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by

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Sovereign Borrowing, Financial Assistance and Debt Repudiation*

Florian Kirsch and Ronald Rühmkorf†

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Abstract

Official lenders provide financial assistance to countries that face sovereign debt crisis. The availability of financial assistance has counteracting effects on the default incentives of governments. On the one hand, financial assistance can help to avoid defaults by bridging times of fundamental crises or resolving coordination failures among private investors. On the other hand, the insurance effect of financial assistance lowers borrowing costs which induces the sovereign to accumulate higher debt levels. To assess the overall effect of financial assistance on the probability of default we construct a quantitative model of endogenous credit structure and sovereign default that allows for self-fulfilling expectations of default. Calibrating the model to Argentinean data we find that the availability of financial assistance reduces the number of defaults that occur due to self-fulfilling runs by private investors. However, at the same time it raises average debt levels causing an overall increase of the probability of default.

Keywords: Sovereign debt, Sovereign default, Self-fulfilling runs, Bailout

JEL Classification: F34, G15, O19

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1 Introduction

Does the availability of financial assistance help to avoid sovereign defaults? In the light of the European sovereign debt crisis this question has again become a pressing concern for policymakers. The overall impact of the availability of financial assistance is a priori unclear as it leads to two counteracting effects. On the one hand, financial assistance as provided e.g. by the International Monetary Fund (IMF) or the European Stability Mechanism (ESM) can counter runs by investors due to self-fulfilling default expectations and bridge deficits in times of low output and high debt levels. On the other hand, by providing insurance the availability of financial assistance lowers risk premia for troubled countries on international capital markets for a given debt level. Such a downward shift in borrowing costs might induce governments to raise debt levels and thus increase default incentives. We analyze the implications of the availability of financial assistance quantitatively within a model of sovereign default. The model features defaults due to bad fundamentals, runs by investors due to multiple equilibria, and an official lending facility that captures the main characteristics of actual international financial institutions. Runs on sovereign debt markets constitute a major threat for indebted governments as they can push countries into default that have in principle sound fundamentals and would not default otherwise. An official lending facility can help to prevent the possible coordination failure as financial assistance supplies the government with funds even when there might be a run by private investors on the market for government debt.

Our model is based on the standard sovereign default model à la Eaton and Gersovitz (1981) and builds on Cole and Kehoe (2000) by considering multiple equilibria due to runs by investors. The government of a small open economy can borrow both from private international investors and from an official lending facility. Each period the government decides whether to repay its debt or to default on its obligations. A default entails exclusion from international financial markets and a loss in output. Bailout loans are commonly protected by seniority clauses which give official lenders a preferred creditor status. We include this characteristic into the model: The government can either default on its market debt only or jointly on both types of debt.[1] In addition to defaults by the government that are caused by bad fundamentals, the private debt market is prone to self-fulfilling runs, in which the investors refuse to provide new credit and the government defaults. Market debt is priced endogenously by risk neutral

[1] In the following the term 'market debt' denotes credit provided by private international investors on international debt markets. We use the terms 'bailout loans' or 'financial assistance' for credit provided by the official lending facility.

international investors acting on perfectly competitive markets. In contrast, bailout loans are always provided according to a fix price schedule that contains a surcharge on the risk-free interest rate. Using financial assistance is therefore unattractive for a country that can borrow at the risk-free rate from international investors. However, when default risk and risk premia are high, turning to bailout loans becomes relatively more attractive. In exchange for loans, the official lending facility demands policy adjustments ('conditionality') from the government: The government has to restrict deficits as long as it keeps making use of financial assistance.

For our quantitative analysis we calibrate the model to match the data around the Argentinean default in 2001. During this crisis Argentina resorted to the IMF for financial assistance. At its peak in 2002, the use of IMF loans by Argentina reached close to 15 percent of GDP, which is at the upper end of the observed ratios for the crisis events in emerging economies between 1994 and 2002 (see Figure 1).[2] Our model captures key features of Argentinean business cycle statistics. To analyze the effect of the presence of the official lending facility on the default probability we compare our benchmark model and a version of the model without bailout loans. We find that the availability of financial assistance reduces the frequency of run-driven defaults. However, its presence leads to substantially higher debt levels and a small *overall increase* in the default probability. For a given level of market debt the presence of financial assistance reduces the probability of a default by providing credit at comparatively low interest rates when international investors charge prohibitively high interest rates. At the same time it reduces the size of the *crisis zone*. The crisis zone consists of combinations of output and debt levels for which a self-fulfilling debt run can occur due to a coordination failure among investors. The reduction of the size of the crisis zone leads to a decrease in the number of run-driven defaults. Hence, defaults on market debt become, all else equal, less likely. This insurance effect of the financial assistance reduces the interest rates charged by international investors. Lower interest rates in turn induce the country to increase its borrowing. This general equilibrium effect leads to larger average debt stocks compared to the model without financial assistance. Larger debt stocks make a government default more likely. For our benchmark calibration we find that the general equilibrium effect outweighs the insurance effect and the default probability is higher in the presence of the official lending facility.

Our model builds on the strand of literature that analyzes the incentives of governments

[2] A detailed empirical account of default events in several emerging markets economies in the 1990s and early 2000s is provided by Sturzenegger and Zettelmeyer (2006), while Roubini and Setser (2004) examine the crisis events of that time with a special focus on the implications regarding crisis resolution policies.

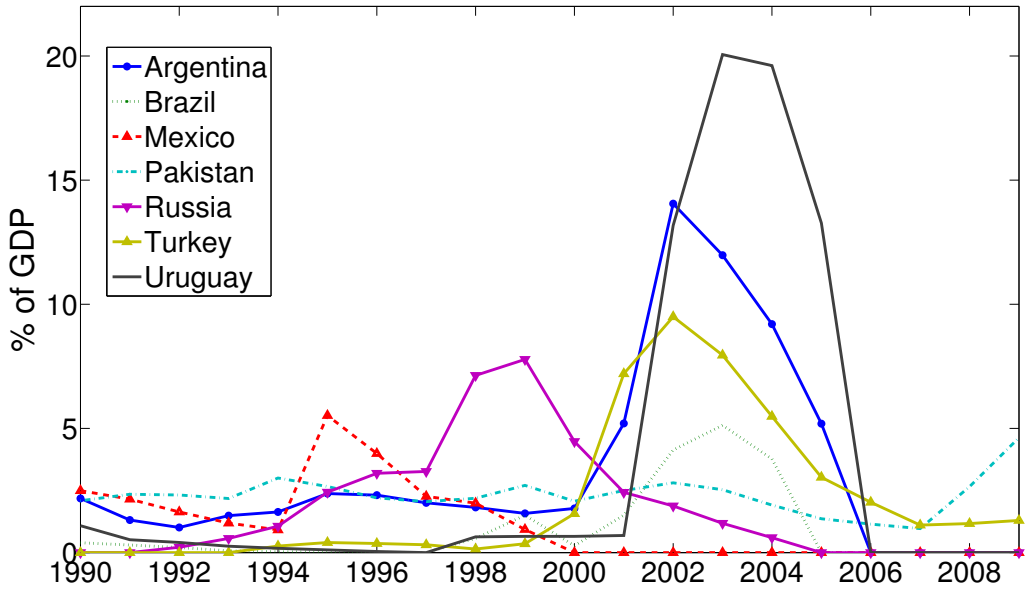

Figure 1: Use of IMF credit relative to GDP of selected countries in financial crises. Data source: Worldbank.

to default on their debt when bond contracts are unenforceable. Eaton and Gersovitz (1981) show that when default is punished, certain levels of government debt can be sustainable in equilibrium even when bond contracts are not enforceable. The government chooses not to default on its debt as long as the costs associated with a default are higher than the utility gains due to the omitted repayment. Arellano (2008) studies the quantitative implications of this model by applying it to the Argentinean default event in 2001 and shows that a calibrated version of the model is able to replicate important features of the Argentinean data. Multiple equilibria in models of sovereign default have been analyzed by Calvo (1988) and Cole and Kehoe (1996; 2000). In the Cole and Kehoe model there exists an interval of debt levels, the crisis zone, for which the government finds it optimal to default only in case it cannot issue new debt because of a run on the sovereign debt market.

Our paper is also related to recent work by Boz (2011), Fink and Scholl (2011), and Roch and Uhlig (2012) who study bailouts in a model of optimal default.[3] Boz (2011) includes bailout loans supplied by a third party (the IMF) along with market debt held by foreign private

[3] Aguiar and Gopinath (2006) briefly discuss an unconditional bailout grant in a sovereign default model with trend shocks.

investors. She assumes that IMF credits are repaid for sure and shows that her model is able to reproduce the countercyclical use of IMF loans while market debt is used procyclically.[4] Fink and Scholl (2011) model bailout loans as a grant that is constantly available to the government and associated with a restriction on government spending. Their model is able to mimic the empirical duration and frequency of bailout programs. In contrast to our model, both papers do not consider self-fulfilling runs on side of the investors and model bailouts differently. Roch and Uhlig (2012) embed multiple equilibria into an Arellano-type model and analyze a bailout agency that possesses a sufficient amount of funds to guarantee the actuarially fair price of the sovereign debt at all times. Considering this theoretical bailout mechanism, the model illustrates the effect of a bailout agency that can distinguish between fundamental crisis and runs and eliminates self-fulfilling runs completely. Similar to Roch and Uhlig (2012) we allow for runs by investors in an Arellano-type model. The focus of our model is however different as we model the official lending facility such that it captures the main characteristics of observed official lending. One of the key problems of official lenders is to identify whether the demand for bailout loans derives from a run on sovereign debt markets or from bad fundamentals. We incorporate this property into our model by the assumption that the official lending facility always provides financial assistance according to a fixed price schedule. Furthermore, we model conditionality and seniority associated with bailout loans.

