# Sovereign Default and Banking*

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**Abstract**

Several recent defaults on government debt were accompanied by major banking crises in the defaulting countries. We argue that the banking crises, triggered by the defaults, may have been due to inadequate prudential regulations, which did not recognize the riskiness of the government debt. We use a simple model of prudential regulation to illustrate this point. We provide supporting evidence from the Russian 1998 crisis. We further show that the failure to adjust prudential regulation can be a conscious decision of the government, rather than an oversight. When risky government debt is considered safe by the regulation, domestic banks gamble by constructing portfolios correlated with government default. These banks bid up the price of the government bonds, which lowers government's cost of borrowing and may postpone (and give a chance to avoid) the default.

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# 1 Introduction

Several recent defaults on government debt were accompanied by major banking crises in the defaulting countries, Russia in 1998 and Argentina in 2001 being prime examples. We argue that inadequate prudential regulations, which did not recognize the riskiness of the government debt, may be to blame for the banking crises, which were triggered by the defaults.

The basic story is simple. Banks invest other people's money, and are protected by limited liability. This situation creates incentives for excessive risk-taking on the part of the banks.[1] To prevent excessive risk taking, governments introduce prudential regulation, which requires banks to hold sufficient amounts of capital (have enough of their own wealth at stake) so that excessive risk taking is no longer attractive. Certain "safe" securities are exempt from capital adequacy requirement. The classic such safe security (from the point of view of prudential regulation) is the government debt. However, the government debt is not always as safe as the prudential regulation considers it to be. What happens when the "safe" government debt becomes risky? Prudential regulation may fail in that case. The banks are then able to gamble (by taking on excessive risks correlated with the government debt) while still satisfying the prudential regulation. If the government does not default *ex-post*, the gamble works out, and everyone is happy; but if the government does default, the whole banking system comes crashing down.

We provide a very simple model that captures this story. The model provides an interesting insight into why the prudential regulations were not adjusted to account for the riskiness of the government debt. Highly indebted governments may *choose* not to adjust the regulation in order to postpone (or prevent) a looming debt crisis. By not adjusting the regulation the government lowers its cost of borrowing as banks are willing to pay more than actuarially fair prices for the government bonds. Effectively, by allowing the banks to gamble with depositors' money, the government themselves are gambling for redemption. If the government are more interested in avoiding (or even postponing) default than in the well-being of its citizens, they will choose to (let the banks) gamble in this way. In a way, the key message of our paper can be

[1] As Jensen and Meckling (1976) point out in their seminal work, the basic insight appears in Smith (1776).

viewed as an example of the problem which Hurwicz (2008) termed "Who will guard the guardians?".

We capture this story with a very basic model of prudential regulation. As expected, prudential regulation, that does not recognize the riskiness of government bonds, fails to prevent excessive risk-taking by the banks. Specifically, banks invest in excessively risky assets that are strongly correlated with the government debt. What may be less obvious is that these gambling banks are willing to pay more than actuarially fair prices for the risky government debt. This creates incentives for an indebted government not to adjust the prudential regulation as it lowers the cost of (re-)financing the debt.

We then augment the model to incorporate some important aspects of reality, and show that all the basic findings are robust and hold true in the more realistic environment. Strikingly, more realistic (and rational) form of prudential regulation (which makes capital requirement contingent on the amount of safe securities held) creates greater incentive for the government not to recognize the riskiness of its debt. The government's cost of borrowing falls even further in this case than in the case of a simplistic prudential regulation which considers capital and reserve requirements separately.

It is worth noting that the failure to adjust prudential regulation (and the ensuing excessive risk taking by the banks) may not be inconsistent with a benevolent government maximizing the welfare of its citizens. Think of a government of a severely borrowing constrained country, which wants to attract foreign lenders. The amount of debt such government is able to raise (credibly promise to repay) is directly linked to how costly a default would be for such a country. If default is followed by a banking crisis, as it is in our model, then the cost of the default is greater ex-post, and the government would be able to borrow more ex-ante. This argument is similar in spirit to the endogenous cost of default in Gennaioli, Martin, and Rossi (2009).[2] Such model could deliver endogenous *rational* crises, much like Brusco and Castiglionesi (2007). A rather related model is provided by Alessandro (2009), where (large) domestic banks internalize the effect of their holding of government bonds on the likelihood of government defaulting on the debt. We are thus not arguing that the crises in Russia and

[2]The idea that the cost of sovereign default is endogenous and is affected by domestic agents is also present in Broner, Martin, and Ventura (2010).

Argentina were necessarily due to a *political* failure, merely a failure of the prudential regulation. But we do want to point out that the mechanism we are emphasizing implies that an office-motivated politician has an additional incentive not to adjust the prudential regulation — failure to recognize the riskiness of government bonds lowers the cost of borrowing (domestically) for the government.

