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Eugenio Proto

Growth expectations and banking system fragility in developing economies

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BOFIT Discussion Papers
Editor-in-Chief Iikka Korhonen

BOFIT Discussion Papers 13/2005
7.11.2005

Eugenio Proto: Growth expectations and banking system fragility in developing economies

ISBN 952-462-792-2
ISSN 1456-4564
(print)

ISBN 952-462-793-0
ISSN 1456-5889
(online)

Multiprint Oy
Helsinki 2005

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Tässä tutkimuksessa haetaan selitystä havaintoon, jonka mukaan pankkikriisien todennäköisyys näyttää olevan suurempi nopean talouskasvun maissa. Tutkimuksen teoreettinen malli perustuu Diamondin ja Dybvigin tunnettuun malliin, jossa pankit tarjoavat kuluttajille vakuutuksen kulutuksen vaihteluita vastaan. Mallin tuloksien mukaan nopea odotettu kasvu nostaa optimaalisen likviditeettivakuutuksen tasoa, vaikka tämä lisäisikin talletuspaon mahdollisuutta. Empiiriset tulokset tukevat tätä hypoteesia. Talletuskorkojen vaikutus pankkikriisin todennäköisyyteen on suurempi pitkän nousukauden jälkeen. Julkisen vallan toimet – kuten pankkien pelastaminen tai talletusvakuutus – ovat mallissa tehokkaita, vaikka ne lisäisivätkin pankkisektorin haavoittuvuutta.

Growth Expectations and Banking System Fragility in Developing Economies*

Eugenio Proto†

April 2005

Abstract

The likelihood of a banking crisis appears to be higher in fast-developing countries. An explanation is provided in a Diamond and Dybvig framework, where banks are vehicles of consumption-smoothing, offering insurance against shocks to the consumption path of consumers. The theoretical model shows that the higher consumer growth expectations, the higher the optimal level of illiquidity insurance – even if it implies higher exposure bank runs. Empirical evidence supports this result and suggests that the effect of deposit interest rates on the probability of crisis is stronger after a period of high, uniterrupted growth. Policies of providing bail-outs or deposit insurance are demonstrated to be efficient even when they increase the fragility of the banking system.

1 Introduction

Banking panics were frequent phenomena in the developing economies of nineteenth century Europe and the United States.[1] Modernly, bank crises have tended to be associated with emerging economies. Several studies, using various definitions for banking crisis, find that at least 70% of banking crises in the last quarter century occurred in developing countries.[2] Interestingly, banking

*I thank Wiji Arulampalam, Mathias Dewatripont, Marcelo Fernandes, Patrick Legros, Andrew F. Newman, Carlo Perroni, Oved Yosha, Luca Sala, and Philippe Weil for helpful comments and advice. My appreciation also extends to the seminar participants at Venice (EEA 2002), Warwick (RES 2003), University of Helsinki, BOFIT (Bank of Finland Institute for Economies in Transition), Ente Einaudi, and Royal Holloway. Finally, I wish to thank the BOFIT for financial support. The usual disclaimers apply.

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[1] See e.g. Kindleberger (2000).

[2] Londgren, Garcia and Saal (1996), Kaminsky and Reinhart (1996), Caprio and Kilinger (1999), Demirguç-Kunt and Detragiache (1998a, 1998b, 2002).

crises tend to hit fast-growing economies with increasing frequency as the number of years of uninterrupted high growth rises (see Table 1).

We argue this pattern in developing countries is linked to growth expectations stoked by years of consistent good economic performance. In actuality, growth for such countries during this period of economic "take-off" is highly unpredictable; the economy is still poorly diversified and an exogenous negative shock can easily hamper or halt the development process (Acemoglu and Zilibotti 1997). This pattern suggests individuals form high expectations for the future after observing a period of continuous, uninterrupted growth. Starting from this simple notion, we develop a theoretical explanation of the link between growth and fragility as presented in Table 1 and demonstrate that high growth expectations lead agents to prefer deposit contracts with a higher risk of bank run.

Table 1. Frequencies of crisis in countries with differing growth records, 1986-99[3]

Years of previous growth > 5%	$\frac{\#Crisis}{\#Obs.}$	$\#$ *Observations*
fewer than 2	.032	1736
2, 3 or 4	.052	77
5 or more	.111	27
all observations	.034	1840

At a more detailed level, it appears individuals smooth their consumption path by increasing their demand for liquidity when growth expectations increase, even if this implies greater exposure to financial crises. The macroeconomic literature analyzes consumption-smoothing with respect to fully predicted consumption needs.[4] Using the same logic, we can also posit that a rational individual might desire to smooth her random consumption needs and demand a higher level of insurance against "illiquidity shocks" as her future income expectations rise. In the model devised by Diamond and Dybvig (1983) (henceforth DD model), banks provide an insurance against illiquidity shocks by investing some of depositors' liquid capital in long-term assets. In a competitive market, banks meet the higher demand for illiquidity insurance by offering higher interest rates on deposits. In doing so, they also increase their short-term liabilities and become more vulnerable to crisis.

[3] Crisis data are elaborated from Caprio and Kligebiel (1999), and Lindgren, Garcia and Saal (1996). Growth rates are from World Bank's WDI database. Years of ongoing crisis are excluded. In the empirical section, we provide a more detailed description of the dataset.

[4] See e.g. Blachard and Fisher (1989), pp. 275-300.

We empirically test our findings using the econometric model developed by Demirguç-Kunt and Detragiache (1998, 1999, 2002) for measuring the determinants of financial crisis. We show that the real interest rate on deposits increases, more than elsewhere, the probability of crisis in countries characterized by years of high, uninterrupted growth .

Most papers applying the DD model deal with differentiating between real-shock-driven and sunspot-driven bank runs or identifying real-shock-driven runs.[5] Here, we focus on real-shock-induced crises and determine the external conditions that increase the exposure of banking systems to real shocks.[6] The modeling features of the paper are to some extent similar to Allen and Gale (1998), who consider an optimal deposit contract in the situation where a real signal can trigger a generalized run. The Allen-Gale model (AG model) finds that a bank run may produce an efficient result when a bank's portfolio is perfectly illiquid. We start by assuming that early liquidation is costly, but possible, and then analyze the effect of economic fundamentals on the likelihood of a financial crisis.[7]

Chang and Velasco (2001) utilize a DD-based model to explain the financial crises of the mid-1990s. They focus on the role of short-term international capital flows in increasing the fragility of a banking system with respect to a sunspot-driven bank run. While the Chang-Velasco (CV) model represents a powerful tool in explaining currency crises and their connection to banking crises, it lacks general empirical support in considering purely banking crises.[8] Moreover, it fails to provide a clear link between past growth and financial crises.