Bailout loans are also considered in the literature using global games methods. Corsetti, Guimarães, and Roubini (2006) develop a three-period model to analyze bailouts and the implications of the liquidity support on moral hazard. They find that limited contingent liquidity support can help to prevent liquidity runs by raising the number of investors willing to lend to the country. Moreover, they identify circumstances in which official lending actually strengthens a government's incentive to implement desirable but costly policies. Morris and Shin (2006) find similar results.

The rest of this paper is organized as follows: Section 2 decribes the benchmark model used for our analysis. Section 3 discusses the calibration of the model and describes the employed solution method. Section 4 presents the results of our quantitative analysis and Section 5 concludes.

[4] Dellas and Niepelt (2011) show in a two-period model that a debt agreement with a lending partner that possesses a better enforcement technology can be beneficial both for the lending and the borrowing country, and that the bilateral loans are used more during times of crises than in times with good economic conditions and low interest rates on the private market.

2 Model

2.1 Preferences and endowments

Our analysis is set in a small open economy with an infinite time horizon. The preferences of the representative household of the small open economy are given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t\right), \tag{2.1}$$

where c_t is consumption in period t, $\beta \in (0,1)$ is the discount factor, and E_0 is the expectation operator. The period utility function $u\left(\cdot\right)$ is strictly increasing and strictly concave and hence implies risk aversion.

The country receives a stochastic stream of endowments which follows a Markov process. In each period the benevolent government of the small open economy decides on the debt policy of the country in order to maximize the discounted sum of the household's utility by borrowing or lending on international financial markets. The government can trade bonds with international financial investors and has access to a limited amount of bailout loans. The bailout loans are provided by a supranational official lending facility which represents an International Financial Institution (IFI) like the IMF or bilateral agreements with other countries. All loans have a maturity of one period.[5] As long as the government repays all of its debt, the country faces the following resource constraint:

$$c = y + q^d\left(d', h', y\right) d' - d + q^h\left(h'\right) h' - h. \tag{2.2}$$

where y is the country's endowment income, d denotes the country's outstanding debt (i.e. positive values of d imply that the government is indebted), and q^d is the price the government receives for newly issued market bonds (next period's variables are indicated by a prime). The variable h denotes the amount of bailout loans borrowed from the official lending facility and q^h is the price of these loans.

[5] One period bonds are also used e.g. by Arellano (2008) and Boz (2011). Chatterjee and Eyigungor (2012) and Hatchondo and Martinez (2009) analyze long term loans with a fixed maturity while only considering one type of debt.

2.2 International investors

We assume that international investors are acting in perfectly competitive markets. They can borrow and lend at world financial markets at a risk-free interest rate r and are risk neutral.[6] Following Cole and Kehoe (2000), we allow for self-fulfilling crises during which a run by the investors triggers a government default. Given that in a certain period there is no run, the international investors' profit maximization implies the following bond price equation, which ensures zero profits in expectation:

$$q^d\left(d', h', y\right) = E_{\zeta', y'|y}\left[\frac{1-\delta\left(d', h', y', \zeta'\right)}{1+r}\right]. \tag{2.3}$$

The investors price the bond by forming expectations over the sunspot shock ζ' and next period output y' which, along with the government debt level, influence the default decision $\delta\left(d', h', y', \zeta'\right)$. As output is assumed to follow a Markov process, expectations about next period output are formed conditional on the current output level. The indicator variable δ denotes the default decision of the government in the next period. If the government either defaults on market debt only or on both types of debt, δ takes a value of one. If there is no default and the government fulfills all its debt obligations, δ equals zero. Anticipating the government's default decision, the investors take into account the probability of a default for a given choice of d' and h' and adjust the bond price accordingly. The equilibrium interest rate on sovereign debt held by private international investors hence rises with the risk of a default as the investors demand a risk premium for compensation.

As we will explain in more detail in Section 2.4, there are certain combinations of the state variables d, h, and y for which self-fulfilling crises become possible. In this crisis zone there are two possible equilibria: In one equilibrium, the investors are willing to provide new lending, the government rolls over its debt, and there is no default. In the other equilibrium, the investors expect the government to default and hence do not provide new credit for a rollover of the outstanding government debt and the sovereign defaults. We use the sunspot variable ζ to determine which of these two equilibria realizes. ζ is assumed to be i.i.d. over time and takes a value of one with probability π and a value of zero with probability $(1-\pi)$. If the country is in the crisis zone, a realization of $\zeta = 1$ induces a run by the investors. The investors anticipate the probability of a run-driven default by the government in the next period which depends on

[6] See Lizarazo (2012) for a model of sovereign default with risk averse lenders.

the realization of ζ'. If there is a run already in the *current* period (induced by $\zeta = 1$), the investors are not willing to provide any lending to the government at a positive bond price. Thus the bond price in the current period is equal to zero and no longer given by equation (2.3).

2.3 Official lending facility

As long as the country is in good credit standing, it can make use of financial assistance from an official lending facility. We assume that the lending facility always provides financial assistance, independent of whether the country's demand for bailout loans derives from a run or high interest rates that are driven by bad fundamentals. Following Boz (2011), the price of bailout loans q^h is not determined by a market mechanism, but set by the official lending facility according to an exogenously fixed schedule. Hereby we capture the fact that the lending conditions of the official lending facility are rather guided by political decisions (which we do not model) than by pure profit considerations. Consistent with the actual price schedule of IMF loans, we assume that the price depends on the amount of bailout loans demanded.[7] The exogeneity of the bond price for bailout loans makes it necessary to impose a maximum h_{max} on the amount of bailout loans. Otherwise a country in good credit standing could always borrow arbitrarily large amounts before declaring default in the next period.[8] To capture important characteristics of actual official lending we model bailout loans to be senior to market debt (see Section 2.4). Furthermore, we assume that the official lending facility possesses a better punishment technology than the private international investors, i.e. the punishment after a default on bailout loans is stronger than the punishment after a default on market debt only. This seems plausible as a default on bailout loans might lead to an even stronger loss of reputation. Moreover, the official lenders might use political measures like sanctions, which are not available to international investors, to punish the defaulting country.

The government can only borrow from the official lending facility if it complies with conditionality obligations set by the facility. The IMF provides loans to troubled countries con-

[7] According to the IMF's lending policies for the so called 'stand-by arrangements', the effective total interest rate demanded from borrowers consists of a number of different fees and charges that are added to the riskless interest rate (International Monetary Fund, 2012). Some of the additional charges are independent of the size of the loans (e.g. there is a 50 basis points service charge). Other surcharges on the interest rate are increasing with the size of the demanded IMF loans, as e.g. the 'surcharge for large loans' of 200 basis points for loans sizes above 300 percent of the country's quota.

[8] This problem does not exist when the bond price is determined on the private debt market. In this case, international investors assess the default probability and the bond price falls to zero when the default probability approaches one.

ditional on certain policy adjustments. The requirements of this conditionality are aimed at resolving the balance of payment and government debt problems of the borrower. They include macroeconomic and structural measures (Bird, 2007). An additional rationale for imposing conditionality is to alleviate debtor moral hazard problems (Guitián, 1995). A large part of these measures is related to fiscal policy and may include amongst others limits on the budget deficits and on the level of external debt (International Monetary Fund, 2002). We capture important program features by assuming that a government that is borrowing from the official lending facility has to follow a debt adjustment program. As long as the government holds positive amounts of bailout loans, its decision on new debt is bounded by the following constraint on total new borrowing:

$$d' + h' \leq \lambda \left(d + h \right). \tag{2.4}$$

The parameter λ determines the strictness of the conditionality: For λ above one, the total debt of the country is still allowed to increase, but at most by $(\lambda - 1) \times 100$ percent per period. For a λ below one, total debt has to decrease by $(1 - \lambda) \times 100$ percent per period. For the case of a default on market debt we assume $\lambda = 1$ which implies that the country may not increase its amount of bailout loans.

2.4 Decision problem of the government

In each period the government takes two decisions. First, it has to decide whether to default or not. Second, in case the government does not default on its old debt, the government has to decide on the amount of new debt (market debt and bailout loans). We assume that the country can either default on market debt only or on both market debt and bailout loans at the same time. We allow for the former option because historical evidence shows that countries defaulted on their debt obligations to private international investors while receiving IMF support (see e.g. Sturzenegger and Zettelmeyer, 2006). However, a default on bailout loans without simultaneous default on market debt is not allowed as loans from the IMF are contractually protected by seniority clauses.