We argue that this failure of prudential regulation and the excessive risk-taking on the part of the banks may have been what happened in Russia in 1998 and in Argentina in 2001. In Section 5, we provide some evidence from Russia, which supports the idea of excessive risk taking by banks. Some Russian banks were rather inventive in constructing risky portfolios strongly correlated with government default — realizing that the default would be accompanied by a devaluation of the ruble, the banks got into (derivatives on) currency futures (Ippolito (2002)). Argentina provides the best anecdote in support of the idea of the government's *decision* not to recognize the riskiness of the debt — not only was the banking regulation not adjusted, but the regulation of pension funds was changed to encourage them to hold the government debt.

Using a unique dataset of balance sheets of Russian banks just prior to (and during) the 1998 crisis, we establish the presence of strong correlation between the private banks' holdings of government debt and their foreign currency liabilities prior to the crisis. Notably, this correlation disappears after the crisis happens, lending further support to our key mechanism. In a recent paper, Alessandro (2009) provides a novel motivation for the domestic banks' holdings of potentially risky government bonds, but his mechanism does not imply a correlation of individual banks' bond holdings with foreign currency exposure.

An important question that arises in this context is: Who pays for all this? Our answer is not surprising — we assume it is the taxpayers who end up paying the cost of the excessive risk-taking through the tax burden of the deposit insurance. Another plausible answer would be to say that the depositors are the ones bearing the cost. But the question then becomes: Why then do the depositors keep their money in the banks when the possibility of the crisis arises? We could assume that they do not have a meaningful alternative — if all productive investments have to be intermediated through banks, e.g. to resolve the free-riding problem in monitoring the productive projects (as in Diamond (1984) or Boyd and Prescott (1986)). Buying government bonds is no better than keeping the funds in the bank. Holding cash is not a good alternative either, as the defaults are typically accompanied by devaluations. However, with the benefit of 20/20 hindsight, it seems that holding US dollars in a mattress was the way to go. We do not really have an answer for why (more) people in Russia and Argentina did not take that option. Rather than tackle this question, we choose to assume that the supply of households' deposits is inelastic, and concentrate on the government's decision not to adjust the prudential regulation. Empirically, at least in the case of Russia, the depositors did not flea the banking system. As can be seen in Figure 1, the amount of individuals' deposits in Russian bank more than doubled in the two quarters immediately preceding the crisis, while the firms' and banks' deposits contracted. Admittedly, naivete of depositors may have also contributed to the situation in Russia (Karas, Pyle, and Schoors (2010) found that, while Russian depositors "disciplined" the banks after the crisis, they did not seem to do so prior to the crisis of 1998).

Our analysis does not in any way contradict existing suggestions that the banks (and the pension funds in the case of Argentina) were often forced to hold the risky bonds (e.g., Díaz-Cassou, Erce-Domínguez, and Vázquez-Zamora (2008)). Our story is complementary to the idea of forcing the banks to hold risky government bonds. Presumably, there is a limit to governments' ability to force the banks to hold the bonds. Notably, the data from Russian banks show that the gambling on foreign currency was much more prevalent among the private banks, over which the government presumably had much less sway.

The paper most closely related to ours is Brusco and Castiglionesi (2007), which studies the failure of prudential regulation due to cross-country insurance arrangements among banks. The paper shows that prudential regulation which is sufficient under autarky may fail once international financial arrangements are possible. In that case, the familiar moral hazard on a country-level leads to excessive risk-taking and the possibility of the crisis, while the financial linkages lead to contagion of the crisis across countries.

Our paper is organized as follows. The next section presents the simplest environment which lends itself to the analysis of prudential regulation. Section 3 presents the basic findings. Section 4 introduces a sequence of augmentations that make the environment more realistic and establishes that the key results still hold (and even get strengthened) in these richer environments. Section 5 offers some anecdotes and some systematic micro-level evidence from Russia that support the plausibility of the basic story. Concluding remarks are offered in Section 6.

# 2 The Basic Environment

We start with the simplest environment in which there is a role for prudential regulation of banks, and impose the simplest form of prudential regulation which grants the "safe" status to government bonds. We then introduce the possibility of government default, and derive our key analytical results in this rudimentary environment. In Section 4, we introduce a more sophisticated environment with a more sophisticated (and realistic) prudential regulation, and show the key insight only strengthens there.

Consider an economy populated by competitive banks and a government, which regulates the banks and may need to borrow to finance a random stream of expenditures. We model the households in a rather simplistic way, which results in perfectly inelastic supply of deposits to the banking system. Mechanically, it is equivalent to assuming that the total stock of deposits $X$ is given exogenously.

## 2.1 Households

In order to generate the inelastic supply of deposits, we assume that economy has measure 1 of identical households born every period. The households live for two periods and have (after-tax) endowment of $e$ when young and 0 when old. Their period utility function is $u(c) = \ln c$, and they do not discount the future. This implies that the aggregate supply of deposits is $X = \frac{e}{2}$.

