Sovereign Bailouts*

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February 15, 2014

Abstract

JEL classification: F34, F41.
Keywords: Bailouts, Sovereign Default, Moral Hazard

We extend the standard Eaton and Gersovitz (1981) model to study bailout policies. In our setup a country that concentrates a significant fraction of bond holders decide on a period by period basis whether to bailout a debtor government. The combination of bailout policies and decentralized lending decisions give rise to a pecuniary externality.

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1 Introduction

After the 2009 election in Greece, the newly government announced a revised 2009 budget deficit forecast of 12.7% of GDP (the previous estimate was 6.0% and the final figure ended up at 15.6% of GDP) and revised upwards the budget deficits for previous years acknowledging higher government liabilities.[1] The premium on Greek sovereign debt increased from less than 2% by the end of 2009 to almost 10% by May 2010. Rating agencies downgraded Greeks rating from (A-) in early December 2009 to junk bond status by April 2010. The high borrowing cost meant that the Greek government was de facto excluded from bond markets and it is not clear whether the Greek government would have stayed current on its debt obligations if it had not been for the rescue package received on May 2010.[2] Several other European governments faced an significant increase in their borrowing cost in the following months and eventually ended up receiving assistance from members of the European Union and the IMF.[3]

Those rescue packages European raised resistance among some taxpayers in European Union countries that funded them. A commonly cited benefit for those rescue packages was that they could help in averting a further deterioration in the European banking system due to their exposure to sovereign debt of peripheral European countries. For example, Lane (2013) and Allen et al. (2011) discuss that many banks in the more advanced European countries had already suffered losses as a consequence of the U.S. financial crisis. Banks in the more advanced European countries were directly exposed to sovereign risk in peripheral European countries because of their holdings of sovereign debt issued by those countries but also were indirectly exposed to it, for example through claims on banks located in countries in trouble.[4] Those rescue packages also raised moral hazard concerns about private investor behavior. Those rescue packages and other European Central Bank policies were criticized for benefitting investors who

[1] See Zettelmeyer et al. (2012) and Lane (2013) and the references therein for an account of events during the recent European debt crisis.

[2] The Greek government received a three-year loan of €80 billion from the European Union and a loan of €30 from the IMF.

[3] Ireland received a three-year €85 billion loan on November 2010, Portugal received a three-year €78 billion loan on May 2011, and Spain received a loan of €100 billion in 2012.

[4] Concerns about the exposure of European banks to sovereign and other sources of risk motivated various rounds of stress tests (see EBA (2011)).

purchased European sovereign bonds at very low premia prior to 2009.[5]

In this paper we quantitatively investigate this narrative in an Eaton and Gersovitz (1981) setup with two economies. In order to fix ideas, let Germany serve as the stand-in for those countries that incurred in the cost of financing rescue packages, and let Greece serve as the stand-in for those countries that received assistance. We assume that aggregate income in Germany and Greece follows an exogenous stochastic process. Both countries are populated by a unit measure of risk-averse agents and the government's objective in each country is to maximize the welfare domestic residents. In each period, the Greek government makes two decisions: first, it decides whether to default on its debt and second (if it has not defaulted), it decides how many bonds it issues. Greek bonds are purchased by atomistic investors in Germany and by risk-neutral investors that are foreign to these two countries. The risk neutrality of those investors may stem, for example, from a well diversified portfolio. The role of risk-neutral investors in our model is to simplify the pricing of bonds and to endogenize the geographical distribution of sovereign debt. German investors buy Greek bonds taking bond prices as given. At the beginning of each period the German government evaluates extending a bailout to the Greek government. For simplicity, we assume that the bailout consists of a direct one-time transfer. The Greek government receives the transfer only if it repays its debt obligations in the current period. On the one hand, the bailout is beneficial to German agents because it averts wealth losses caused by a Greek default. On the other hand, the bailout is costly because it leads them to lower their current consumption in order to finance the transfer. The German government balances-off those two effects when it designs the current bailout. We assume that the Greek and German government decide their actions on a sequential basis and do not have commitment to future policies.[6] Importantly, we assume that the Greek government cannot selectively default on German or the foreign risk-neutral investors. This means that when the German government extends a bailout, it does not internalize the world-wide negative effects of avoiding a Greek default and, thus, it may not find it optimal avoid all defaults. This setup allows for a negative pecuniary externality raised by

[5]Eventually, private holders of Greek sovereign were forced to realized a loss in the restructuring agreement of 2012.