The government's choice between the different options depends on the specification of the respective consequences. As commonly assumed in the literature, default always occurs on the

full amount of outstanding debt.[9] After a default, the country is excluded from financial markets for a limited time and incurs an output cost $l(y) \geq 0$.[10] During the exclusion period the country can thus only consume its endowment net of the output cost: $y_t^{def} = y_t - l(y_t)$. A country that has defaulted on its debt only regains access to financial markets with a certain probability. While we assume the output cost to be the same for both types of default, the average exclusion length depends on the type of default. A country that defaults on market debt only is modeled to have a shorter average exclusion length than a country that defaults on both market debt and bailout loans simultaneously. We therefore distinguish between the probability to return to financial markets after a default on market debt only, θ, and the probability to return to financial markets after a default on both types of debt, θ_H, with $\theta \geq \theta_H$. Both probabilities are assumed to be constant over time. The difference in average exclusion length reflects that the official lending facility has a stronger commitment to punish a defaulting sovereign than a private creditor.

The value of being in good credit-standing $V^o(d, h, y, \zeta)$ depends on the amount of outstanding debt (market debt and bailout loans), the income state, and the sunspot variable ζ. It is given by the maximum of the three possible options of repayment or default:

$$V^o(d, h, y, \zeta) = \max\left\{V^c(d, h, y, \zeta), V^{defD}(h, y), V^{defDH}(y)\right\}. \tag{2.5}$$

V^c is the value of repayment of both types of debt. In this case the country fulfills its contractual obligations, i.e. it pays back its outstanding debt (market debt and bailout loans), and chooses the optimal level of new market debt and bailout loans. V^{defD} is the value of defaulting on market debt only and consequently continuing without access to private credit markets. V^{defDH} is the value of defaulting on both market debt and bailout loans and losing access to both types of borrowing.

The value function associated with a default on market debt only, V^{defD}, is given by:

[9] An exception is Yue (2010), who considers a model of debt renegotiation where the haircut is determined in a Nash bargaining between debtor and creditor.

[10] For a discussion of the empirical evidence see Panizza, Sturzenegger, and Zettelmeyer (2009).

$$V^{defD}(h,y) = \max_{\{h'\}} \Bigg\{ u\left(y^{def} + q^h(h')\,h' - h\right) + \beta \int_{y'} \Big[\theta\big[(1-\pi)\,V^o(0,h',y',0) + \pi V^o(0,h',y',1)\big] + (1-\theta)\,V^{defD}(h',y')\Big] f(y',y)\,dy' \Bigg\}. \tag{2.6}$$

In this case, the country still fulfills its contractual obligations with the official lending facility, but has zero market debt as it just defaulted. The value V^{defD} is therefore independent of d and the sunspot shock ζ. With probability θ the country can return to international financial markets in the next period. π is the probability that the sunspot variable takes a value of one. $f(y',y)$ denotes the transition probability to income state y' in the next period given income state y in the current period.

After a default on both types of debt the country has no access to further borrowing and the households can only consume the endowment. The value function for a default on both types of debt, V^{defDH}, is given by:

$$V^{defDH}(y) = u\left(y^{def}\right) + \beta \int_{y'} \Big[\theta_H\big[(1-\pi)\,V^o(0,0,y',0) + \pi V^o(0,0,y',1)\big] + (1-\theta_H)\,V^{defDH}(y')\Big] f(y',y)\,dy'. \tag{2.7}$$

The value of debt repayment, V^c, is given by:

$$V^c(d,h,y,\zeta) = \max_{\{d',h'\}} \Bigg\{ u\big(y + q^d(d',h',y)\,d' - d + q^h\left(h'\right)h' - h\big) + \beta \int_{y'} \Big[(1-\pi)\,V^o(d',h',y',0) + \pi V^o(d',h',y',1)\Big] f(y',y)\,dy' \Bigg\}. \tag{2.8}$$

For certain combinations of the state variables the government prefers to repay its debt only

if it has access to new borrowing but it defaults if it cannot roll over its maturing debt. In this case self-fulfilling debt runs can emerge due to a coordination failure among international investors. Given that there is a run by the investors, the country has no access to new market debt ($d' = 0$). To facilitate the following exposition, we introduce V^c_{run} to denote the value of repayment *in case of a run*, i.e. V^c_{run} is V^c for combinations of the state variables that imply a run. V^c_{run} is given by:

$$V^c_{run}(d,h,y,1) = \max_{\{h'\}} \Bigg\{ u\big(y - d + q^h(h')\,h' - h\big) + \beta \int_{y'} \Big[(1-\pi)\,V^o(0,h',y',0) + \pi V^o(0,h',y',1) \Big] f(y',y)\,dy' \Bigg\}. \tag{2.9}$$

Figure 2 illustrates the decision problem of the government. It shows the four different values for an intermediate output level in a situation where the government has no outstanding bailout loans. The two values of repayment decrease in the level of outstanding debt as the funds repaid to the investors cannot be consumed by the households.[11] For low levels of market debt, both the value of repayment without a run, $V^c(d,h,y,0)$, and the value of repayment with a run, $V^c_{run}(d,h,y,1)$, lie above the value of default, which does not depend on the level of outstanding debt. In this region the government would not default even if there was a run by the investors. Anticipating this, the investors would not run in the first place and no self-fulfilling crisis is possible for the given state combination. However, with increasing levels of outstanding debt the distance between $V^c(d,h,y,0)$ and $V^c_{run}(d,h,y,1)$ increases and for an interval of intermediate amounts of outstanding debt $V^c(d,h,y,0)$ lies above $V^{defD}(h,y)$, while $V^c_{run}(d,h,y,1)$ lies below $V^{defD}(h,y)$. This is the crisis zone where self-fulfilling crises become possible as the government only prefers to default in case of a run. Rational investors anticipate the behavior of the government. Consequently, if an individual investor expects the other investors *not* to roll over the debt, she will anticipate a government default and will not be willing to lend to the government either. Given that the investors are not willing to roll over the debt, the government defaults. However, in case an individual investor expects

[11] For this illustration, we compute $V^c_{run}(d,h,y,1)$ also for levels of outstanding market debt for which in equilibrium no run occurs. $V^c(d,h,y,0)$ is always larger or equal to $V^c_{run}(d,h,y,1)$, as a run restricts the options of the government. Without a run the government could always choose $d' = 0$ and be at least as well off as in the case of a run.

all other investors to roll over the debt, she knows that the government will not default and she is also willing to buy new bonds. Given that the government can roll over its debt, it does not default in equilibrium.[12] Therefore, there exist combinations of the state variables for which there are two possible equilibria, one with rollover and no default and one without rollover and a default by the government. Which of these equilibria is actually realized is determined by the realization of the sunspot variable ζ. For high levels of debt not only $V^c_{run}(d, h, y, 1)$ but also $V^c(d, h, y, 0)$ is lower than the value of default $V^{defD}(h, y)$. In this case the government defaults for sure, independent of the rollover decision of the investors.[13]

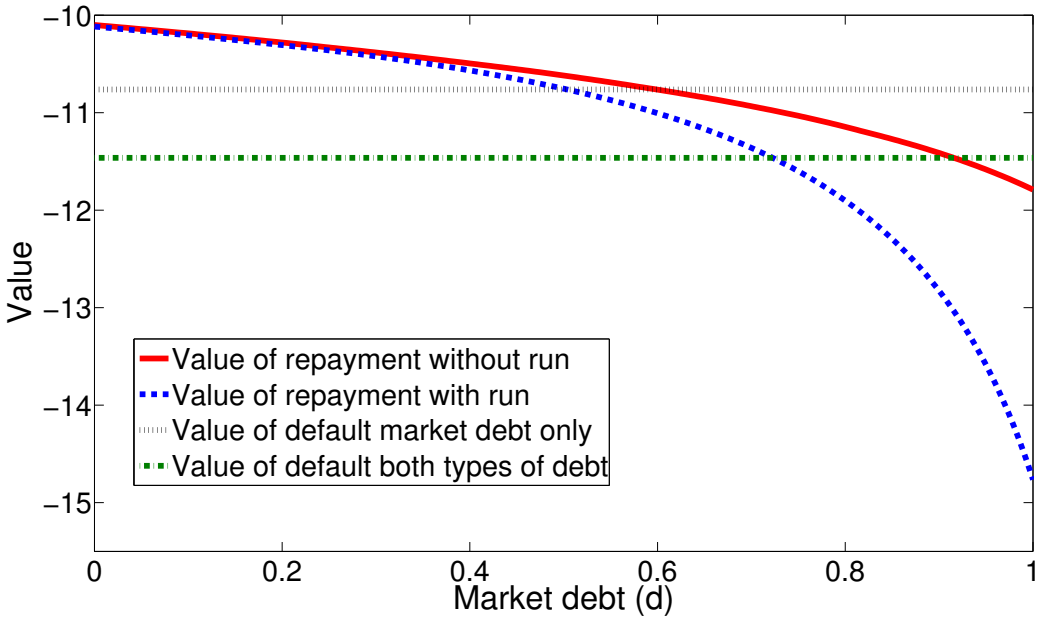

Figure 2: Values of possible government choices for given levels of market debt

Notes: Values are calculated for a government without outstanding bailout loans and an intermediate output level. Computations are based on the benchmark calibration outlined in Section 3.

