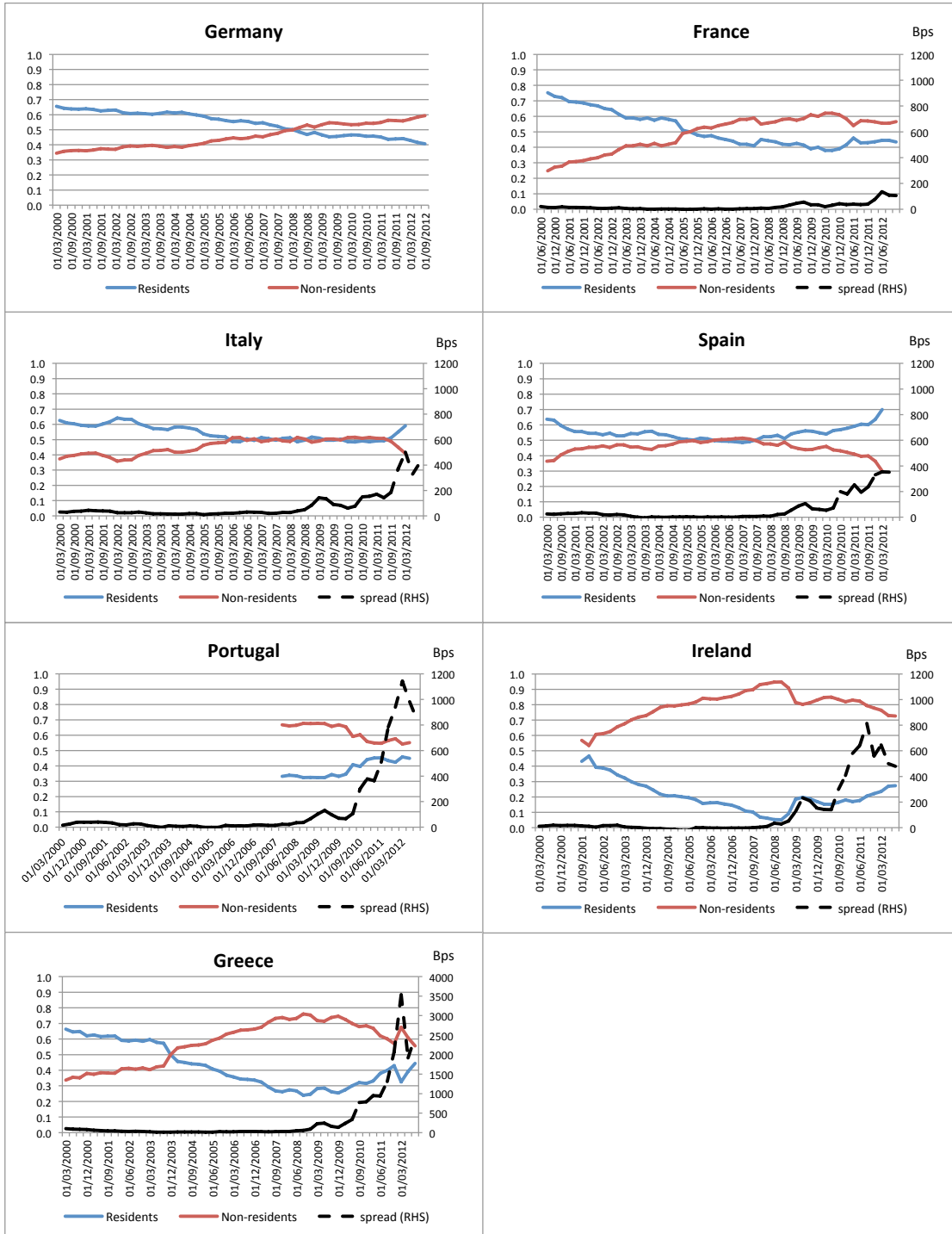
Sources: National Central Banks' Monetary Surveys and authors' calculations.