By assuming that the supply of deposits is inelastic, we are abstracting from the analysis of the households' incentives to participate in the banking system.[3] While

[3] Alternatively, we could follow Brusco and Castiglionesi (2007) and assume that our households are Diamond and Dybvig (1983) consumers subject to liquidity shocks, and that the banks provide liquidity insurance to the households. While this may provide a reason for the households to keep their money in the bank as it does in Brusco and Castiglionesi (2007), we feel that the issue of

this is obviously an important issue, we think it is outside the scope of this paper, partly due to the fact that the Russian households (unlike other depositors) did not flea the banking system (see Figure 1).

## 2.2 Banks

The banks are risk-neutral. They maximize expected profits, subject to limited liability. The banks are endowed with heterogeneous wealth, which will serve as the banking capital. The total wealth owned by the banks is $B$. The banks accept deposits from the households, promising to pay net interest rate $i$ on these deposits next period. The aggregate supply of deposits is $X$. There are two types of investment projects available to the banks: risky and risk-free. Each project is infinitesimal relative to the size of a bank. The banks are competitive – they compete both for deposits and for investments.

Risk-free projects deliver $r$ per unit of investment. Risky projects deliver $R$ with probability $p$ and 0 otherwise. We will assume that

$$pR < r < R.$$

Thus, investing in risky projects is inefficient. If such investment does take place, we will call it "excessive risk-taking". Assume that a bank can pick risky projects so that they are perfectly correlated with each other (or completely uncorrelated, for that matter).

Banks have limited liability. That is, if the returns from investments fall short of the amount promised to depositors, the banks are not responsible for the balance. The banks lack commitment. Lastly, assume that nobody can verify whether the bank is investing in risky or risk-free projects, and that individual depositors cannot effectively monitor capital adequacy of banks.

## 2.3 Laissez-faire

The only equilibrium in the environment described so far is "excessive risk-taking" by all banks. All banks create portfolios of perfectly correlated risky projects, promise

liquidity insurance is orthogonal to our analysis and adopt the simpler formulation.

return $i = R - 1$, and repay depositors only with probability $p$. Note that while depositors would prefer to receive a lower interest rate with certainty (from investments in risk-free projects), no bank can *credibly* offer such contract. The potential banks which have capital do not accept any deposits and invest (only their own funds) in the risk-free projects.

As was noted previously, the excessive risk-taking is inefficient. Thus, there is a role for prudential regulation in this economy. To eliminate the excessive risk-taking and to support optimal risk-free investment, we introduce the government which has the ability to set and to enforce the prudential regulation.

## 2.4 The Government

The government has two roles in the model. First, it is the regulator of banks. Second, the government issues debt, which is used to finance budget deficits.

The government faces a random (exogenous) stream of budget balances (net of taxes). The deficits are financed by issuing debt. The debt takes form of non-contingent one-period bonds. Denote by $D$ the amount the government needs to borrow. The rate of returns (the price) of the government bonds is determined in equilibrium. Denote the interest rate on government debt by $i_g$. We assume that the government's sole objective is staying in power, and that a default on the government debt leads to the immediate fall of the government. Thus, the government honors the debt whenever it is possible.

The government also sets prudential regulation that the banks must abide by. The prudential regulation takes the form of both capital adequacy and reserve requirements. We begin by considering "simple" prudential regulation: the banks must own fraction $b$ of their investments, and fraction $q$ of the investments must be invested in verifiably safe assets. One such asset is the government bonds.[4] For exposition purposes, assume that the bonds are the only verifiably safe asset. Assume further that the government needs to raise more debt than is needed to serve as the safe asset

[4]We consider a more realistic "sophisticated" prudential regulation, which makes the capital requirement a function of the reserves, in section 4.2.

for the purposes of prudential regulation:

$$D > q(X + B). \tag{1}$$

We are interested in a situation where the government cannot force the banks to buy all of its debt. That is, the situation that goes beyond the coercion described in Díaz-Cassou, Erce-Domínguez, and Vázquez-Zamora (2008).

# 3 Findings

We begin by verifying that the prudential regulation is effective in achieving the efficient investment in risk-free projects when the government debt is itself risk-free (there is no possibility of government default). We then introduce the possibility of government default and show that the prudential regulation fails. Lastly, we show that the government may prefer not to adjust the prudential regulation if it faces a risk of default.

## 3.1 Risk-free Government Debt

Assume that the government debt is repayed with certainty.

**Proposition 1** *Prudential regulation rules out excessive risk-taking as long as*

$$b > (1 - q)\frac{p(R - r)}{r(1 - p)} \tag{2}$$

**Proof.** We proceed by characterizing the equilibrium without the excessive risk-taking and verifying that the banks do not have an incentive to take on excessive risk (invest in risky projects).