[12] Cole and Kehoe (2000) outline a detailed within-period timing of actions that leads to this type of coordination game with the potential emergence of self-fulfilling crisis.

[13] The position of $V^{defDH}(y)$ relative to $V^{defD}(h, y)$ depends on the level of outstanding bailout loans. The government chooses the default option that yields the higher value. The emergence of the three regions holds independent of which of the two values of default is the higher one.

Definition: Given the parameters, the output process, and the price schedule for bailout loans, the recursive equilibrium for this economy is defined by the set of policy functions c, d', h', the default decision function of the government, and the bond price function $q^d(d', h', y)$ such that:

1. Given the government's policies, the country's resource constraint is satisfied.
2. Taking as given the bond price schedule $q^d(d', h', y)$ and possible runs by the investors, the government's policies d', h', and its default decision solve the government's optimization problem.
3. The bond price $q^d(d', h', y)$ reflects the default probabilities and ensures zero profits in expectation for the investors. When there is a self-fulfilling run, the bond price $q^d(d', h', y)$ is equal to zero.

3 Calibration

We solve the model numerically. Therefore, we need to assume specific functional forms and assign parameter values. The utility function of the representative household is a constant relative risk aversion utility function given by:

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}. \tag{3.1}$$

The income process is given by an AR(1) process for $\log(y)$:

$$\log(y_t) = \rho \log(y_{t-1}) + \eta_t \tag{3.2}$$

where $\eta_t \sim N\left(0, \sigma_\eta^2\right)$. The output costs are modeled as in Chatterjee and Eyigungor (2012) by a non-linear function:

$$l(y) = \max\left\{0, l_0 y + l_1 y^2\right\}. \tag{3.3}$$

where $l_1 \geq 0$. This convex cost function implies that a default is more costly in the case of a high output realization than in a period with low output.[14] The state-dependence of the output cost function is necessary to generate a sufficient number of defaults in equilibrium by inducing

[14] The convexity of the cost function can also be generated endogenously in a production economy with working capital loans for foreign intermediate inputs (see Mendoza and Yue, 2012).

a strong relation between the default decision and the output level.[15] If a good income state is likely for the next period, bond prices are high and the country can accumulate high debt stocks on which it defaults when the output level is low.

In line with the interest rate schedule of the IMF, the price for the bailout loans is assumed to depend on the borrowed amount. As in Boz (2011) the official lending facility demands a linearly increasing surcharge $\psi(h')$ on the risk-free interest rate:

$$q^h(h') = \frac{1}{1 + r + \psi(h')}, \tag{3.4}$$

where

$$\psi(h') = \psi_{min} + \frac{\psi_{max} - \psi_{min}}{h_{max}} h'. \tag{3.5}$$

We calibrate the model at quarterly frequency using data for the Argentinean economy before its sovereign default in 2001. As Chatterjee and Eyigungor (2012) point out, from 1993 to 2001 Argentina was at the same time in a currency board regime pegging the Argentinean Peso to the US Dollar and borrowing via marketable bonds on international credit markets. This makes this time period especially suitable for the analysis of the model. The parameter values of our benchmark calibration are stated in Table 1.

The relatively low discount factor β can be interpreted as indicating the strong impatience of the government of the economy which is mainly concerned about the short-run. β is set to match the average ratio of market debt to quarterly GDP and lies in the range of values considered in the literature. To compute Argentinean debt levels, we use data on external public debt provided in the World Bank's Global Development Finance Database. As the series is annual and our model is quarterly we have to transform the data. At yearly frequency, the average ratio of debt held by private international investors to GDP in the years from 1993 to 2000 is 16.3 percent which implies a quarterly value of approximatively 65.2 percent. Following Chatterjee and Eyigungor (2012) we target only 70 percent of this debt-to-GDP ratio as this was roughly the size of the haircut after the Argentinean default.[16] Consequently, only this share of the debt (45.6 percent of quarterly GDP) is considered as the unsecured and hence defaultable debt stock. The parameter of risk aversion σ is set to 2, which is a standard value in the literature. The output process is estimated using Argentinean data from the 20 years before the default

[15] Arellano (2008) shows that even without (state-dependent) output costs as in equation (3.3) default incentives are decreasing in the endowment.

[16] See Sturzenegger and Zettelmeyer (2008) for an estimate of the size of the haircuts in several default events.

Parameter		Value	Target/Source	Value
Discount factor	β	0.9005	Debt-to-GDP-ratio	0.456
Risk aversion	σ	2	Literature	
Autocorrelation $\log(y_t)$	ρ	0.945	Argentinean Data	
Std. dev. output shock	σ_η	0.025	Argentinean Data	
Risk-free rate	r	0.01	Literature	
Prob. of reentry - defD	θ	0.125	Avg. exclusion length	2 years
Prob. of reentry - defDH	θ_H	0.025	Estimate	
Output costs	l_0	-2.34	Default probability	3.1%
Output costs	l_1	2.508	Std. dev. of interest spread	4.58
Max. of bailout loans	h_{max}	0.25	Observed max. in data	0.2
Debt adjustment	λ	1.01	Max. annual deficit (% of GDP)	1.85
Interest surcharge	ψ_{min}	0.00125	IMF service charge	0.5% p.a.
Interest surcharge	ψ_{max}	0.113	Mean h/y	0.053
Prob. of run in crisis zone	π	0.16	Corr(y, $\Delta d/y$)	0.141

Table 1: Calibration

event, taken from the dataset by Neumeyer and Perri (2005). We take the logarithm of deseasonalized quarterly real GDP data and detrend the series with a linear trend. The risk-free rate is equal to one percent per quarter, which implies an annual real rate of roughly four percent, a standard value in the real business cycle literature. The value of the reentry probability after a default on market debt only, θ, lies in the range of values used in the literature and is consistent with the estimates of Gelos, Sahay, and Sandleris (2011), who report only short periods of exclusion from international financial markets. Specifically, the median duration of exclusion after a sovereign default in the 1990s was two years. There is no empirical counterpart for θ_H as until now there has been no outright default on IMF credits of an emerging market economy. The value of θ_H employed in our calibration implies on average 10 years of exclusion and is an estimate based on the fact that Argentina still has not fully returned to international financial markets since its default in 2001, which involved major disagreements between the Argentinean government and the IMF. In Section 4.5 we show that our results are robust against considering a higher value of θ_H, i.e. a shorter average exclusion after a default on both types of debt. The first parameter of the output cost function, l_0, is set to match the default frequency of 3.1 percent (in annual terms) observed in Argentina.[17] The second parameter, l_1, is set to

[17] To obtain this estimate, we use the default and rescheduling events documented by Reinhart and Rogoff (2009), which can be clustered to six default episodes from Argentinean independence in 1816 until 2011.

match the standard deviation of the interest rate spread which is 4.58 in the data.[18] The values of h_{max} and λ are consistent with past IMF programs. We choose a h_{max} of 25 percent of average output, which is slightly higher than the largest amount of IMF loans used by Argentina, which was around 20 percent of pre-crisis output (see Roubini and Setser, 2004). The debt adjustment of $\lambda = 1.01$ is equivalent to a maximum debt increase of 3.9 percent per year which is approximately equal to an allowed deficit of 1.85 percent of GDP per year.[19] The minimum surcharge, ψ_{min}, is set to 0.00125, which equals a 50 basis points service charge (annually) demanded by the IMF. The maximum value of the linearly increasing interest rate surcharge, ψ_{max}, is set to match the mean ratio of bailout loans to quarterly GDP which is 0.053 for the period from 1970 to 2000.[20]

The probability of a run in the crisis zone, π, cannot be observed in the data. We set the parameter to match the correlation of output with the change in market debt relative to output, corr(y, $\Delta d/y$). This correlation has a value of 0.141 and is calculated for the time period 1993-2000, which is not affected by debt restructuring or default. Defaults that are caused by runs occur both at relatively high and at low output levels. Increasing π leads to a rise in the number of run-driven defaults and thereby decouples the risk of a default and consequently the bond price from the output level. This yields a decrease in the correlation. In our benchmark calibration π is set equal to 0.16.

We solve the model by value function iteration. Starting with a guess for the bond price schedule we compute the optimal policies of the government. Given these policies we compute the probabilities of a default in the next period depending on the choices of new loans (market debt and bailout loans) and the given output realization. These probabilities then enter into an update of the bond price function. This procedure is repeated until convergence. We discretize the state space by approximating the log output process with the Tauchen algorithm using 31 grid points. The mean of the log output process is set to zero. For the dimension of market debt we use a grid of 300 points within the interval [-0.1; 1.0] that spans the asset space from ten percent assets to hundred percent debt relative to a quarterly output of unity. For the dimension

[18] The spread is calculated as the difference between the Argentinean interest rates reported by Neumeyer and Perri (2005) and the rate of a 3-month U.S. Treasury bill in the period from 1993Q1-2001Q4.