Figure 4: Domestic bank credit to public versus private sectors and sovereign spreads



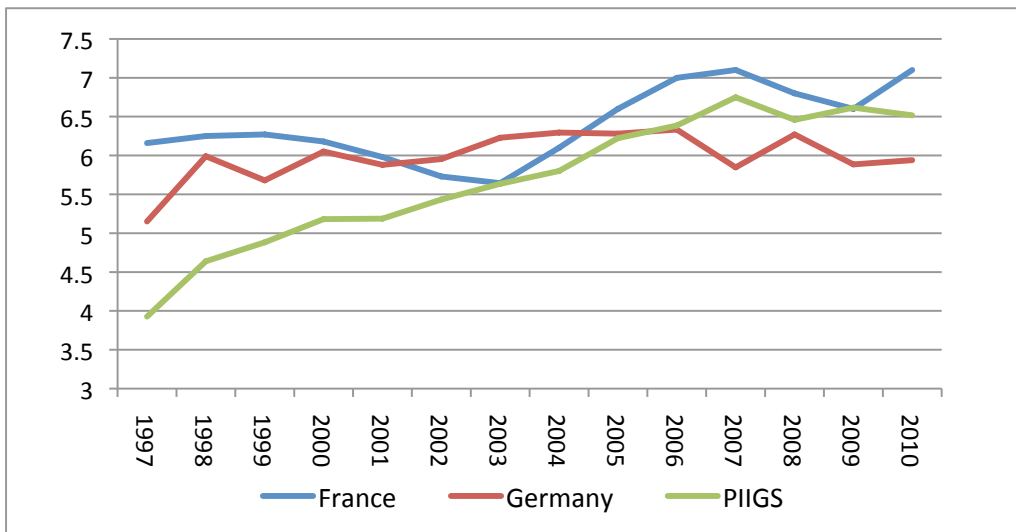
Sources: National Central Banks' Monetary Surveys, Financial accounts, Datastream and authors' calculations.

Figure 5: Sovereign Debt Holdings: Residents versus Non-Residents



Data on sovereign debt holdings comes from Andritzky (2012), Merler and Pisani-Ferry (2012) and Banco de España. Spreads come from Datastream. The spreads refers to the difference in yield between the corresponding reference 10 years bond and the German 10 years Bund. Data on sovereign holdings is nominal value for all countries but Greece, where it mixes market and nominal values. The right hand side axis for Greece presents a wider scale to be able to collect the jump in spreads during 2011.