Ennis and Keister (2003) analyze the link between growth and financial crisis in a DD framework, emphasizing the impact of bank runs on economic growth to determine the social costs of financial crisis over the long term. Here, we consider the flip side of this effect (i.e. the impact of

[5] Gorton (1987), Chiari and Jaganathan (1988), Jacklin and Battacharya (1988), Goldstain and Pauzner (1999), Gren and Li (2000), and Peck and Shell (2003). See Freixas and Rochet (1999) and the more recent Gorton and Winton (2002) for excellent surveys on the argument.

[6] The fact that bank run are triggered by real shock rather than by sunspot, like in the original DD model, seems supported by the empirical literature. Gorton and Winton (2002) in their recent survey on financial intermediaries mention a number of empirical papers and conclude (page 77): "The previous evidence about the organization of the banking system strongly suggest that, at least hystorically, there is not necessary a link between banks and panics".

[7] The AG model assume all agents can be treated equally in case of a run, while in our model we specifically account for the first-come first-served constraint, whereby the first customers making it to the counter are able to withdraw more money. This adds an element of inefficiency to the bank run, because individuals face a non-insurable risk of arriving late at the counter.

[8] See the empirical evidence in the last section, Demirguç-Kunt and Detragiache (1998), and Eichengreen and Arteta (2000).

growth on financial crisis) to determine underlying causes.

The paper is organized as follows: In the next section, we analyze the main model with the simplifying assumptions that early asset liquidation, while costly, yields exactly the initial capital. In section 3, we provide an empirical test of the previous results. In section 4, we consider the effects of lowering asset liquidation costs. We draw our conclusions in section 5.

2 The model

We now present a model of banking along the lines of the DD model. Additionally, drawing on the AG model, we assume asset revenue is random and that a bank run can be generated by a bad real signal. Individuals take into account the risk of a bank run ex ante and consider the trade-off that occurs as increased liquidity increases the risk of a bank run.

In our model economy, there is a continuum of agents with mass 1 and a single good that can be consumed or invested. Every agent owns a unit of endowment at $t = 0$ and lives for three periods. The good can be costlessly stored or invested in an illiquid investment. This investment consists of a share of the market portfolio, which we assume is perfectly correlated with the aggregate production in the economy. A unit invested at time 0 yields R^h after two periods with probability q and R^l with probability $1-q$, where $R^l < R^h$. If agents perceive that the economy is on a path of high growth, q is close to 1. Conversely, q is close to 0 in a stagnating economy. We define $\tilde{R}$ as the random variable describing the returns on portfolio with $E(\hat{R}) > 1$. Two possible outcomes are indicated with the vector $R \equiv (R^l, R^h)$.

To simplify, we assume that a unit of the capital invested at time 0 can be disinvested and yields exactly a unit of the good at time 1. Under this simplifying assumption, it is optimal at $t = 0$ to invest the entire wealth in the illiquid asset. (In section 4, we analyze the effect of the asset's liquidation costs and allow for the asset to be sold on the secondary financial market at a price p.)

The performance of the economy at time 2 is public knowledge at time 1, after the agent receives a perfect signal about the state of the economy. At time 0, since all agents are the same and have the same information about economic fundamentals, they have identical growth expectations. Accordingly, individuals decide on their optimal consumption path c_1^* and c_2^*, knowing R and q.

There are two types of individuals: "patient" and "impatient." Every individual knows their types only at time 1, while at time 0 each individual knows that she will be impatient with a probability of $\frac{1}{2}$. An impatient individual obtains no utility in consuming at $t = 2$, so her utility is

$$u_I(c_1, c_2) = u(c_1).$$

Otherwise, a patient individual gets her utility from consuming at time 2. Moreover, given that the good can be perfectly stored between the two periods, the patient agent's utility function is

$$u_p(c_1, c_2) = \begin{cases} u(c_1) & c_1 > c_2, \\ u(c_2) & c_1 \le c_2. \end{cases}$$

As usual, function $u(\cdot)$ is twice continuously differentiable, increasing, and strictly concave. We also assume individuals are "sufficiently" risk averse, so that

$$-\frac{cu''(c)}{u'(c)} > 1. \tag{1}$$

This is a standard assumption in the DD model; it ensures that individuals are willing to adequately insure themselves against a liquidity shock, so that $c_1^* > 1$.[9] For our purposes, it is instructive to think of (1) in terms of the inverse of elasticity of substitutions, i.e.

$$-\frac{u'(c)}{cu''(c)} < 1.$$

Put in this way, we see that assumption (1) implies a preference to translate part of the increase in expected returns at time 2 into time 1 consumption. Therefore – and this is crucial for our model – individuals prefer a smoother consumption path. Higher expected returns in the long run always translate into higher short-term consumption rather than into higher long-run investment (i.e. the income effect outweighs the substitution effect). In the following discussion, we will see that the benefit to individuals of a smoother consumption path comes at the cost of greater exposure to financial crisis.

2.1 The standard deposit contract

Following DD, a bank can increase the utility of individuals as it can insure them against an idiosyncratic illiquidity shock. A demand deposit contract can provide this insurance. However, the demand deposit contract is not always risk-free, since R is random and there is the risk of a bank run in certain circumstances.[10] Following Allen and Gale's insight that the realization of $\tilde{R}$ is known at time $t = 1$, we assume that the signal about the economy is not contractible. Otherwise, a contract contingent on R would always avoid an information-induced bank run and

[9] It is possible to show that condition (1) corresponds to the assumption that $cu'(c)$ is decreasing.

[10] Since there are multiple equilibria in the model, a bank run will be possible for any values of R. Here, however, we do not consider pure sunspot-based bank runs.

achieve the first-best insurance.[11]

The standard deposit contract promises a fixed payment at each date. The consumption path is described by $(c_1, c_2(R))$, since the level of c_2 necessarily depends on R. As Jacklin and Battacharia (1988) observe, this is equivalent to a standard deposit contract that promises a fixed c_2 without specifying ex ante $c_2(R^l)$. The bank promises $c_2(R^h)$ as the normal level, but individuals know the bank can only pay R^l/R^h of the promised payment in the event of a negative shock.

Notably, a run does not necessarily follow a bad shock.