[19] See International Monetary Fund (2003) for actual targets of the Argentinean program. Specifically, allowed deficits for the first two years of the program were 2.3 percent and 1.4 percent of GDP. One can transform the deficit targets (measured in percent of GDP) into maximum debt increases by dividing them by the debt-to-GDP level targets for the respective year (which have been 0.477 and 0.473 in 2000 and 2001).

[20] The mean ratio of IMF loans to GDP in annual data is 0.0132, which implies a quarterly value of approximatively 0.053.

of bailout loans the grid consists of 40 points within the interval [0; 0.25].

4 Results

4.1 Business cycle statistics

To assess the performance of the model, we simulate the model and compare the resulting business cycle statistics with the corresponding statistics from Argentinean data.[21] Table 2 shows that the results for the benchmark calibration are in line with the data. Consumption is more volatile than output. All of the correlations have the correct signs: Consumption and output show a strong co-movement, while the interest rate spread (on market debt) and the trade balance are both countercyclical. We target an overall default probability of 3.1 percent. The resulting probability of a run-driven default is 0.9 percent, which means that more than a quarter of the defaults is caused by runs. For the benchmark calibration there are no joint defaults on both market debt and bailout loans. The model nearly matches the number of periods that the country uses bailout loans. We calibrate our model to match the average debt stock of Argentina. In accordance with the data, the model implies that market debt is used procyclically, while the use of bailout loans is countercyclical.

4.2 Effects of financial assistance

Given that the model successfully matches the data, we turn to answering our initial question of how the presence of financial assistance affects the probability of a government default. We compare the outcome of our benchmark model with the results obtained by simulating a version of our model that does not feature the official lending facility. For this comparison we apply the parameter values of the benchmark calibration in both models. The results summarized in Table 3 show that without the availability of bailout loans the overall default probability is slightly lower than in the benchmark model (3.0 vs. 3.1 percent). This overall default probability is partly caused by run-driven defaults. Without the lending facility there are substantially more run-driven defaults (1.4 vs. 0.9 percent). We find that the model without the lending facil-

[21] We simulate the model for one million quarters and exclude default and exclusion periods. Additionally, similar to Chatterjee and Eyigungor (2012), we exclude two years after redemption as the country counterfactually returns to financial markets with zero debt. We calculate the business cycle statistics over the more than 870,000 remaining episodes.

Variable	Benchmark model	Data
Std. dev. Output	6.82	7.68 *
Std. dev. Consumption	9.27	8.38 *
Std. dev. Interest rate spread	4.56	4.58 **
Std. dev. Trade balance	4.47	1.50 **
Corr(Output, Interest rate spread)	-0.41	-0.79 **
Corr(Output, Trade balance)	-0.31	-0.81 **
Corr(Output, Consumption)	0.88	0.98 *
Corr(Interest rate spread, Trade balance)	0.61	0.82 **
Default prob. market debt	3.1%	3.1%
$\rightarrow$ of which due to runs	0.9%	-
Default prob. market debt and financial assistance	0.0	0.0
Prob(h>0)	0.55	0.60
Average market debt (% of GDP)	45.6	45.6
Average financial assistance (% of GDP)	5.3	5.3
Average spread market debt	3.9	8.15
Corr(y, $\Delta d/y$)	0.141	0.141
Corr(y, $\Delta h/y$)	-0.06	-0.15

Table 2: Business cycle statistics

Notes: Data on output, consumption, interest rates, and trade balance from Neumeyer and Perri (2005). Spreads are calculated based on the rate of 3-month U.S. Treasury bills (data from FRED). Data on bailout loans from World Bank and International Financial Statistics (IFS), market debt from World Bank. Calculations are for 1980Q1-2001Q4 (*) and 1993Q1-2001Q4 (**). Prob(h>0) is calculated for 1946Q1-2011Q4. Debt levels are at quarterly frequency. For calculation of default probability, debt levels, and spread see Section 3. Due to limited data availability corr(y, $\Delta d/y$) is reported for annual data. corr(y, $\Delta h/y$) and the other correlations and std. dev. are reported for quarterly data. The average spread on market debt is reported in annualized terms.

ity exhibits on average a lower total debt level than the benchmark model (35 vs. 51 percent of quarterly GDP). While, by definition, there are no bailout loans in the model without the lending facility also the average level of debt borrowed from private international investors is lower than in the benchmark model. Our results imply that an official lending facility can in fact help to reduce the probability of runs by the investors. However, it also substantially decreases the incentive for countries to limit their debt levels. In total, the probability of default is higher when financial assistance is available. This results from the fact that the increase in the default incentives due to higher debt levels outweighs the lower probability of run-driven defaults.

4.3 Model dynamics

Turning to the underlying economic mechanisms of the model, we find that it preserves several important features of standard sovereign default models. First, the incentive to default is

Variable	benchmark model	without financial assistance
Default probability market debt	3.13%	2.98%
$\rightarrow$ of which due to runs	0.90%	1.41%
Average market debt (% of GDP)	45.6	34.9
Average financial assistance (% of GDP)	5.3	-

Table 3: Effect of financial assistance on default probability and debt levels

growing with the amount of debt as higher debt levels increase the possible gain of not repaying. Second, given a low realization of output repaying a certain amount of debt leads to lower consumption than repaying the same amount given a high realization of output. Therefore, default incentives are stronger for low output states than for high output states. Figure 3 depicts the default decision of a government that has no outstanding financial assistance (left panel) and of a government that already uses the maximum amount of available financial assistance (right panel). The black areas indicate combinations of output realizations and market debt holdings for which the government decides to default on its market debt. The government refrains from a default when output is high and debt is low (white area). The crisis zone (grey area) is located between the two areas in which the government always or never defaults. Self-fulfilling runs by the investors can only materialize when the default decision of the government depends on the decision of the investors to run. For high market debt and low output the government always prefers to default, independent of a possible run by the investors. Likewise, the government would always prefer to repay its debt in low debt and high output combinations, even if there was a run by the investors (which would have the consequence that the government could not roll over its debt). With rising debt levels and decreasing output a default becomes more and more attractive for the government. A run by the investors can then become decisive for whether or not the government defaults. This leads to the emergence of self-fulfilling expectations by the investors. A comparison of the left and the right panel of Figure 3 illustrates that the crisis and default zones are larger when the country already uses the maximum amount of financial assistance. This reflects the fact that the insurance effect of financial assistance is stronger the more of financial assistance is still available. Moreover, default incentives are stronger when the country borrows from the official lending facility in addition to its market debt as it has to pay back a larger total amount of debt.

Figure 4 compares the default decision of the government in our benchmark model with the default decision of the government in the model in which no bailout loans are available. The left panel of Figure 4 shows that the default region is larger in the model without bailout loans.