**Figure 8: Average term to maturity**



Sources: OECD and authors' calculations

Figure 9: The extreme laws of motion

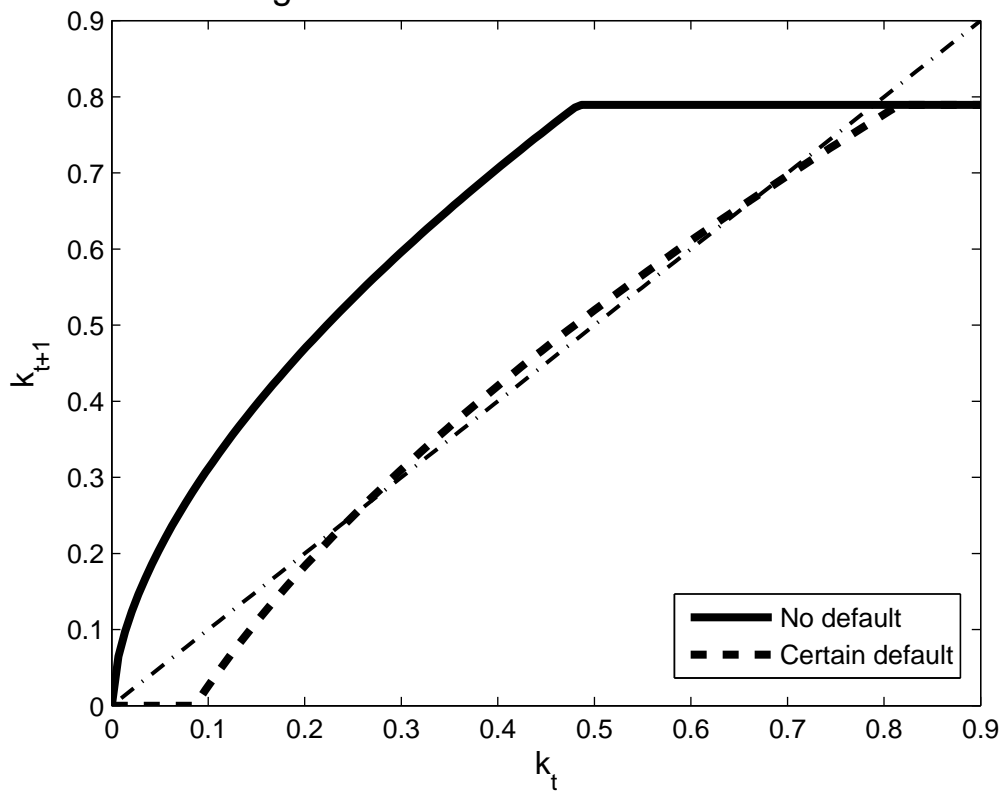




Figure 10: Law of motion with probabilistic default