[6]A more explicit path for future policy actions have been discussed in the European Union (see, for example, European Council (2012)).

the fact that when individual investors in Germany buy Greek debt, they do not internalize the future aggregate bailout cost of their actions.

1.1 Related Literature

The paper extends the quantitative sovereign default model studied in Aguiar and Gopinath (2006), Arellano (2008) and in other recent work by allowing for bailouts between countries.[7] Roch and Uhlig (2012) and Conesa and Kehoe (2011) study bailout policies in a sovereign default model that allows for multiple equilibria a la Calvo (1988) and Cole and Kehoe (2000). In their environment investors face a coordination game. If investors expect the debtor government to default because no investor extends credit in the current period, this may effectively give rise to a default validating investors initial expectations. There are combinations of aggregate state variable at which a debtor government may be vulnerable to such bad equilibria. A bailout policy may help in avoiding those bad equilibria. We focus on a different role for bailouts that abstracts from that inefficiency raised the multiplicity of equilibria.

Bianchi (2011), Bianchi and Mendoza (2013), and Jeanne and Korinek (2010) study setups in which decentralized borrowing introduces a pecuniary externality: individual borrowers do not internalize how their individual decisions increase the probability of a future crisis, which is socially costly. We study a setup in with there is a pecuniary externality because of the combination of decentralized lending decisions and centralized bailout policies.

2 The environment

The baseline model captures the interaction between two types of foreign lenders and a government in a small open economy. We label that economy the borrowing economy. The model extends the canonical Eaton and Gersovitz (1981) model in two dimensions. First, sovereign bonds can be purchased by two groups of atomistic investors. One group of investors is assumed to be risk averse and are concentrated in a single economy, which we label the lending economy.

[7] See, for example, Cuadra and Sapriza (2008), Yue (2010), Mendoza and Yue (2012), Lizarazo (2013), Chatterjee and Eyigungor (2012), and Hatchondo and Martinez (2009)

The other group is risk-neutral and are assumed to be dispersed across various countries. Second, we assume that the government in the lending economy internalizes the effects of the sovereign borrower's defaulting decision on domestic investors and may offer a bailout to the sovereign borrower as long as the borrower stays current on its debt payments.

Endowment and preferences There is a single tradable good. The borrowing economy receives a stochastic endowment stream y_t^B of this good. The lending economy receives a stochastic endowment stream y_t^L of this good. Both y_t^B and y_t^L follow a Markov process and may be correlated with each other.

The government's objective in each of the two economies is to maximize the present expected discounted value of future utility flows of local residents, namely

$$E\left[\sum_{t=0}^{\infty}\beta^{it}u\left(c_t^i\right)\right], \quad \text{for } i = B, L$$

where E denotes the expectation operator, β^i denotes the subjective discount factor of agents in economy i, c^i denotes the consumption of the representative agent in country i, and the utility function is assumed to display a constant coefficient of relative risk aversion denoted by γ. That is,

$$u\left(c\right) = \frac{c^{(1-\gamma)} - 1}{1-\gamma}.$$

Bond market We assume that the government can issue a one-period discount bond but it cannot commit to repay its debt. Each period, the government makes two decisions. First, it decides whether to default. Second, if it has not defaulted in the period, it decides how many bonds to issue

We assume that bonds are priced by the risk-neutral investors that face an outside risk-free interest rate r. Atomistic investors in the lending economy individually decide how many bonds to purchase taking the bond price as given. We assume that agents in the lending economy have only one investment option: the bonds issued by the debtor government.

Defaults We assume that there are no selective defaults. That is, the government cannot selectively default on one group of bond holders. Sovereign defaults are assumed to be ex-post socially costly. Once the government declares a default, it remains in default for a stochastic number of periods. While the government is in default, it cannot issue debt and domestic aggregate income is reduced by a fraction α. We assume that the state of default ends with a time-invariant probability $1-\theta$. Once the default ends, we assume that the government regains access to capital markets. The recovery rate of debt in default is assumed to be zero.