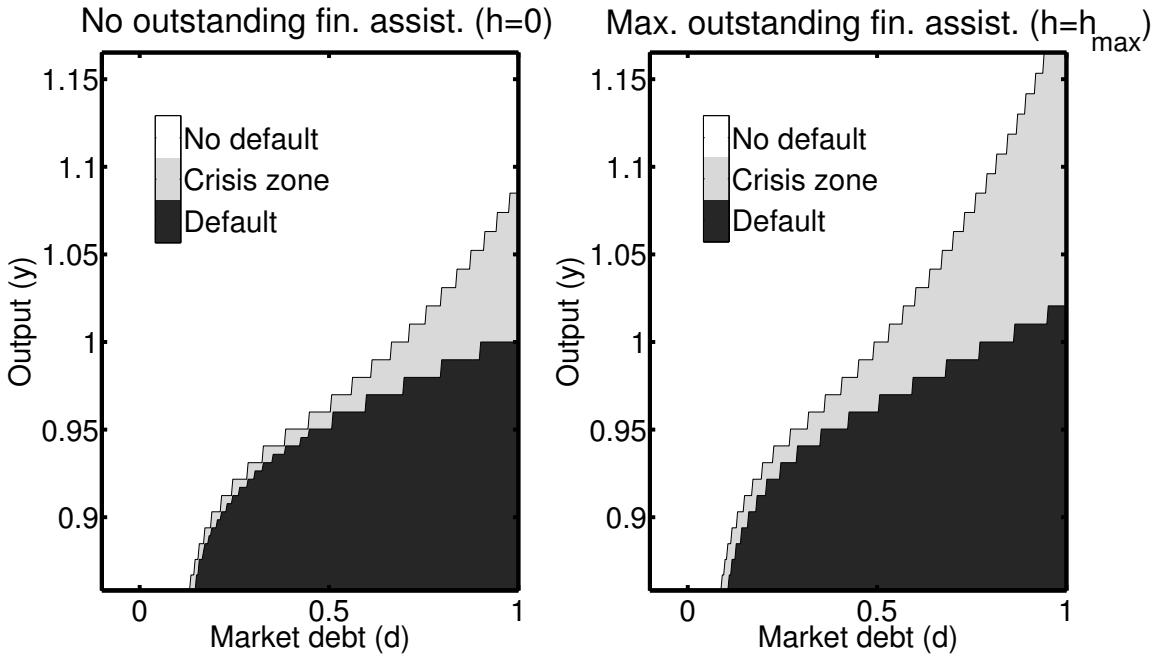

Figure 3: Default decision of the government

While the black area in the left panel of Figure 4 indicates where the default zones of the two models overlap, the grey area denotes combinations of output and debt for which the government defaults only in the model without the official lending facility. The availability of bailout loans also reduces the size of the crisis zone as illustrated in the right panel of Figure 4. The figure shows the crisis zone in the benchmark model for a government that has no outstanding bailout loans and compares it to the crisis zone in the model without bailout loans. While for certain state combinations the crisis zone prevails in both models (black area), the dark grey area to the left of the black area indicates those state combinations for which self-fulfilling crises occur only in the model without the official lending facility. For a few state combinations there exists a crisis zone only in the model with bailout loans (light grey area to the right of the black area). However, in the model without the official lending facility the government defaults in this area for sure. The overall reduction in the size of the crisis zone is substantial. Once the country uses all of the available bailout loans this effect vanishes and the crisis zones are almost identical in the two model versions (right panel of Figure 8 in the appendix). Both the reduction in the size of the default region and the crisis region make a default of the government for a given debt level less likely due to the insurance effect of financial assistance.

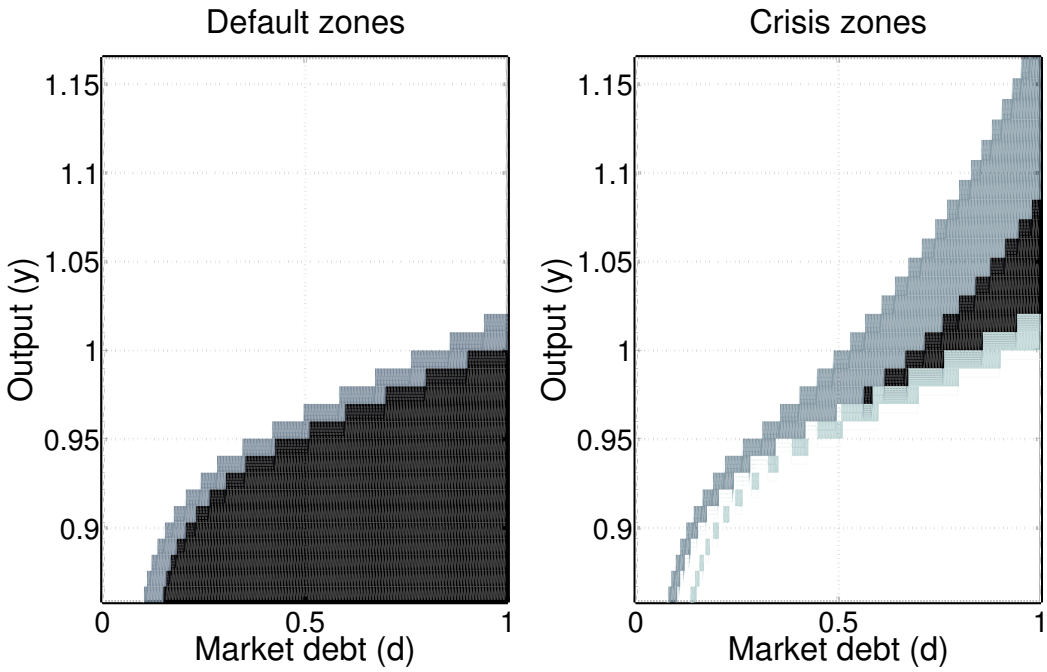

Figure 4: Comparison of default zones (left panel) and crisis zones (right panel)

Notes: black areas: zones overlap, grey areas: default/crisis only when no financial assistance is available, bright grey area: crisis zone only in the model with financial assistance.

As defaults are less likely (for a given debt level) when the official lending facility is present, the international investors charge lower interest rates than when no financial assistance is available. Figure 5 illustrates the resulting shift in the bond price schedule. The bond price drops as debt levels increase. The continuous (black) lines denote the bond price schedule in the benchmark model for a government that has no outstanding bailout loans, but has them at its disposal. The dashed (blue) lines denote the schedule for a government in the model without the official lending facility. The availability of financial assistance shifts the bond price schedule to the right, resulting in lower interest rates for the government. The effect is present both at low output levels (left panel) and at high output levels (right panel). Facing a more favorable interest rate schedule, the government on average borrows a larger amount of debt when the official lending facility is present. Figure 5 also shows that the fall of the bond price occurs at lower debt levels when the output realization is low (left panel in comparison to right panel). Taking into account that default incentives increase for bad output realizations, investors charge

higher interest rates for any amount of market debt demanded. The interest rate of market debt therefore follows a countercyclical pattern. The government reacts by demanding less market debt when output is low and by demanding more market debt when output is high. Hence, the government borrows procyclically on private bond markets (see also Table 2).

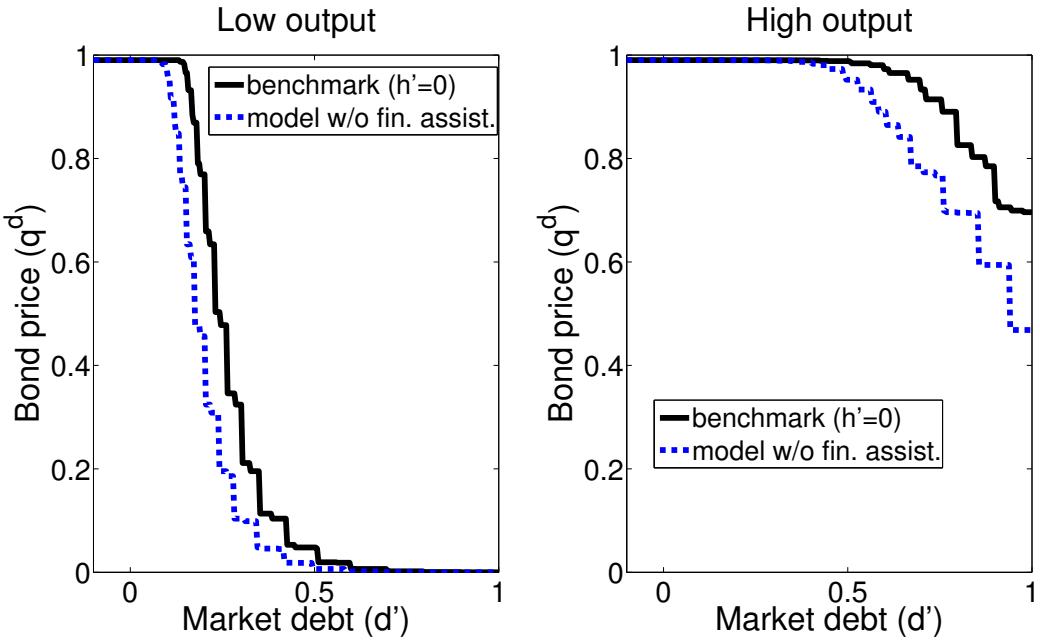

Figure 5: Comparison of equilibrium bond price schedules for market debt

The smaller size of the default and crisis zone in the benchmark model stems from the fact that the government turns to official lending instead of choosing an outright default. Figure 6 shows the demand for financial assistance of a government that has no outstanding bailout loans. The chosen volume of bailout loans increases for lower output realizations and for higher levels of outstanding market debt. For very low output and high market debt the demand for bailout loans is again zero as in this case the government prefers to default on market debt without using bailout loans. The region in which the demand for bailout loans spikes corresponds to the reduction of the crisis zone in the right panel of Figure 4. While the bond price for market debt falls rapidly when output levels are low (see Figure 5), the interest rate schedule of bailout loans is fixed independent of output levels. The government therefore substitutes market debt by bailout loans when output realizations are relatively low. However, due to the additional charges and fees of bailout loans, in good output states market debt is cheaper and the government demands no bailout loans. As a consequence the resulting demand

for bailout loans is countercyclical.