Since there is more debt than is required for prudential regulation (from (1)), the banks must be willing to hold government debt. Thus, the equilibrium interest rate on government debt $i_g = r - 1$. Competition among the banks implies that the banks make 0 profits (they earn market rate of return on the banking capital), and the interest rate on deposits is also $i = r - 1$.

Consider the most profitable possible deviation (excessive risk-taking): a portfolio of perfectly correlated risky projects with the minimal required amount invested in the government bonds and minimal required amount of capital held. The expected profit generated by such deviation (per unit invested) is

$$\pi' = p\Big((1-q)R + q(1+i_g) - (1+i)(1-b)\Big) - br.$$

Recalling that $1+i = 1+i_g = r$ and imposing $\pi' < 0$ yields the desired inequality (2). ■

Note that the capital requirement ($b > 0$) is essential — no reserve requirement would work without it. On the other hand, the reserve requirement is not essential per se if the depositors are willing to hold the government debt directly. Absent any reserve requirement ($q = 0$), the aggregate banking capital needed to support investment of $(X - D)$ of depositors' wealth in productive projects has to satisfy

$$\frac{B}{B+X-D} > \frac{p(R-r)}{r(1-p)}, \tag{3}$$

which follows directly from (2). However, if the depositors prefer bank deposits to government bonds (e.g., because it allows them to economize on transaction costs or avoid indivisibility of the government bonds), and the banks hold the bonds on behalf of the households, then recognizing the safety of the government bonds is critical. If all the government debt is held by the banks and the safety of it is not recognized, then the minimal aggregate banking capital needed to support the entire stock of deposits has to satisfy

$$\frac{B}{B+X} > \frac{p(R-r)}{r(1-p)}. \tag{4}$$

Clearly, that minimal amount of capital implied by inequality (4) is greater than the one implied by inequality (3). Thus, although the reserve requirement is not per se *essential* in our model, the government would choose to employ it. And of course, it is essential to our basic story.

## 3.2 Risky Government Debt

Consider now the environment in which there is positive probability of government default. For simplicity, take the probability of repayment to be exogenous and equal to

$p$, so that the banks can create portfolios of risky projects that are *perfectly* correlated with the government debt.

If the riskiness of the government debt is recognized by the prudential regulation, the regulation remains effective. The "adjustment" to the regulation has to either recognize some other verifiably safe asset or increase the capital requirement.

On the other hand, if the regulation *relies on* the reserve requirement, i.e.

$$\frac{p(R-r)}{r(1-p)} \quad > \quad b \quad > \quad (1-q)\frac{p(R-r)}{r(1-p)},$$

and the riskiness of the bonds is not recognized, the regulation fails.

**Proposition 2** *If the prudential regulation that relies on the reserve requirement does not recognize the riskiness of the government debt, the banks take excessive risks.*

**Proof.** When government bonds are risky, but the banking regulation (which relies on reserve requirement) does not recognize them as such, the only equilibrium features all the deposits being invested only in government bonds and risky projects that are perfectly correlated with these government bonds. The only investment in the desirable risk-free projects may come from the capital of banks, which choose not to comply with the regulation, forfeiting the ability to accept any deposits, and invest only their own wealth.

Since there is more government debt outstanding than is required for the purposes of prudential regulation, the (gambling) banks must be willing to hold the bonds. That implies that $1 + i_g = R$. Since banks have to invest their own capital (the opportunity cost of which is $r$), the deposit interest rate has to satisfy

$$p(R - (1-b)(1+i)) = br. \tag{5}$$

This interest rate exceeds the risk-free projects' rate of return: $1 + i > r$. If that were not the case, the capital requirement alone would provide enough discipline for the banks, and the prudential regulation would not have been *relying on* the reserve requirement in the first place.

That means that the safe banks, if they existed, could not compete for the deposits. Note that such banks cannot credibly commit to not investing in risky projects, and hence cannot credibly offer security as compensation for lower interest rates. ∎

In this equilibrium, some potential banks will choose not to comply with the regulation, not to accept any deposits, and invest only their own funds in the risk-free projects. These "safe banks" cease to be registered banks. Since investment in government bonds is unattractive to them, but is required by the banking regulation, these agents will choose to abandon their status as banks (and their ability to accept deposits). Ironically, the only prudent investment entities in the economy are not classified as such, since they do not comply with the prudential regulation.

## 3.3 Key Insight

What makes this model more than just an illustration of the basic story is the insight it provides into the possible reason why the government does not adjust the prudential regulation when its debt becomes risky.

**Proposition 3** *The interest rate on the risky government bonds is lower when the prudential regulation does not recognize the riskiness of the debt.*

**Proof.** If the prudential regulation is adjusted to recognize the riskiness of government bonds, the government has to pay at least the actuarially fair risk premium on its debt: $1 + i_g = \frac{r}{p}$. As we so in the proof of proposition 2, the equilibrium interest rate on government bonds, when the regulation is not adjusted, is $1 + i_g = R$. Since $pR < r$, the interest rate on the government bonds is lower when the regulation does not recognize the riskiness of the bonds. ■

To illustrate how this lower cost of financing provides incentive for a government, which wants to avoid default, not to adjust the prudential regulation, consider the following illustrative example.