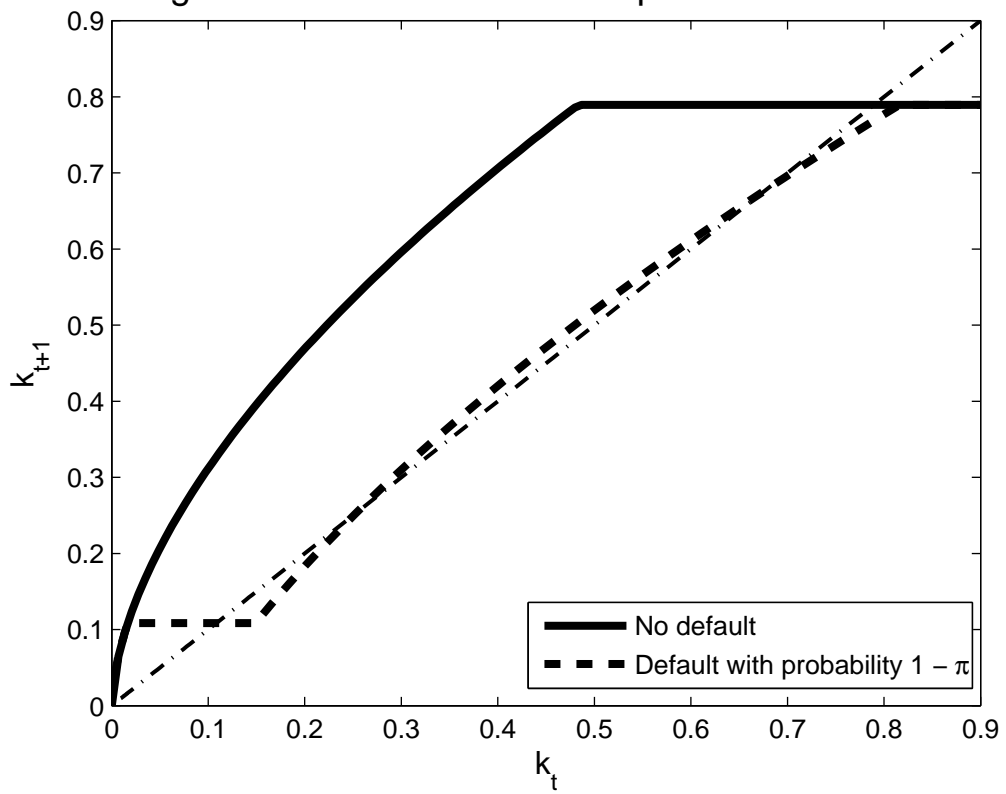


Figure 11: An increase in debt

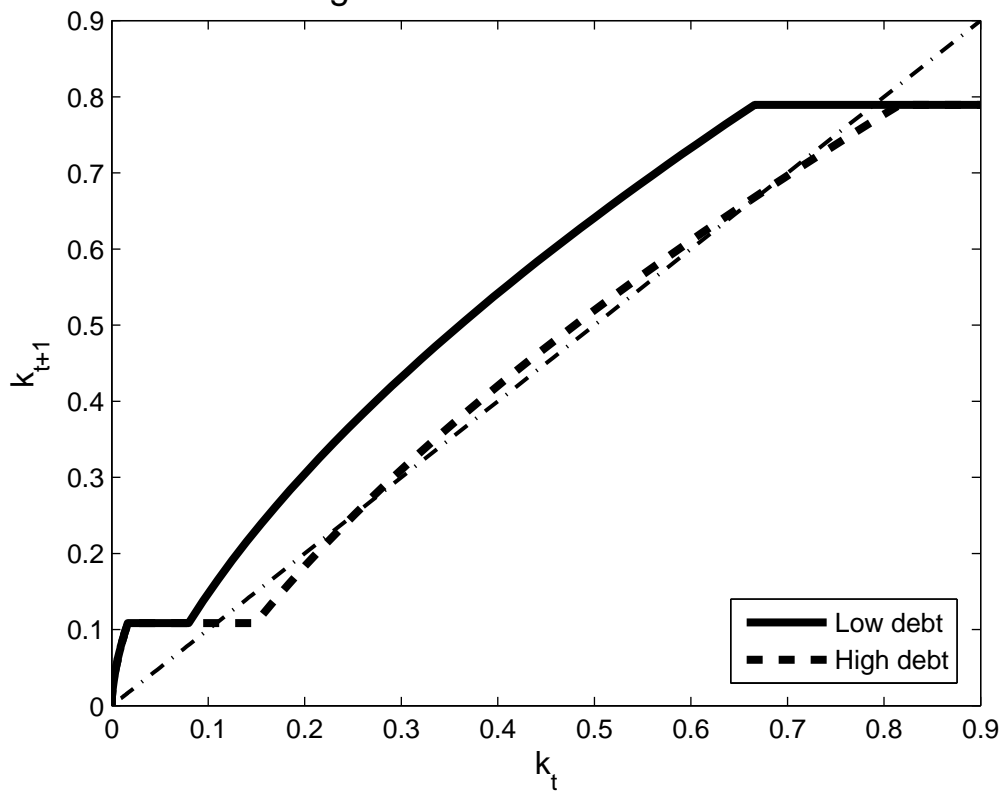


Figure 12: An increase in default probability

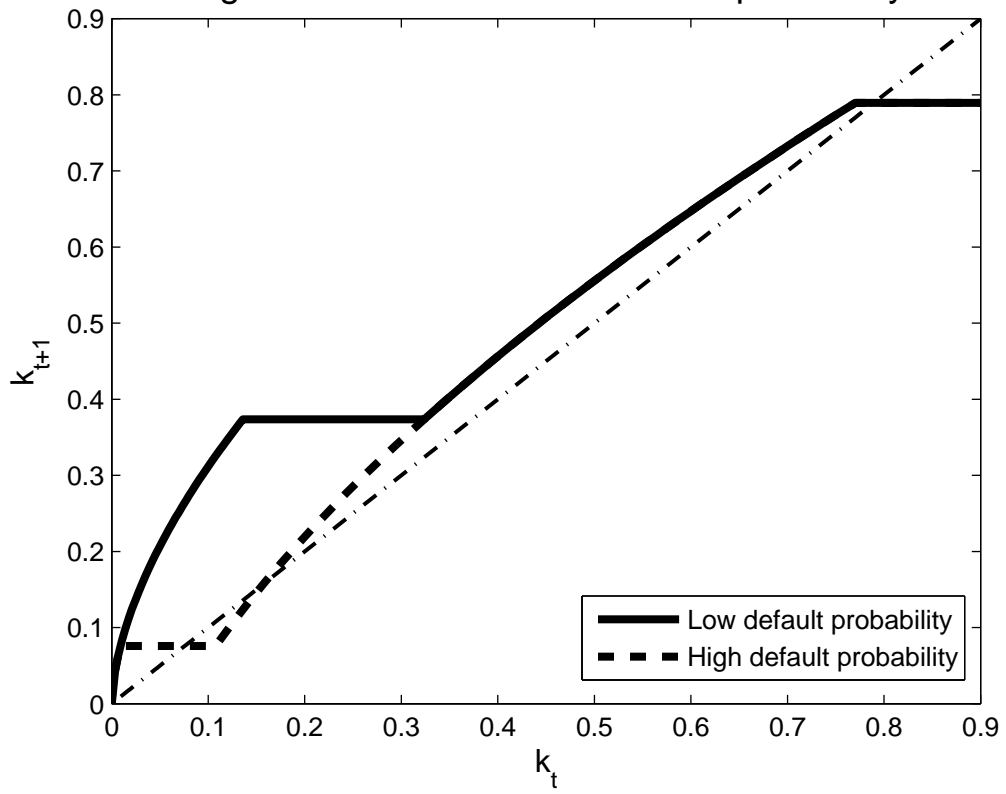


Figure 13: Optimistic and pessimistic laws of motion