The optimal level of c_1 is chosen ex ante from the bank knowing the possibility of the run. A run will not take place when $c_2 \geq c_1$. Thus, patient individuals have the incentive to declare their own true type and only impatient individuals withdraw at time 1. Given that $c_2 = (2 - c_1)R$, there is a run if

$$c_1 > \frac{2R}{R+1}. \tag{2}$$

Thus, banks choose $(c_1, c_2(R))$, knowing that a run can take place when condition (2) is true. In order to determine the optimal deposit contract, we define ρ as the number of individuals withdrawing their deposit at time 1 and assume the following timing for the run:

- Individuals observe the realization of $\tilde{R}$. If $c_1 > \frac{2R}{R+1}$, they join the bank run, regardless of whether they are patient or impatient.

- The bank respects sequential (first come, first served) service and gives $\tilde{c}_1$ to the first $\rho = \frac{1}{2}$ individuals.

- When $\rho > \frac{1}{2}$, there is a bank run and the bank liquidates and distributes its remaining capital $(1 - \frac{1}{2}c_1)$. We assume the bank does this after formally closing the counter, i.e. all remaining individuals receive the same amount, $2(1 - \frac{1}{2}c_1)$.

Intuitively, this sequence of events appears to reflect actual bank behavior during a run. Run are unexpected and it often takes banks several days to fulfill the requests of an unexpectedly large number of withdrawers. Accordingly, banks normally serve the first customers arriving at the counter, but at some point, perhaps when a bank exhausts its cash, the counter closes and the bank spends the next few days liquidating its assets. At this point, the bank distributes equally to all the remaining customers the liquidity realized from the asset sales. Alternatively, we may

[11] An assumption that the signal is perfect is unnecessary, but it is made to keep the exposition as simple as possible. Naturally, we can more realistically assume that only a share s of individuals receive the signal, but this leaves the model essentially unchanged as we show in note 13.

assume that the government decides to suspend convertibility once it is certain a run is taking place, i.e. if $\rho > \frac{1}{2}$.[12]

Since we assume that everybody observes the signal at the same time and runs to the counter when (2) is true, $\frac{1}{2}$ is the probability of being in the first $\frac{1}{2}$ to arrive at the counter with other early withdrawers.[13] Accordingly, the agents' utility at time 0, conditional that the run happens, is $\frac{1}{2}u(c_1) + \frac{1}{2}u(2(1-\frac{1}{2}c_1))$. Alternatively, the ex-ante utility with no run is $\frac{1}{2}u(c_1) + \frac{1}{2}E\left[u(2(1-\frac{1}{2}c_1)\tilde{R})\right]$.

Let us define $r = R^h - R^l$. We write this problem as

$$\max_{c_1(r,q)} \{V^{br}(r,q), V^{rp}(r,q)\} \tag{3}$$

$$V^{rp}(q,r) = \max_{c_1} \frac{1}{2}u(c_1) + \frac{1}{2}E(u((2-c_1)R)) \text{ s.t. } c_1 \leq \frac{2R}{R+1},$$

$$V^{br}(q,r) = \max_{c_1} \frac{1}{2}u(c_1) + \frac{1}{2}\left(qu\left((2-c_1)(R^l+r)\right) + (1-q)u(2-c_1)\right) \text{ s.t. } c_1 > \frac{2R}{R+1}.$$

If the contract is *bank-run proof*, the expected utility from the contract is $V^{rp}(r,q)$. In case of a risky contract, the expected utility is $V^{br}(q,r)$. Since banks are in competition, they maximize individuals' utility.

If $R = R^h$, the fundamental run will never take place. This is intuitive, since a contract where a bank run happens cannot be optimal in any case. In formal terms, we can state:

Lemma 1 *If $R = R^h$, there is never a bank run.*

Proof. Suppose there is a bank run when $R = R^h$. Since $c_1 > \frac{2R^h}{R^h+1}$, the solution of problem (3) implies

$$u'(\tilde{c}_1) = u'(2(1-\frac{1}{2}c_1)) \tag{4}$$

or

$$c_1 = c_2 = 1,$$

but then $1 > \frac{2R^h}{R^h+1}$, or $1 > R^h$, which is impossible, since $E(\hat{R}) > 1$. ■

[12] Although such behavior is realistic, it is not the only possible behavior. For example, a pure sequential service constraint would bind the bank to serve all customers according to their position in the queue. This would leave those later in line without anything once the bank exhausts its cash. However, we assume this pattern only to simplify the algebra of the model. From the economic policy standpoint, what is critical for certain results in the last section is that early and late withdrawers are not treated similarly, i.e. there is a non-insurable risk of arriving late.

[13] The assumption that everybody observes the signal is not necessary. Let s be the probability of receiving the signal, hence $\frac{s+1}{2}/\frac{1}{2} = \frac{1}{(1+s)}$ is the probability of being in the first $\frac{1}{2}$ to arrive at the counter. Since the probability of being an early withdrawer is $\frac{1}{2}(1+s)$, the ex-ante probability of being among the first $\frac{1}{2}$ is $\frac{1}{2}$.

If $R^l < 1$, it is optimal to liquidate the asset when the realization of $\tilde{R}$ is low because its liquidation value is higher than the second-period return. In this case, a bank run always takes place.[14] Perhaps the more interesting case is where $R^l > 1$ and the bad shock is insufficient to consistently trigger a run.

To simplify the exposition, we initially solve numerically problem (3) under the CRRA assumption and present the solution in Figure 1. We then state the more general proposition 1.

Using Figure 1, we analyze the optimal contractual choice with respect to different levels of q, for a given difference between good and bad state, r. When the $q < \underline{q}$ constraint (12) is not binding, it implies there is only one available contract that solves problem (3) and that the contract is bank-run proof. When $\underline{q} \leq q < \overline{q}$ (12) is binding and $V^{rp} > V^{br}$, agents prefer a safe contract and choose $c_1 = \frac{2R^l}{R^l+1}$. Finally, when $q > \overline{q}$ then $V^{br} > V^{rp}$: the expected utility for a risky contract is so high that agents choose it despite the risk of a bank run.

Accordingly, countries which are on a stable growth path and where individuals expect high growth with a probability q close to 1 are vulnerable to bank runs. In contrast, countries where agents are uncertain about the future (a lower q), or countries with stagnating growth (or even negative growth, if we relax the assumption that the good is non-perishable), with q close to 0, face no risk of bank runs.