### 3.3.1 Illustrative Example

Suppose there are two possible states, $s_1$ and $s_2$, in period $T+1$. The government can repay up to $Q_1$ in state $s_1$ and up to $Q_2$ in state $s_2$, where $Q_1 > Q_2$. The probability of (favorable) state $s_1$ is $p$. Assume first that $pQ_1 > Q_2$, so that the government can raise more money in period $T$ by issuing risky debt with face value $Q_1$ than by issuing safe debt with the maximum face value of $Q_2$, even if the government pays actuarially fair risk premium.

If the prudential regulation recognizes the riskiness of government bonds (whenever the face value exceed $Q_2$), this government can raise at most $D_r = \frac{pQ_1}{r}$ in period $T$ by selling its debt. If the prudential regulation considers the government debt safe, the government can raise $D_g = \frac{Q_1}{R} > D_r$.

If the total of current obligations on debt and current budget deficit in period $T$ is $D_T \in (D_r, D_g]$, then the government has two options: default immediately in period $T$ or let the banks gamble in period $T$ by instituting the prudential regulation which considers the government debt safe. The second scenario postpones the default and even generates a positive probability ($p$) of avoiding it. If the government's objective is to avoid default (which may mean staying in power), such government will effectively gamble for resurrection, with the banking system being the gambling table.

Note further that the government may have the incentive to gamble even if $pQ_1 < Q_2$, as long as $\frac{r}{R}Q_1 > Q_2$ . In this case, while the safe debt going forward (promising to repay no more than $Q_2$) raises more in period $T$ than the risky debt which pays the actuarially fair premium, $D_s = \frac{Q_2}{r} > D_r$, the government can still raise more funds at $T$ by issuing risky debt *and* allowing the banks to gamble: $D_g = \frac{Q_1}{R} > D_s$. As before, if $D_T \in (D_s, D_g]$, the government may well choose to gamble for resurrection rather than to default immediately.

# 4 Augmented Environment

The basic environment described so far is rather rudimentary and has very stark predictions — in the pre-crisis period, none of the households' deposits are invested in the risk-free projects, and all (registered) banks fail following the government default. Furthermore, the prudential regulation is also rather simplistic — the capital requirement does not depend on the observable riskiness of the bank's portfolio. We will now augment first the model and then the prudential regulation to address these issues. We find that all the key findings still hold in the more realistic environments.

## 4.1 Richer Model

We begin by altering the model so that some of the households' investments are channeled into the risk-free projects. We do so by endogenizing the rate of return on these safe (and desirable) projects. We will no longer assume that these projects exhibit constant returns to scale. Assume instead that there is measure 1 of decreasing return to scale risk-free projects, which are owned by "entrepreneurs" who have no wealth of their own.[5] The entrepreneurs consume the profits from the projects. The households are unable to finance the entrepreneurs directly — the banks still have the unique ability to finance the projects. As before, we motivate this by the need to monitor the entrepreneurs. The banking system remains competitive, and all sides take interest rates as given.

We will now let $r$ denote the marginal rate of return to capital in these risk-free projects. This market rate of return will now be determined in equilibrium. Keeping the model similar to the simple benchmark, assume that if all available funds $(X + B - D)$ are invested in the risk-free projects, the marginal product of capital, which we will denote $r^{FB}$, falls in the interval $(pR, R)$.

If there is no risk of government default or the prudential regulation recognizes such risk, the equilibria are the same as before with $1 + i = r^{FB}$.

If the risk of government default exists, and is not recognized by the prudential regulation, the equilibrium has some banks gambling as before, while others invest in risk-free projects. The safe banks invest only the minimal required amount in government securities. These banks survive the default and fully repay their depositors. These safe banks do lose a fraction of their capital when the government default occurs.

The gambling banks are the only ones holding government debt in excess of the reserve requirement. They behave just like before — they create portfolios of risky projects perfectly correlated with government bonds. Since these banks must be willing to hold the government bonds, $1 + i_g = R$. Since the opportunity cost of funds is still $r$, equation (5) still holds. However, with some of the funds going into the risky

[5] We could alternatively assume that these project are owned by our risk-neutral banks, as long as the banks cannot get around limited liability by credibly pledging the projects as a guarantee to their depositors.

projects, the rate of return on safe projects goes up relative to the social optimum, $r > r^{FB}$, and some banks find it profitable to invest in safe projects. These banks hold minimal required amount of government bonds (the bonds are still unprofitable for the safe banks) and will survive the default. To see that the safe banks will survive, one simply has to realize that the banks will not settle for $r < R$ unless they do survive, and that when $r = R$ no investment in risky projects takes place.