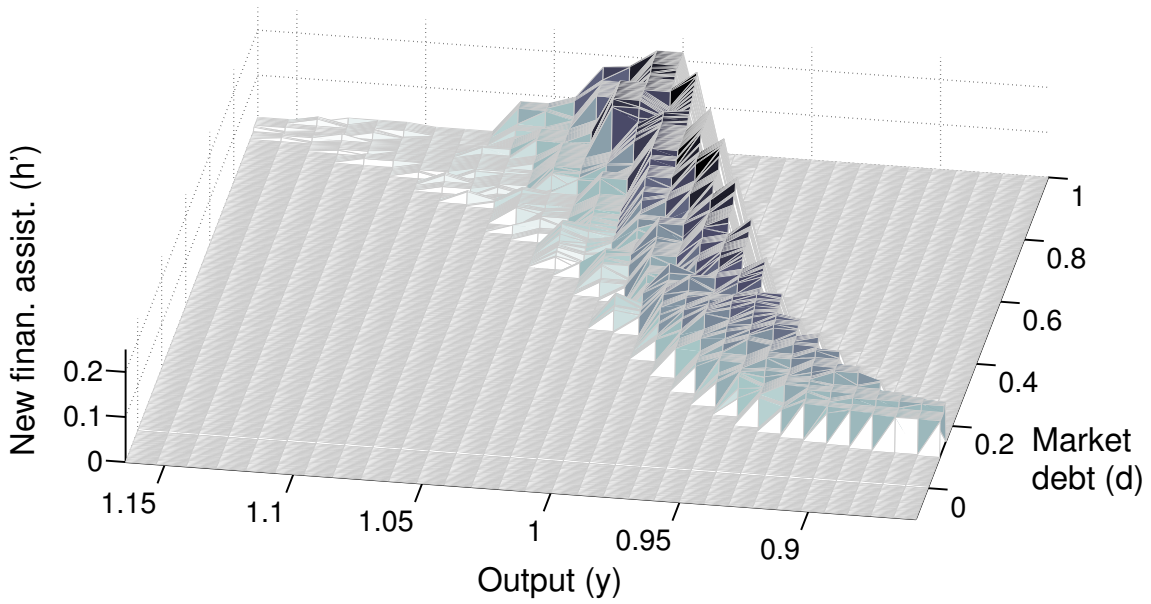

Figure 6: Choice of financial assistance (for $h = 0$)

4.4 Welfare

Despite the fact that the presence of the official lending facility is associated with a higher default probability, the welfare implications of bailout loans are a priori unclear. Having an additional borrowing opportunity can potentially improve the country's welfare. Also, there is a possible welfare gain as the official lending facility helps to (partly) resolve the inefficiency generated by the coordination failure of private international investors. The limited commitment of the sovereign and the presence of incomplete markets might, however, lead to a situation in which the country is worse off if financial assistance is available. Without the official lending facility the government has only one defaultable (i.e. state-contingent) bond at its disposal. Having an additional borrowing opportunity, however, changes the default incentives and hence influences the endogenous price schedule. The shift of the price schedule changes the constraints of the optimization problem of the government and it chooses much higher equilibrium debt levels which are also associated with higher interest rate payments. To assess the welfare implications numerically, we compare the certainty equivalent consumption in the

benchmark model and in the model without financial assistance. More precisely, we compute the amount of additional consumption that is necessary to make households indifferent between living in the model with financial assistance and without financial assistance.[22]

As a first step, we conduct a state by state comparison. This comparison is similar to establishing a new official lending facility in a world without financial assistance. Figure 7 displays the resulting welfare gain (in percent of certainty equivalent consumption) due to the availability of financial assistance. The country benefits from the additional borrowing opportunity in case it has no outstanding bailout loans. Outstanding bailout loans automatically imply higher total repayment obligations and therefore have an impact on utility levels. Consequently, the state by state comparison is only meaningful for a government that currently does not have outstanding bailout loans. The state-dependent welfare gain depicted in Figure 7 ranges from 0.3 percent to 3.5 percent of certainty equivalent consumption and depends both on the level of market debt and the output level. The highest welfare gain occurs at high market debt levels and intermediate output. The regions with high welfare gains correspond to the reduction in the sizes of the crisis and default zones as illustrated in Figure 4. There is only a small welfare gain in the default zone where the sovereign has no direct benefit from the shift in the bond price schedule as it defaults despite the presence of the official lending facility.

The state by state comparison, however, does not take into account the general equilibrium effect of living in a world with financial assistance instead of living in a world without financial assistance. To account for the general equilibrium effect, we simulate both models and weigh the state-dependent values with the endogenous probabilities of being in the according state combination. A comparison of the resulting values shows that the certainty equivalent consumption in the model with official lending facility is 0.84 percent lower than in the model without lending facility. This indicates that the negative effects of the higher default probability and higher debt service outweigh the benefits associated with financial assistance in terms of better consumption smoothing and lower borrowing costs. The international investors are not affected by the presence of the lending facility because they are risk neutral and always make zero profits in expectation due to perfect competition. There are no defaults on the bailout loans for the benchmark calibration. Therefore, the official lending facility does not incur any losses due to its lending activity, but generates profits by charging the surcharge on the riskless rate.

[22] For the welfare comparison we solve for g in the equation $g^{1-\sigma}V^{FA}(d,h,y,\zeta) = V^{no\ FA}(d,y,\zeta)$, where V^{FA} is the country's value of being in the benchmark model with financial assistance and $V^{no\ FA}$ the value of being in the model without financial assistance.

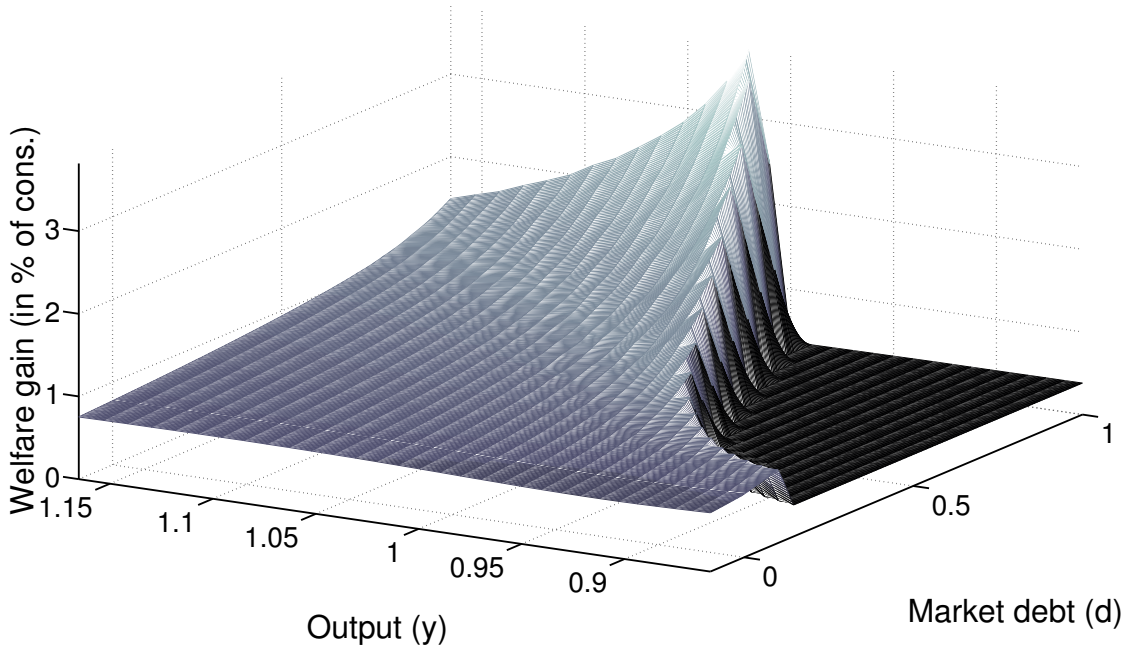

Figure 7: State-dependent welfare gain from the availability of financial assistance (for $h = 0$)

4.5 Robustness

To check the robustness of our results we vary the parameter values that govern the official lending facility, namely the strictness of the conditionality, λ, and the probability of returning to international financial markets after a default on financial assistance, θ_H. In the first column of Table 4 we restate the results of the benchmark calibration to facilitate comparison. In columns two and three we vary λ, while column four shows the results of changing θ_H. Our main result that the probability of default increases when financial assistance is available is robust against changes in λ and θ_H. Furthermore, the reduction of the probability of run-driven defaults and the increase of the average level of market debt are basically unaffected by the changes in λ or θ_H.

In the benchmark calibration we use a value of $\lambda = 1.01$, which is implied by the IMF program in Argentina. To evaluate the impact of the strictness we first set λ equal to one. This is equivalent to a zero deficit target as in this case no further increase of the total amount of debt is allowed when the country is borrowing from the official lending facility. Additionally, we allow for a laxer conditionality by changing λ to 1.06.[23] Increasing the strictness of the condi-

[23] A value of $\lambda = 1.06$ corresponds to a deficit target of more than 12 percent of GDP, analogous to the calculations

tionality to $\lambda = 1$ results in a reduction of the use of bailout loans. There is a decrease in both the average level of financial assistance and the frequency of the use of financial assistance. As the level of market debt stays the same, the total debt level of the country slightly decreases. The stricter conditionality increases the correlation of output with the change in market debt relative to output, corr(y, $\Delta d/y$). This is because the government cannot increase its level of market debt when output is low and it is already borrowing from the official lending facility. Decreasing the strictness of the conditionality to $\lambda = 1.06$ has the opposite effect. The average levels of financial assistance and market debt and the frequency of the use of financial assistance increase. This results in a slightly higher probability of default. With laxer conditionality the government still increases its borrowing from private international investors while using financial assistance. This causes a slight reduction of the correlation of output with the change in market debt relative to output. Strict conditionality leads to higher welfare than the benchmark case and lax conditionality. Lax conditionality results in higher debt levels and a higher default probability, which is detrimental to the country's welfare.