Now, we more generally state:

Proposition 1 *For any given difference $R^h - R^l > \overline{r}$, with $\overline{r}$ finite and positive, there exists a $\overline{q}$ such that the risky contract (strictly) dominates the bank-run-proof contract if, and only if, $q > \overline{q}$ ($q > \overline{q}$).*

Proof. See appendix. ■

3 Empirical evidence

In this section, we test empirically the results of the theoretical model obtained in section 2. In particular, we establish that high real interest rates on deposits significantly affect the probability of financial crises, especially for countries that have experienced five or more years of uninterrupted

[14] This condition is made more stringent by our assumptions for the liquidability of the initial investment and the non-perishability of the good. A good perishable at a level of $R^l < 1$ could also be compatible with a run-proof contract.

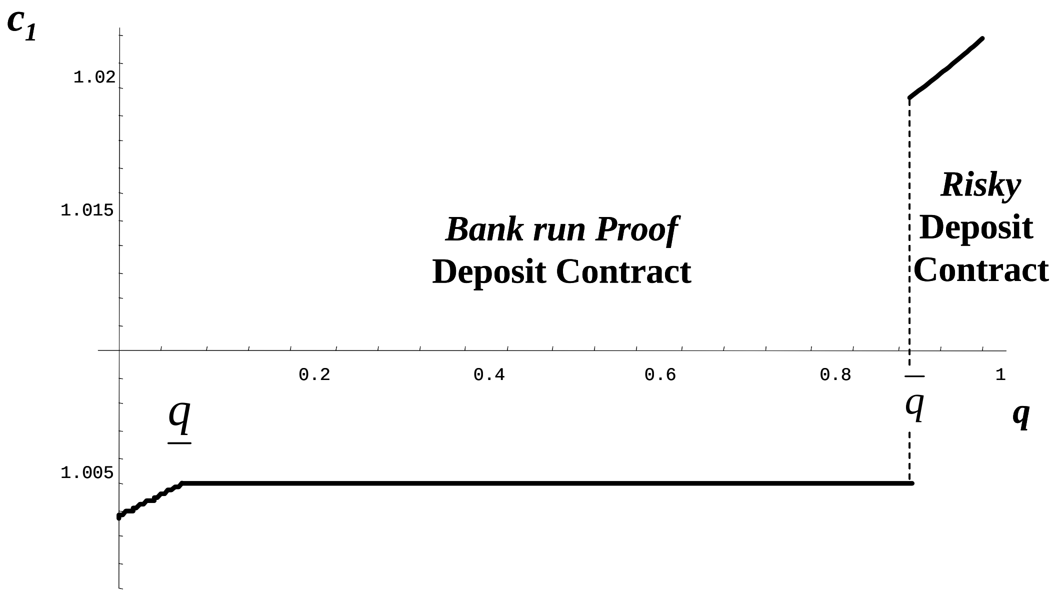

Figure 1: Deposit Contracts and Risk ($\sigma = 2$, $R^h = 1.05$, $R^l = 1.01$)

growth. We use the logit econometric model developed by Demirguç-Kunt and Detragiache (1998a and 1998b and 2002) (DKD model) on the determinants of banking crisis.

Consistent with our modelization, we assume that at the beginning year $t-1$, individuals in country i make their decisions on whether to consume at the end of time $t-1$ and the end of time t knowing the inflation rates $INF_{i,t-1}$,the expected real return R_t^e, and what an investment at the beginning of time $t-1$ will yield at the end of time t. The realization of $\tilde{R}$ is linked to the growth rate. We assume that if growth GR_t is the larger of a certain threshold, then $R = R^y$, otherwise $R = R^l$.Competitive banks, optimizing individuals' utility, determine the equilibrium real deposit rate $RDIR_{i,t-1}$.

The main problem derives from the determination of expectations for $\tilde{R}$ (or GR).[15] We deal with this problem, assuming as we argued in the introduction, that at $t-1$ agents generate their growth expectations at t as a function of past and current growth rates $GR_{i,t-1-k}$. We arbitrarily define a threshold of 3 percent and a threshold of 5 percent, indexed by j, and then determine

[15] *Realized* growth rates are a poor proxy, given that high growth expectations do not always translate into high growth rates. Moreover, we lose the unexpected shocks, which, according to our model, are the ones that generate the crisis. Therefore, by proxying R with the actual growth rate, we lose exactly what triggers the crisis in our model.

the dummy variables

$$RH(j)_{i,t-1} = \begin{cases} 1 & \text{if } GR_{i,t-1} > j, \ldots, GR_{i,t-1-5} > j \\ 0 & \text{otherwise} \end{cases} \quad \text{for } j = \{3; 5\}.$$

In other words, $RH(j)_{i,t-1} = 1$ when a country has experienced at least 5 years of uninterrupted growth. Therefore, we assume that growth expectations at $t-1$ for time t become high, i.e. q exceeds $\overline{q}$, only after 5 years of uninterrupted high growth.[16]

3.1 Sample and variables

The difficulty of building a reliable dataset for banking crises reflects the fact that only a minority of crises actually result in bank runs. In most cases, governments or external institutions intervene to avoid the run. Therefore, several criteria need be fixed to distinguish a systemic banking crisis from an isolated episode of financial distress for banks. We follow the DKD model in our definition of banking crises, including in our dataset all episodes listed in Caprio and Kingebiel (1999) and Lingren, Gillian, and Saal (1996) where at least one of the following conditions holds (a complete list of crises appears in the appendix):

1. An extensive bank run took place or emergency measures were enacted by the government in response to a crisis.

2. The cost of rescuing the financial system was at least 2 percent of GDP.

3. The banks involved collectively controlled over 50% of the credit market.

4. A deep restructuring, such as wide-scale nationalization, took place in the sector.

5. The ratio of non-performing assets over the total assets in the banking system exceeds 30 percent.

From these conditions, we determine a dummy variable $Crisis_{i,t}$, which takes the value one when a banking crisis occurs in country i and time t, and 0 otherwise. The years of crisis following the first have been excluded from the sample to avoid problems of endogeneity.[17]

[16] In the appendix, we present the sub-sample with $RH(3)_{i,t} = 1$. Considering 1998 per capita income, this sub-sample include none of the top ten richest countries and only Ireland makes it into the top 20. Therefore, both for $j = 3$ and $j = 5$, all observations where $RH(j)_{i,t-1} = 1$ can be rightly said to include only emerging economies.

[17] Recall that, apart from the growth rate, we already consider the effect of variables $t-1$ on a crisis at time t. Thus, there is no problem of endogeneity for the first year of crisis.