The interest rate and the rate of return on the safe projects is jointly determined by the zero profit condition of the gambling bank (equation (5)) and the zero profit condition of the safe banks:

$$pqR + (1 - q)r - (1 + i)(1 - b) = br. \tag{6}$$

Knowing the rate of return on the safe projects, one can back out the total amount invested in them. The rest of available funds are invested in risky projects.

To summarize, the interest rates in the economy line up as follows:

$$R = 1 + i_g > r > 1 + i > r^{FB} > pR. \tag{7}$$

Note that even though the risk free interest rate in this equilibrium is higher than it would have been if the prudential regulation were adjusted, $r^{FB}$, the government cost of borrowing, $R$, is still lower than it would have been with the adjusted regulation. Thus, the government still has the incentive to let the banks gamble.

## 4.2 Sophisticated Prudential Regulation

In reality, the capital requirement imposed on the banks takes into account the portfolio composition of individual banks. Strikingly, incorporating this into our model only strengthens the results.

As opposed to treating capital and reserve requirements completely separately as we did so far, consider a more sophisticated (and more realistic) regulation, which disposes with the reserve requirement and makes the capital requirement a function of the reserves held:

$$b(q) = (1 - q)\frac{p(R - r)}{r(1 - p)} + \epsilon, \tag{8}$$

where $q$ is now the actual fraction of government debt held by a bank. An arbitrarily small $\epsilon$ is sufficient to make this prudential regulation work when the government debt is safe.[6]

If there is no risk of government default or the prudential regulation recognizes such risk, the equilibria are the same as before. If the government debt is risky and the prudential regulation does not recognize it as such, the "sophistication" of the regulation backfires. Holding more government bonds allows a bank to lower the amount of own capital involved in the gamble. This makes the bonds even more attractive to gambling banks than it was in the original model. The price of the bonds is driven even further up (the interest rate is driven even further down). In the limit, setting $\epsilon = 0$, the rate of return in the risky government bonds is equal to that on the risk-free projects:

$$R > 1 + i_g = r = 1 + i > pR. \tag{9}$$

In this equilibrium, it is the capital-poor banks that hold most of households' deposits. These banks hold the minimal amount of government debt needed to satisfy the regulation, and gamble by investing in risky projects perfectly correlated with the government debt. Capital-rich banks tend to choose the safe route – invest only in safe projects and hold no government debt at all. In this equilibrium *all* government debt is held for the purposes of satisfying the prudential regulation (that means that little banking capital is involved in gambling banks' satisfying the regulation). Ironically, all the banks, that satisfy the prudential regulation by holding reserves, are in fact gambling.

Note that the households now cannot do any better than holding their deposits in the bank (we ruled out holdings of foreign assets and direct holding of safe projects). Holding government debt directly is a bad idea.

[6]In the model, we allow the banks to hold reserves in the form of government bonds, while in reality they typically have to be held in cash. First, for simplicity, we do not have cash (which is subject to devaluation) in the model. Second, absent our assumption, the model generates complete dichotomy between gambling with the government bonds and the rest of the investments — banks either buy only bonds and hold no capital at all or stay away from the bonds altogether. However, this dichotomy misses a key aspect of reality. Due to minimal capital requirements, the banks cannot avoid risking some of their capital while holding governments bonds. Modeling the minimal capital requirement dramatically complicates the model as it necessitates a monopolistic competition model of banking. While we are working on such a model in a separate paper, we choose to simplify the analysis here by assuming that banks can use the bonds to satisfy the reserve requirement.

# 5 Empirical Support

In our theoretical analysis, we have established that, when prudential regulation considers risky government bonds safe, some banks gamble by constructing portfolios of risky assets strongly correlated with the bonds. In this section we examine data concerning the behavior of banks operating in Russia around the 1998 financial crisis, which hit in August of that year. This crisis led the Russian government to effectively default on GKO (domestic government bond) obligations. This was followed by a substantial devaluation of the Ruble, where roughly two-thirds of its value was lost in a matter of a month. These two occurrences provide an ideal situation whereby to test the implications of the model developed above.

Striking anecdotal evidence in support of our main mechanism can be found in Ippolito (2002).[7] Having realized that the government default on its debt would be accompanied by a dramatic devaluation of the ruble, some banks took enormous positions in the currency futures market. Table 1 provides a snapshot of some Russian banks' positions in that market a month before the default. Notably, these banks did not just hold currency futures, but rather *derivatives* on these futures, which meant that the banks only had to pay out in the event of a devaluation. The data cited in Johnson (2000) provides further support for our key mechanism.