Bailouts We allow the government in the lending economy to offer a transfer of τ goods in the current period to the debtor government if the latter does not declare a default in the current period. It may be optimal for the government in the lending economy to offer such a transfer because a sovereign default is harmful to domestic residents. The transfer is enough to avert a default in the current period. However, it may not be optimal to always avert a default. If investors in the lending economy hold a sufficiently low fraction of the borrowing government's debt, it would be relatively too costly for the government in the lending economy to incur in the cost of averting a default.

2.1 Recursive formulation

None of the two governments can commit to future decisions. Thus, one may interpret this environment as a game in which the governments making decisions in period t are players who take as given the strategies of other players (governments) who will decide after t. We focus on Markov Perfect Equilibria. That is, we assume that in each period, the governments' equilibrium decisions depend only on payoff-relevant state variables.

Decision problems in the borrowing economy The debtor government decides first whether to default on its debt. In doing so, it evaluates the values of repaying and defaulting. The first one is denoted by $V^{B,R}$ and the second one is denoted by $V^{B,D}$. The borrower's value function of at the beginning of the period thus satisfies:

$$V^B\left(W^B, W^L, y^B, y^L\right) = \max_{d\in\{0,1\}} \left\{(1-d)V^{B,R}\left(W^B, W^L, y^B, y^L\right) + dV^{B,D}\left(y^B, y^L\right)\right\},$$

where W^i denotes the post-transfer aggregate financial wealth in economy i. The aggregate post-transfer financial wealth in the borrowing economy consists of the transfer τ received by the government minus total debt outstanding. The aggregate post-transfer financial wealth in the lending economy consists of the bonds purchased by local agents minus the transfer τ.

The value of defaulting only depends on current and foreign income. The second one matters only because it helps predict future income levels in the lending economy. Given the zero recovery rate assumption, and that the transfer τ is conditional on repaying the debt, the total financial wealth is zero in the borrowing and lending economies. Formally, the value function of a government in default satisfies:

$$\begin{aligned} V^{B,D}\left(y^B, y^L\right) &= u\left(\left(1-\alpha\right)y^B\right) \\ &+ \beta^B\left[\theta\int V^B\left(0,0,y^{B'},y^{L'}\right)dF\left(y^{B'},y^{L'}\mid y^B,y^L\right)\right. \\ &+ \left.(1-\theta)\int V^{B,D}\left(y^{B'},y'^{L'}\right)dF\left(y^{B'},y^{L'}\mid y^B,y^L\right)\right], \end{aligned}$$

where $1-\theta$ is the probability with which the default ends at the end of the current period.

If the government repays its debt, it receives the transfer τ, and decides how many bonds to issue in the current period (B'). Formally,

$$V^{B,R}\left(W^B, W^L, y^B, y^L\right) = \max_{B'} u\left(c\right) + \beta^B\int V^B\left(W^{B'}, W^{L'}, y^{B'}, y^{L'}\right)dF\left(y^{B'}, y^{L'}\mid y^B, y^L\right),$$

subject to

$$\begin{aligned} c &= y^B + W^B + q\left(B', G^L\left(B', W^L, y^B, y^L\right), y^B, y^L\right)B', \\ W^{B'} &= \hat{\tau}\left(B', G^L\left(B', W^L, y^B, y^L\right), y^{B'}, y^{L'}\right) - B', \text{ and} \\ W^{L'} &= G^L\left(B', W^L, y^B, y^L\right) - \hat{\tau}\left(B', G^L\left(B', W^L, y^B, y^L\right), y^{B'}, y^{L'}\right). \end{aligned}$$

The function G^L denotes the perceived aggregate bond accumulation by agents in the lending economy and the function $\hat{\tau}$ denotes the perceived transfer rule that the government in the lending

economy will follow in every future period. The price at which the government issues debt is denoted by q. It depends on the total debt issued by the borrowing government because that will affect future incentives to default, it depends on the total debt bought by agents in the lending economy because that is likely to affect future bailout incentives and, thus, future incentives to default by the debtor government.