We consider all countries in the World Bank development indicators 2004 (WDI) database from 1975 to 1999. Since each observation contains a variable lagged up to six years, our sample is restricted to the period 1981–1999 with gaps from missing data and data for subsequent crisis years deliberately omitted. We also exclude centrally planned economies, economies in transition, and countries with inflation rates above 200 percent.[18] In this way, we are left with 108 countries and 51 crisis episodes, i.e. a total of 1,389 observations for the regressions in the largest sample (the list of countries and financial crises in our dataset are reported in the appendix).[19]

Our explanatory variables are: (1) the Real Deposit Interest Rate DIR, which is determined by subtracting the deposit interest rate paid by commercial or similar banks (IMF's International Financial Statistics dataset) from the contemporaneous rate of inflation, measured by the change in the GDP deflator (World Bank); and (2) the yearly growth rate of per capita GDP, GR (World Bank).

Our control variables are: (1) the inflation rate, INF, (calculated in terms of GDP deflator, World Bank) to account for central bank monetary policy and macroeconomic mismanagement; (2) the real interest rate, RIR , defined as the lending interest rate adjusted for inflation (IFS), to control for economic policy on interest rates and for the effect of high interest rates on non-performing loans rate; (3) the currency devaluation, DEV (IFS) to test whether the crises are driven by excessive foreign exchange risk exposure (see below for a more detailed description of the argument); and (4) per capita GDP, (WDI), as a proxy for the quality of bank regulation and the legal environment.

3.2 Results and robustness

We follow the literature on banking difficulties and apply a logit model to estimate the regressions.[20] We also introduce a random effect to control for countries' heterogeneity. These results are reported in Table 2.

In general, we can see that the parameters of the variables in common with DKD (1998) – the closest in terms of countries included in our sample – have the same sign and their magnitudes are comparable.[21]

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[18] This is true since both interest rates and inflation are yearly averages and the interest rates do not adjust instantaneusly to inflation rates, especially at the beginning of the inflationary period. The countries excluded for this reason are Angola, Argentina, Bolivia, Brasil, Chile, Israeal, Liberia, Mongolia, Peru, Somalia and Suriname.

[19] The period covered is shorter than 18 years for some countries.

[20] DKD (1998), note 17.

[21] They are GDP, DEV, and GR.

In regression 1, the effect of the real deposit interest rate $RDIR$ is positive and significant at the 5 percent level, while the dummy $RH(3)$ interacted with DIR is positive and significant at one percent level. Thus, the effect of interest rates on the probability of crisis is always significant and substantially higher in countries that have experienced five years of uninterrupted growth at three percent. Furthermore, we note that growth rate $GR$is negative and highly significant, confirming the notion that a real shock is needed to trigger a crisis.[22]

To have an idea of the magnitude of the effect of deposit real interest rate on the probability of crisis, we estimated its elasticity for three countries among the ones that experienced a crisis after at least 5 years of high growth. For the 1986 crisis in Malaysia a one percent decrease in the real deposit interest rate would have decreased the probability of crisis of about 32 percent; for the 1987 crisis in Cameroon a one percent increase of deposit interest rate would have reduced the probability of crisis of about 21 percent; in the 1997 crisis in South Korea the same negative change in the deposit interest rate would have lowered the probability of crisis of about 30 percent.[23]

The significativity of $RDIR$ and $RH(3)^*DIR$ is essentially robust to the introduction of the lending interest rates, RIR, as we can see in regression 2. Moreover, the variable RIR is not significant, which seems to rule out the possibility that the banking crisis might have been generated by high lending interest rates through an increase in non-performing loans. From regression 3, we observe that the magnitude of $RH(3)^*DIR$ is unaffected when we introduce the dummy $RH(3)$. This dummy is not significant in regression 3, but becomes highly significant when introduced alone in regression 4. Regressions 3 and 4 together suggest that the higher vulnerability of developing countries is entirely related to the high real deposit interest rate.

To verify whether the result is driven solely by the east Asian crisis, we run regression 5 , which excludes 1997 and subsequent years. The coefficient of $LRDIR$ is substantially unchanged, while the magnitude of $RH(3)^*RDIR$ is lower, but still significant at 5 percent level. Finally, in regression 6, we note that the coefficient of $RH(5)*\ LRDIR$, when the growth threshold considered is 5 percent instead of 3 percent, is not substantially different from $RH(3)^*RDIR$.

The currency devaluation DEV results are insignificant, which seems to rule out the external capital channel as a general determinant of banking crises. If a crisis would had been generated by an sudden halt in the inflow of external capital, the crisis should have been preceded by a devaluation of the domestic currency. This would have been generated by a massive sale of

[22]Problems of endogeneity may arise in this case, but they are minor given that financial crises seriously hit the economy in subsequent years.

[23]The total marginal effect $\frac{dcrisis_t}{dDIR_{t-1}}$ has been obtained by adding the marginal effect of DIR_{t-1} to the marginal effect of $RH(3) * DIR_{t-1}$.

domestic currency either to buy dollars and repay loans denominated in domestic currency or to liquidate assets denominated in foreign currency.[24]

[24] Both DKD (1998) and Eichengreen and Arteta (2000) arrive at a similar result. However, the depreciation appears positively related to the crisis in DKD (2002).

Table 2. Deposit interest rates and banking crises

	1	2	3	4	5	6
years	$1981-99$	$1981-99$	$1981-99$	$1981-99$	$1981-96$	$1981-99$
Control variables						
GDP/CAP$_{t-1}$	-0.035	-0.036	-0.035	-0.041	-0.036	-0.039
	(1.65)*	(1.68)*	(1.65)*	(1.87)*	-1.62	(1.84)*
Depreciation$_{t-1}$	0.001	0.001	0.001	0.001	0.001	0.001
(DEV_{t-1})	-0.39	-0.37	-0.38	-0.53	-0.6	-0.44
Inflation$_{t-1}$	0.032	0.036	0.032	0.033	0.031	0.031
(INF_{t-1})	(2.90)***	(2.87)***	(2.87)***	(3.09)***	(2.83)***	(2.92)***
Lend. Real Int$_{t-1}$		-0.018				
(RIR_{t-1})		-0.67				
Explanatory variables						
Growth$_t$	-0.094	-0.096	-0.093	-0.093	-0.087	-0.085
(GR_t)	(3.42)***	(3.46)***	(3.38)***	(3.38)***	(3.15)***	(3.17)***
Dep. Real Int$_{t-1}$	0.03	0.044	0.03	0.033	0.031	0.031
(DIR_{t-1})	(2.14)**	(1.72)*	(2.13)**	(2.42)**	(2.19)**	(2.27)**
$RH(3)^{*}DIR_{t-1}$	0.295	0.294	0.304		0.209	
	(4.24)***	(4.21)***	(2.34)**		(2.58)**	
$RH(5)^{*}DIR_{t-1}$					0.322	
					(3.00)***	
$RH(3)$			-0.074	1.259		
			-0.08	(2.83)***		
No. of obs.	1391	1391	1391	1391	1181	1391
No. of crises	51	51	51	51	46	51
No. of countries	108	108	108	108	106	108
$\sum_{i=0}^{N} RH(3)$	93	93	93	93	79	
$\sum_{i=0}^{N} RH(5)$						26

Dependent variable $Crisis_{i,t}$. Absolute value of z statistics in parentheses.