For the benchmark calibration we employ a value of $\theta_H = 0.025$ which corresponds to an average of ten years of exclusion after a default on financial assistance. To verify to what extent our results depend on the chosen value of θ_H, we solve the model for $\theta_H = 0.0625$, which implies on average four years of exclusion after a default on financial assistance. Column four of Table 4 shows the resulting business cycle statistics. While the probability to default on both market debt and financial assistance is now positive, the overall probability of default remains basically unaffected. Also, the debt stocks are similar to the benchmark. Our results are therefore robust to shortening the average exclusion spell after a default on both types of debt. Defaults on both types of debt, which are present for the higher value of θ_H, imply that the government's total repayment obligations are reduced stronger than in the case of a default on market debt only. In contrast to the substantial welfare loss in the benchmark calibration we find that the country actually gains from having the financial assistance at its disposal when it faces a shorter exclusion. In comparison to the case of a longer exclusion after a default on both types of debt welfare is now about one percentage point higher. This comparatively large increase in welfare is likely to be generated by the fact that the country only defaults on both types of debt when it finds itself in an especially severe output crisis. Reducing the punishment for a complete default on both types of debt therefore increases the country's utility substantially in these cases. While the defaults on bailout loans increase the country's welfare they however

for the benchmark calibration in Footnote 19.

also reduce the profits generated by the official lending facility.[24]

	benchmark	$\lambda = 1$	$\lambda = 1.06$	$\theta_H = 0.0625$
Std. dev. Output	6.82	6.82	6.81	6.81
Std. dev. Consumption	9.27	9.27	9.30	9.31
Std. dev. Interest rate spread	4.56	4.62	4.58	4.88
Std. dev. Trade balance	4.47	4.50	4.48	4.57
Corr(Output, Interest rate spread)	-0.41	-0.40	-0.42	-0.40
Corr(Output, Trade balance)	-0.31	-0.30	-0.31	-0.30
Corr(Output, Consumption)	0.88	0.88	0.88	0.88
Corr(Interest rate spread, Trade balance)	0.61	0.61	0.63	0.63
Default prob. market debt	3.1%	3.1%	3.2%	3.0%
$\rightarrow$ of which due to runs	0.90%	0.89%	0.91%	0.87%
Default prob. priv. market and fin. assist.	0.0	0.0	0.0	0.2%
$\rightarrow$ of which due to runs	0.0	0.0	0.0	0.01%
Prob(h>0)	0.55	0.53	0.71	0.54
Average market debt (% of GDP)	45.6	45.6	45.7	45.6
Average financial assistance (% of GDP)	5.3	5.2	5.9	5.1
Average spread market debt	3.9	3.8	3.9	3.9
Corr(y, $\Delta d/y$)	0.141	0.143	0.138	0.142
Corr(y, $\Delta h/y$)	-0.06	-0.06	-0.06	-0.06
Welfare gain due to financial assistance	-0.84 %	-0.82%	-0.87%	0.18%

Table 4: Sensitivity of the results

4.6 Comparison to related studies

Comparing our results with related findings in recent quantitative studies we find important differences. Boz (2011) and Fink and Scholl (2011) also include financial assistance into a model of sovereign default. However, both studies have a focus different to ours and do not consider the full set of channels through which financial assistance affects the probability of default in our model. The presence of an official lending facility raises average debt stocks of the government in our model. Total debt of the government increases by 16 percentage points (which is an increase of 50 percent). A rise of equilibrium debt levels is also present in the model by Fink and Scholl (2011), while Boz (2011) finds the opposite effect. In contrast to our results both studies find that the inclusion of financial assistance increases the default probability strongly. In Boz (2011) the number of defaults rises drastically from 5.8 to 64.6 per 10,000 quarters and in Fink and Scholl (2011) the default probability increases from 2.88 to 5.00 percent. One important reason for this difference is the presence of defaults due to

[24] For all considered parametrizations the lending facility generates positive profits.

self-fulfilling crisis in our model. The official lending facility is able to decrease the occurence of this type of default substantially. In the two other models this channel is excluded and the potential impact of bailout loans is hence restricted. Another reason for the difference might be found in the exact modeling of the official lending facility. In Boz (2011) the IFI provides unlimited amounts of non-defaultable loans to the country, which is consequently still able to smooth consumption relatively effectively after a default on market debt. This reduces the costs associated with a default relative to a version of the model without bailout loans. While there might be doubts about the commitment of the IFI to stop lending to a country in crisis, we think that our modeling choice of restricting the amounts of official lending is in line with actual policies. Roch and Uhlig (2012) consider a (basically unlimited) bailout guarantee that completely eliminates runs by private investors. In a preliminary numerical exercise they find a lower overall default probability when the guarantee is present. In difference to Roch and Uhlig (2012) in our model the government holds bailout loans in equilibrium which are senior to market debt. The associated repayment obligations affect the default incentives of the government. Considering an endogenous debt structure of both market debt and bailout loans we find that the presence of financial assistance leads to a slightly higher default probability in equilibrium.

5 Conclusion

We construct a quantitative model of sovereign default to study the effects of the availability of financial assistance on the occurrence of defaults. The calibrated model yields business cycle statistics in line with Argentinean data. Simulating the benchmark model with financial assistance and a model version without financial assistance, we find that the presence of the official lending facility increases the probability of a default of the government on its market debt. At the same time the model version with this facility displays a higher average debt level than a model version without bailout loans. The insurance effect of bailout loans, which makes defaults less likely for a given level of debt, is therefore dominated by the general equilibrium effect of the resulting lower interest rates. The shift in the bond price schedule leads to higher equilibrium debt levels of the government and makes defaults again more likely. While the official lending facility is successful in reducing the number of defaults that are caused by runs of the investors it does not reduce the overall default probability. These results are robust against variations in the strictness of the conditionality and shortening the average exclusion

spell after a default also on bailout loans. A welfare comparison shows that certainty equivalent consumption is lower in the model with financial assistance than in the model without financial assistance. Stricter conditionality leads to a higher welfare than lax conditionality as it results in lower total debt levels. The presence of financial assistance leads to an increase in welfare only when the punishment after a default on both types of debt is sufficiently weak such that the country sometimes chooses to default also on bailout loans. The recent increase in official lending underscores the importance of understanding its impact on default incentives and welfare. Our results suggest that, while financial assistance can help to avoid defaults in the short run, it might entail substantial unintended consequences in the long run.

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A Appendix

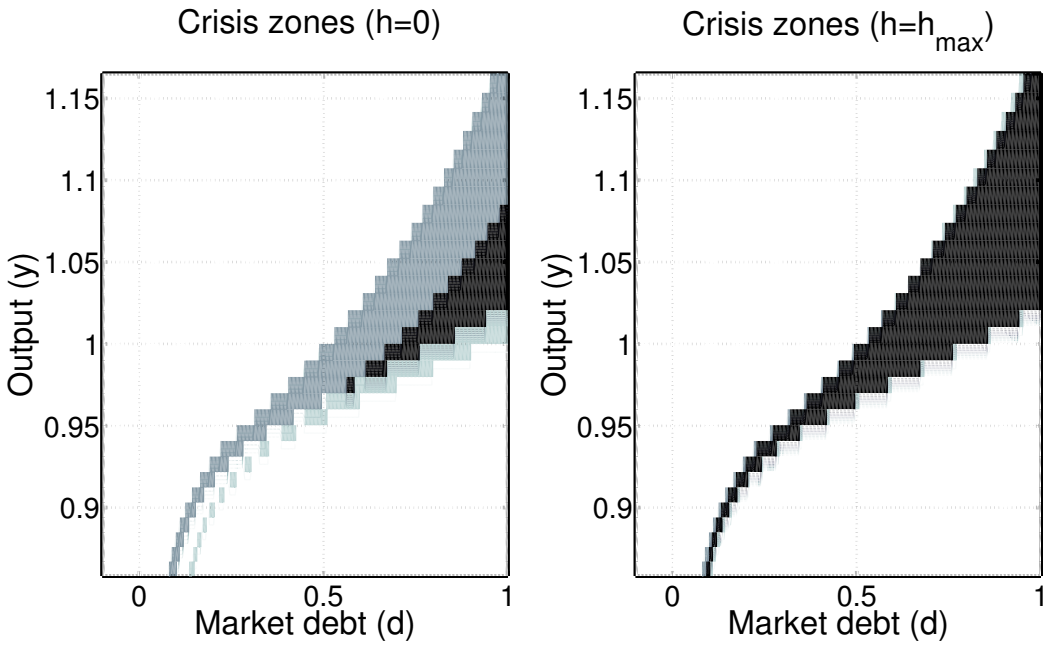

Figure 8: Comparison of crisis zones

Notes: black areas: zones overlap, grey areas: crisis only when no financial assistance is available, bright grey areas: crisis zone only in the model with financial assistance.