Bond prices We assume that bond prices are determined by the zero expected profit condition of risk-neutral investors, namely

$$q\left(B', B^{L'}, y^B, y^L\right) = \frac{1 - \int \hat{d}\left(W^{B'}, W^{L'}, y^{B'}, y^{L'}\right) dF\left(y^{B'}, y^{L'} \mid y^B, y^L\right)}{1+r} \text{ for all } B' \text{ and } B^{L'}.$$

where$\hat{d}$ denotes the defaulting rule followed by the debtor government. The post-transfer financial wealth for the next period satisfy

$$W^{B'} = \hat{\tau}\left(B', B^{L'}, y^{B'}, y^{L'}\right) - B'.$$

and

$$W^{L'} = B^{L'} - \hat{\tau}\left(B', B^{L'}, y^{B'}, y^{L'}\right).$$

Individual decision problems in the lending economy If the debtor government repays its debt in the current period, each atomistic investor in the lending economy collects a bond payoff of b^L at the beginning of the period and transfers τ resources to its government in order to support the bailout transfer, and buys $b^{L'}$ bonds issued by the debtor government. Formally

$$\begin{aligned} V^{L,R}\left(B', w^L, W^L, y^B, y^L\right) &= \max_{0 \leq b^{L'} \leq B'} u\left(c\right) \\ &+ \beta^L \int V^L\left(B', b^{L'}, B^{L'}, y^{B'}, y^{L'}\right) dF\left(y^{B'}, y^{L'} \mid y^B, y^L\right) \end{aligned}$$

subject to

$$c = y^L + w^L - q\left(B', B^{L'}, y^B, y^L\right) b^{L'},$$

where $w^L = (1 - \hat{d}\left(W^B, W^L, y^B, y^L\right))(b^L - \tau)$ denotes the current post-transfer financial wealth of each investor in the lending economy. Note that the bond price q does not depend on individual bond accumulation policies but on the aggregate bond accumulation in the lending economy $B^{L'} = G^L\left(B', W^L, y^B, y^L\right)$. The continuation value V^L depends on the default rule $\hat{d}$ and borrowing rule G^B followed by the debtor country and the transfer rule $\hat{\tau}$. That is,

$$\begin{aligned} V^L\left(B, b^L, B^L, y^B, y^L\right) &= \left(1 - \hat{d}\left(W^B, W^L, y^B, y^L\right)\right) V^{L,R}\left(G^B\left(W^B, W^L, y^B, y^L\right), w^L, W^L, y^B, y^L\right) + \\ &\quad \hat{d}\left(W^B, W^L, y^{B'}, y^{L'}\right) V^{L,D}\left(y^B, y^L\right), \end{aligned}$$

where current post-transfer financial wealth in the borrowing economy is $W^B = \hat{\tau}\left(B, B^L, y^B, y^L\right) - B$, post-transfer aggregate financial wealth in the lending economy is $W^L = B^L - \hat{\tau}\left(B, B^L, y^B, y^L\right)$, and the individual post-transfer financial wealth $w^L = b^L - \hat{\tau}\left(B, B^L, y^B, y^L\right)$, and the value function under default $V^{L,D}$ satisfies

$$\begin{aligned} V^{L,D}\left(y^B, y^L\right) &= u(y^L) + \beta^L \left[\theta \int V^L\left(0, 0, 0, y^{B'}, y^{L'}\right) dF\left(y^{B'}, y^{L'} \mid y^B, y^L\right)\right. \\ &+ \left. (1 - \theta) \int V^{L,D}\left(y^{B'}, y'^{L'}\right) dF\left(y^{B'}, y^{L'} \mid y^B, y^L\right)\right]. \end{aligned}$$

Government's decision problem in the lending economy The government in the lending economy anticipates the defaulting and borrowing rules by the debtor government and individual bond buying policy of domestic agents and offer a transfer τ that maximizes aggregate domestic welfare. Formally the bailout transfer $\hat{\tau}$ satisfies

$$\hat{\tau}\left(B, B^L, y^B, y^L\right) = \underset{\tau}{argmax} \left\{ \begin{array}{c} \left(1 - \hat{d}\left(W_\tau^B, W_\tau^L, y^B, y^L\right)\right) V^{L,R}\left(G^B\left(W_\tau^B, W_\tau^L, y^B, y^L\right), W_\tau^L, W_\tau^L, y^B, y^L\right) + \\ \hat{d}\left(W_\tau^B, W_\tau^L, y^{B'}, y^{L'}\right) V^{L,D}\left(y^B, y^L\right) \end{array} \right\}.$$

The variable $W_\tau^B = \tau - B$ denotes the post-transfer financial wealth in the borrowing economy conditional on a transfer τ and $W_\tau^L = \tau - B$ denotes the post-transfer (individual and aggregate) financial wealth in the lending economy conditional on a transfer τ.

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