* Significant at 10%; ** significant at 5%; *** significant at 1%

4 Liquidation costs

The exercise of comparative statics, performed in section 2, shows how an increase in growth expectations, i.e. an increase in q, can increase the vulnerability of the banking system. In this section, we analyze the change in costs individuals are expected to bear after a crisis.

Accordingly, we now compare the effects of a bail-out in the event of a crisis and the effect of deposit insurance against bank runs. Both policies avoid the cost of early liquidation of bank assets. At the end of this section, we analyze the impact of an efficient secondary market, where it is possible to sell assets in the event of a bank run, and the resulting reduction in liquidation costs.

Generally speaking, a reduction of liquidation costs appears to increase the fragility of the banking system.

4.1 Economic policy

Consider the impact of two different policies commonly put in place to deal with financial crises. In the first, a government deposit insurance scheme permits a government or central bank to print money to supply liquidity to the banking system. In the second, troubled banks are bailed out by an internal agency such as the central bank or an international agency such as the IMF.

In the past section, we considered a standard deposit contract, where c_1 is fixed at $t = 1$ and it is not contingent on $\tilde{R}$, because the signal is not contractible. Following the argument of the DD model, a government can always do better by changing c_1 by levying a tax on consumptions or printing money, when it observes the realization of $\tilde{R}$. Let us define $\tilde{c}_1(R^l) = c_1(1 - t(R^l))$ and $\tilde{c}_2(R^l) = (2 - \hat{c}_1(R^l))R^l$ the new level of consumption after the intervention.

Ex ante, individuals solve

$$\max_{c_1(R)} \frac{1}{2}u(\tilde{c}_1(R)) + \frac{1}{2}\left(E\left(u(2 - \tilde{c}_1(R))\hat{R}\right)\right). \tag{5}$$

At the beginning of time 1 if $R = R^h$ or if $R = R^l$ and $c_1 \leq \frac{2R^l}{R^l+1}$, the government does not intervene; (5) is the same as problem (11) and $c_1 = \tilde{c}_1$. If $R = R^l$ and $c_1 > \frac{2R^l}{R^l+1}$, the government intervenes such that

$$\max_{\hat{c}_1(R^l),\tilde{c}_2(R^l)} \frac{1}{2}u(\hat{c}_1(R^l)) + \frac{1}{2}u(\tilde{c}_2(R^l))), \tag{6}$$

subject to the truth-revelation constraint

$$u(\hat{c}_1(R^l)) \leq u(\tilde{c}_2(R^l)), \tag{7}$$

which satisfies the conditions

$$u'(\hat{c}_1^*(R^l)) = R^l u'(\tilde{c}_2^*(R^l)) \text{ and } \tilde{c}_2^*(R^l) = (2 - \tilde{c}_1^*(R^l))R^l.$$

From this, we note that (7) is never binding as $R^l > 1$. Unlike in the past section, the incentive compatibility constraint (7) is never violated: the government can choose the level of $\tilde{c}_1$and make sure that (7) is always satisfied when $\rho = \frac{1}{2}$, i.e. when only impatient depositors withdraw at $t = 1$. Accordingly, the government decreases the level of c_1 when $R = R^l$.

We now argue that this mechanism increases the fragility of the system in the sense that banks incur financial distress for a larger interval of q.[25] The bank-run-proof contract determined by sub-problem (11) is always dominated by the risky contract with deposit insurance determined by problem (5). More formally, if q is such that constraint (14) is binding when there is no insurance, (i.e. $\underline{q} \leq q \leq \overline{q}$), problem (6) always dominates constrained problem (11). Hence, a risky contract is always preferred. We illustrate this point using Figure 1: if $q > \underline{q}$ the intervention would be needed any time $R = R^l$, since the bank-run-proof contract is always dominated. Without insurance, a risky contract is optimal only if $q > \overline{q}$. In this sense, the fragility of the system is increased.

Now we analyze a bail-out policy, whereby a central agency is committed to acquiring a troubled bank's assets, or equivalently, to lending money to a troubled bank using its illiquid assets as a collateral. To make our argument straightforward, we abstract from considering the opportunity cost of the funds needed for this operation and assume that they are supplied at no cost. Thus, this policy is zero-cost, since the agency lends at time 1 an amount $2(1 - \frac{1}{2}c_1)R^l$ to the bank, which then completely repays the loan at time 2 when it liquidates assets and realizes R^l.

Such lending avoids the loss $R^l - 1$ for the bank when it liquidates assets. As a result, $c_2(R^l) = 2(1 - \frac{1}{2}c_1)R^l$, no matter if there is a bank run or not. The new problem becomes

$$\max_{c_1} \frac{1}{2}u(c_1) + \frac{1}{2}E(u(c_2(\tilde{R})), \tag{8}$$

with

$$c_2(R) = 2(1 - \frac{1}{2}\tilde{c}_1)R. \tag{9}$$

If $c_1 > \frac{2R^l}{R^l+1}$, there is a bank run and a bail-out takes place. The optimal consumption path satisfies

$$u'(c_1^*) = qR^h u'(2(1 - \frac{1}{2}c_1^*)R^h) + (1-q)R^l u'(2(1 - \frac{1}{2}c_1^*)R^l),$$

and from which we see that $c_1 > \frac{2R^l}{R^l+1}$ is feasible.

[25] Here, we cannot talk about a run. Instead, we define "financial distress" as a situation where external intervention is required.

In this case, the contract determined by problem (11) when (12) is binding and is always dominated by the contract from problem (8) (they are equivalent when (12) is not binding). Referring again to Figure 1, this implies that whenever $q > \underline{q}$, a run will take place if $R = R^l$. The presence of a bail-out also increases the interval of q when a run takes place. At the same time, the utility from problem (8) is higher than in problem (3) because the cost $R^l - 1$ is avoided. Therefore, a bail-out is also efficient even though it increases the fragility of the banking system.