Table 1: Estimates of forward liabilities to non-residents

| Bank | $mln | % of Capital | Bank | $mln | % of Capital |
|---|---|---|---|---|---|
| Inkombank | 1884 | 719% | Sberbank | 379 | 23% |
| Onexim | 1442 | 203% | NRB | 224 | 50% |
| Vneshtorgbank | 1062 | 136% | Menatep | 91 | 37% |
| MDM | 634 | 713% | MFK | 80 | 46% |
| Avtobank | 602 | 299% | Mezhkombank | 67 | 67% |
| Total | | | | 6500 | |

Source: Troika Dialog on the basis of banks' RAS as of 01.07.98

[7] Ironically, Ippolito (2002) argues that it was not the government default that led to the collapse of the Russian banking system in 1998, but rather the exposure of the Russian banks to the exchange rate risk.

## 5.1 Evidence from Micro-Level Data

Encouraged by the anecdotal evidence cited above, we have performed a more systematic analysis of the behavior of banks in Russia around the time of the crisis, using a unique dataset that contains balance sheet data from over 1000 banks.[8] Unfortunately, currency risk data are available only for 1998, thus our analysis is restricted to this year. Luckily, there is important variation in the relevant aspects of the banking system within the year. The crisis took place right in the middle of the third quarter of 1998. We will think of the first two quarters of 1998 as "pre-crisis", when the government debt has become risky, but the banking regulation failed to recognize it as such. Thus, we expect the banks to gamble by combining GKOs (government bonds) with currency forwards in the first two, but not the last two quarters of 1998.

The first and very stark support for our key mechanism comes from simply looking at the correlations between the GKO holdings and the currency risk exposure by quarter. These correlations, reported in Table 2, are positive and quite large in the run-up to the crisis, and are very close to zero after the crisis, when there are no more incentives for the banks to gamble. It is worth noting that the pre-crisis correlations are larger for the private banks. This observation lends support to the idea that allowing private banks to gamble was a complementary mechanism used by the government in addition to coercion they may have exercised over the state-owned banks.

Table 2: Correlations between GKO holdings and Currency Risk

| Period | All Banks | State | Private | Foreign | Domestic |
|---|---|---|---|---|---|
| 1998.Q1 | 0.2173 | 0.0966 | 0.2228 | 0.7431 | 0.1421 |
| 1998.Q2 | 0.1798 | 0.1675 | 0.1820 | 0.5173 | 0.1206 |
| 1998.Q3 | 0.0206 | -0.1576 | 0.0280 | 0.2910 | 0.0116 |
| 1998.Q4 | -0.0004 | -0.2649 | 0.0076 | 0.3717 | -0.0177 |

[8]Our reader may be concerned about the degree of enforcement (and thus relevance) of the banking regulation in Russia in 1998. While such concerns are not entirely unfounded, Claeys and Schoors (2007) suggest that the capital rules were perhaps the most consistently enforced banking standards of the whole battery of banking standards in place in Russia at the time (although the Central Bank of Russia was found to have some biases in its enforcement behavior in favor of systemically important banks).

We get further support for our key story from cross-sectional regressions reported in Table 3. The coefficient on the GKO/Asset ratio is both large and significant in the first two quarters of 1998, but drops to a fraction of its original size and loses its significance in the last two quarters. This demonstrates that just prior to the crisis, the On-Balance Currency Risk of a bank can be explained partly by their GKO/Asset holdings ratio. This further confirms the model's prediction of excessive risk-taking by Russian banks prior to the crisis, and this result is strengthened by the fact that On-Balance Currency Risk fails to be explained by the GKO/Asset ratio after the crisis took place. Note also that the fit of the regressions drops dramatically after the crisis, indicating that the mechanism we are emphasizing is no longer at work.

Table 3: OLS Regression with On-Balance Currency Risk as Dependent Variable; by Quarter in 1998

| Variable | 1998.Q1 | 1998.Q2 | 1998.Q3 | 1998.Q4 |
|---|---|---|---|---|
| GKO/Assets | 0.0955 | 0.0724 | 0.0194 | -0.0111 |
| | (0.0171)*** | (0.0158)*** | (0.0273) | (0.0312) |
| Foreign Dummy | -0.0783 | 0.0230 | -0.0796 | -0.0956 |
| | (0.0318)** | (0.0315) | (0.0402)** | (0.0411)** |
| State Dummy | -0.0311 | -0.0163 | -0.0218 | -0.0278 |
| | (0.0209) | (0.0201) | (0.0296) | (0.0304) |
| (GKO/Assets)*State | -0.0361 | 0.0074 | -0.1104 | -0.1159 |
| | (0.1044) | (0.0899) | (0.1289) | (0.1391) |
| (GKO/Assets)*Foreign | 0.8084 | 0.3751 | 0.3522 | 0.5859 |
| | (0.0826)*** | (0.0794)*** | (0.1556)** | (0.1683)*** |
| Constant | -0.0030 | -0.0021 | -0.0038 | -0.0094 |
| | (0.0024) | (0.0023) | (0.0036) | (0.0040)** |
| $R^2$ | 0.1357 | 0.0806 | 0.0062 | 0.0108 |
| Adjusted $R^2$ | 0.1330 | 0.0775 | 0.0028 | 0.0073 |

Lastly, we exploit the dynamic nature of our dataset in the panel regression reported in Table 4. Interacting GKO/Asset ratio with a Pre-Crisis (PC) dummy variable highlights the change that takes place after the crisis occurs. Pre-crisis, we see a large, significant relationship between On-Balance Currency Risk and GKO/Asset ratio, whereas after the crisis that relationship is not only muted but has changed signs, and is only marginally significant.