Comparing the deposit insurance policy to the bail-out policy, we note that while the bail-out policy improves aggregate utility, it is not first-best efficient like the deposit insurance. If $q > \underline{q}$ and the government commits to bailing out a bank in a crisis, there will always be a bank run when $R = R^l$. In this case, late withdrawers are always treated worse than early withdrawers, since $c_1^* > 2(1 - \frac{1}{2}c_1^*)R^l$. In other words, agents are not insured against the risk of arriving late to the counter in case of a bank run. The same problem does not arise under a deposit insurance scheme, since c_1 can be changed after the fact.

4.2 The secondary market for bank assets

An effect similar to that of a bail-out policy is generated by an increase in the efficiency of secondary financial markets, where banks can sell their assets in the event of a crisis. To analyze this effect, we relax the assumption that an asset can be liquidated at price 1 and assume that $p \leq R^l$ is the market price of a bank asset, so that $R - p$ is its liquidation cost. We interpret a higher p as an increase in the efficiency of financial market. We see that although a high p improves the aggregate welfare, it also increases the fragility of the banking system.

For simplicity, assume that $p > 1$. This ensures, as before, that all the capital will be invested ex ante in risky assets rather than stored.[26] Accordingly, the problem facing banks becomes

$$\max_{c_1(p,q,r)} \{V_p^{br}(p,q,r), V_p^{rp}(p,q,r)\} \text{ where } \tag{10}$$

$$V_p^{br} = \max_{c_1} \frac{1}{2}u(c_1) + \frac{1}{2}\left(E\left(u(2 - \frac{c_1}{p})\hat{R}\right)\right) \text{ if } c_1 \leq \frac{2R^l}{R^l + 1},$$

and

$$V_p^{rp} = \max_{c_1} \frac{1}{2}u(c_1) + \frac{1}{2}\left(qu\left((2 - \frac{c_1}{p})R^h\right) + (1-q)u\left((2 - \frac{c_1}{p})p\right)\right) \text{ if } c_1 > \frac{2R^l}{R^l + 1}.$$

From problem (10), we derive the following

[26] The case $p < 1$, while more cumbersome mathematically, is not qualitatively different.

Proposition 2 *For any given difference* $R^h - R^l > \overline{r}$*, with* $\overline{r}$ *finite and positive, there exists a* $\overline{q}(p)$ *such that risky contract dominates the bank-run-proof contract when* $q > \overline{q}(p)$ $(q < \overline{q}(p))$ *and* $\frac{\partial \overline{q}}{\partial p} < 0$.

Therefore, the higher p, the lower $\overline{q}$, and hence, the larger the interval of q where the contract is risky. An increase in the liquidity of bank assets generated, for example, by an increase in the size of the secondary market would, ceteris paribus, lead the bank to offer more risky contracts and increase the vulnerability of the financial system.

5 Conclusions

This paper considered how a higher level of vulnerability to banking crises may be acceptable in fast developing countries, especially where efficient secondary financial markets can reduce liquidation costs. However, we also found that external interventions are desirable. Both a bail-out policy (when a banking crisis is already under way) and a deposit insurance scheme (to prevent bank runs altogether) are welfare increasing, despite the fact that they may make the banking system more fragile. When a bail-out is expected, banks become more vulnerable to negative shocks. Similarly, a deposit insurance scheme makes the system more dependent on central intervention.[27] Therefore, provided that a deposit-insurance policy or a bail-out policy can be put in place at no cost, our model shows that the advantage in terms of better insurance outweighs the costs deriving from the subsequent higher level of fragility.

Furthermore, our model highlights an important difference between the bail-out and deposit insurance. As a bail-out does not avoid the run to the counter, it introduces an element of inefficiency. In the case of a run, individuals still face an uninsurable cost of arriving late at the counter even when there is a bail-out. This risk is absent under an effective deposit insurance scheme. This may explain why most banking crises never resulted in actual runs in our fairly extensive banking-crisis data taken from Caprio and Kingebiel (1999) and Lingren, Gillian, and Saal (1996).

[27] This last point is empirically supported by Demirguç-Kunt and Detragiache (2002), who find a strong positive effect from deposit insurance on the probability of a crisis.

A Appendix

A.1 Proof for proposition 1

To determine when a bank-run-proof contract is actually chosen, we consider separately two sub-problems (3):

$$\max_{c_1} \frac{1}{2}u(c_1) + \frac{1}{2}\left(E\left(u(2-c_1)\hat{R}\right)\right) \tag{11}$$

$$st.\ c_1 \leq \frac{2R^l}{R^l+1}, \tag{12}$$

and

$$\max_{c_1}\ \frac{1}{2}u(c_1) + \frac{1}{2}\left(qu\left(2-c_1)R^h\right) + (1-q)u\left(2-c_1\right)\right) \tag{13}$$

$$st. c_1 > \frac{2R^l}{R^l+1}. \tag{14}$$

We can rewrite sub-problem (11) as

$$\begin{aligned} L(c_1;\mu) &= \frac{1}{2}u(c_1) + (\frac{1}{2})(qu\left(2(1-\frac{1}{2}c_1)R^h\right) + \\ &\quad (1-q)u\left(2(1-\frac{1}{2}c_1)R^l\right)) + \mu(\frac{2R^l}{R^l+1} - c_1). \end{aligned}$$

If $\mu = 0$

$$u'(c_1) = qR^h u'\left(2(1-\frac{1}{2}c_1)R^h\right) + (1-q)R^l u'\left(2(1-\frac{1}{2}c_1)R^l\right). \tag{15}$$

If $\mu > 0$

$$c_1 = \frac{2R^l}{R^l+1} = \bar{c}. \tag{16}$$

Let c_{1a} be the solution of (15). For simplicity, we split the proof into two parts.

1) *We prove there exists a pair* $\underline{r}$ *and* $\underline{q}$ *such that, for* $r > \underline{r} > 0$, *(12) is binding for* $q > \underline{q} > 0$. Recall that $R^h = R^l + r$ from equation (15) and condition (1), as well as the implicit function theorem for $R^l > 1$, $\frac{\partial c_{1a}}{\partial r} > 0$ and $\frac{\partial c_{1a}}{\partial q} > 0$, with $\lim_{r\to\infty} c_{1a}(q,r) = \infty$ if $q > 0$. Thus, when $r = 0$, constraint (12) is not binding. This is true since (15) implies $c_{1a} < 2(1-\frac{1}{2}c_{1a})R^l$ or $c_{1a} < \bar{c}$. Given an $\underline{r}$ sufficiently large, we can define a function $q(\underline{r})$ such that $c_{1a}(q(\underline{r}),\underline{r}) = \frac{2R^l}{R^l+1}$ with $q'(r) < 0$. For $q > q(\underline{r})$, then $c_{1a}(q,r) > \bar{c}$. Thus, constraint (12) is binding and there exists a level $\underline{q} = \mathrm{q}(\underline{r})$ such that (16) is binding for $q > \underline{q}$.