Table 4: Random-Effects GLS Regression with On-Balance Currency Risk as Dependent Variable. 1998 Q1-Q4.

| Variable | Coefficient | Standard Error | Z-stat |
|---|---|---|---|
| GKO/Assets | -0.0304 | 0.0163* | -1.8600 |
| Foreign | -0.0514 | 0.0272* | -1.8900 |
| State | -0.0264 | 0.0209 | -1.2600 |
| GKO/Assets*Foreign | 0.2659 | 0.0992*** | 2.6800 |
| GKO/Assets*State | -0.0959 | 0.0877 | -1.0900 |
| GKO/Assets*PC | 0.0925 | 0.0153*** | 6.0400 |
| GKO/Assets*Foreign*PC | 0.2183 | 0.0916** | 2.3800 |
| GKO/Assets*State*PC | 0.1229 | 0.0893 | 1.3800 |
| Foreign*PC | 0.0294 | 0.0287 | 1.0200 |
| State*PC | -0.0002 | 0.0191 | -0.0100 |
| Constant | -0.0028 | 0.0023 | -1.2300 |
| sigma_u | 0.0716 | | |
| sigma_e | 0.0755 | | |
| rho | 0.4737 | | |

$R^2$ within = 0.0268, $R^2$ between = 0.0517, $R^2$ overall = 0.0398

Note: PC refers to pre-crisis dummy variable, PC=1 for 1998Q1 and Q2

# 6 Conclusion

We have argued that failure of banking regulation to recognize the riskiness of government bonds can lead to excessive risk-taking by banks and system-wide banking crisis during the government's default. We have used a simple model to show that this failure of prudential regulation may serve the purposes of a self-interested government as it lowers the cost of financing the debt and may postpone (and give a chance to avoid) the default.

Available evidence regarding the behavior of Russian banks around the time of the 1998 crisis lends support to the mechanism we emphasize.

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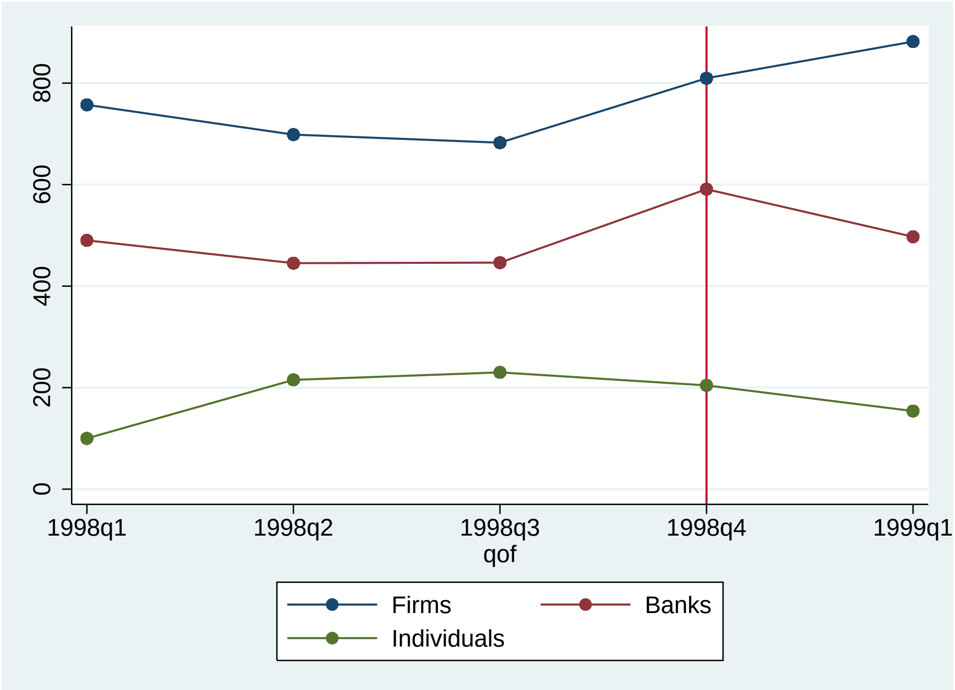


Figure 1: Real value of deposits in Russian banks, by source.*

*Deflated by CPI and indexed so that individuals' deposits in 1998q1 are 100. Does not include state-owned Sberbank, which held vast majority of households' deposits.