2) *We prove that for* $r > \underline{r}$, there exists a $\bar{q}$ such that $V^{br}(q,r) > V^{rp}(q,r)$ if and only if $q > \bar{q}$. Consider problem (13) in the space $r > \underline{r}$ and $q > \underline{q}$, where (12) is binding. The corner solution

of (13) does not exist, so the internal solution, say $c_1 = \hat{c}$, is implicitly determined by

$$u'(\hat{c}) = qR^h u'\left(2(1-\frac{1}{2}\hat{c})R^h\right) + (1-q)u'\left(2(1-\frac{1}{2}\hat{c})\right). \tag{17}$$

and exists only if $\hat{c} > \overline{c}$ and for a sufficiently high q, say $q > \hat{q}$.[28] In this interval of q, we define function $DV(q,R^h) \equiv V^{br}(q,R^h) - V^{rp}(q,R^h)$, i.e.

$$\begin{aligned} DV(q,R^h) &= \\ & (1-q)\left(\frac{1}{2}u(\hat{c}) + \frac{1}{2}u\left(2(1-\frac{1}{2}\hat{c})\right) - u(\overline{c})\right) + \\ & q\left(\frac{1}{2}u(\hat{c}) + \frac{1}{2}u\left(2(1-\frac{1}{2}\hat{c})R^h\right) - \frac{1}{2}u(\overline{c}) - \frac{1}{2}u\left(2(1-\frac{1}{2}\overline{c})R^h\right)\right). \end{aligned} \tag{18}$$

The first term in the RHS of (18) is strictly negative. This is true since $u(\overline{c}) > u(\frac{1}{2}\hat{c}+\frac{1}{2}2(1-\frac{1}{2}\hat{c})) > \frac{1}{2}u(\hat{c})+\frac{1}{2}u(2(1-\frac{1}{2}\hat{c}))$, recalling that $\overline{c} > 1$. The second term is positive. We note that function $\frac{1}{2}u(c) + \frac{1}{2}u\left(2(1-\frac{1}{2}c)R^h\right)$ is increasing in $c \leq \hat{c}$ because $u'(\hat{c}) > R^h u'\left(2(1-\frac{1}{2}\hat{c})R^h\right)$. The last point is true given (17) and given that (1) implies that $Ru'\left(2(1-\frac{1}{2}c)R\right)$ is decreasing in R. Thus, $\frac{1}{2}u(\hat{c}) + \frac{1}{2}u\left(2(1-\frac{1}{2}\hat{c})R^h\right) >. \frac{1}{2}u(\overline{c}) + \frac{1}{2}u\left(2(1-\frac{1}{2}\overline{c})R^h\right)$ since $\overline{c} < \hat{c}$.

Using these observations and the envelope theorem, we can state

$$\frac{\partial DV}{\partial q} > 0. \tag{19}$$

Moreover, we note DV is continuous for $q > \hat{q}$, and for $q = 1$ $DV > 0$. Given these observations, we argue that:

- If $q < \hat{q}$, solution $\hat{c}$ does not exist.
- A bank-run-proof contract is the only feasible arrangement if there exists a $\overline{q} : \hat{q} \leq \overline{q} < 1$ such that for $q > \overline{q}$ $DV > 0$, i.e. a risky contract is preferred. For $q < \overline{q}$, the bank-run-proof contract is either preferred or the only feasible arrangement.

A.2 Proof for proposition 2

The solution for the second sub-problem of (10) is determined by

$$u'(\hat{c}) = qR^h u'\left(2(1-\frac{1}{2}\frac{\hat{c}}{p})R^h\right) + (1-q)u'\left(2(1-\frac{1}{2}\frac{\hat{c}}{p})p\right). \tag{20}$$

[28] For $q = 1$, the two problems are equivalent. We see this in the case $c_{1a} > \frac{2R^l}{R^l+1}$.

and exists for $\hat{c} > \frac{2R^l}{R^l+1}$, i.e. for a sufficiently high q , say $q > \hat{q}(p)$. Moreover, since $\frac{\partial \hat{c}}{\partial p} > 0$, $\frac{\partial \hat{q}(p)}{\partial p} < 0$. Exactly as before, we consider function

$$DV_p(q,r,p) = (1-q)\left(\frac{1}{2}u(\hat{c}) + \frac{1}{2}u\left(2(1-\frac{1}{2}\frac{\hat{c}}{p})p\right) - u(\overline{c})\right) + q\left(\frac{1}{2}u(\hat{c}) + \frac{1}{2}u\left(2(1-\frac{1}{2}\frac{\hat{c}}{p})R^h\right) - \frac{1}{2}u(\overline{c}) - \frac{1}{2}u\left(2(1-\frac{1}{2}\frac{\overline{c}}{p})R^h\right)\right).$$

Using the same reasoning, we argue that this is defined in the interval $q > \hat{q}(p)$ with $\frac{\partial DV_p}{\partial q} > 0$ and $DV > 0$ for $q = 1$. Moreover, we note that $\frac{DV_p}{p} > 0$, since the cost of the bank run is now lower. Defining $\overline{q}(p) : DV_p(\overline{q}, r, p) = 0$, we can argue $\frac{\partial \overline{q}(p)}{\partial p} < 0$.Therefore, there exists a $\overline{q}(p) > \hat{q}(p)$ such that the risky contract is preferred when $q > \overline{q}(p)$. For $q < \overline{q}(p)$, it is either dominated or not feasible.

A.3 Data

Countries in the sample

Algeria, Australia, Bahamas, Bahrain, Bangladesh, Barbados, Belgium, Belize, Benin, Bhutan, Botswana, Burkina Faso, Burundi, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Chile, Colombia, Comoros, Congo, Rep., Costa Rica, Cote d'Ivoire, Cyprus, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Equatorial Guinea, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Honduras, Iceland, Indonesia, Ireland, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Rep., Kuwait, Lebanon, Lesotho, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Morocco, Namibia, Nepal, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Panama, Papua New Guinea, Paraguay, Philippines, Portugal, Rwanda, Samoa, Senegal, Seychelles, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Uganda, United Arab Emirates, United Kingdom, Uruguay, Vanuatu, Venezuela, Zambia, Zimbabwe

List of Banking Crises

1990-96, Bangladesh- 1988-93, Burkina Faso- 1987-92, Cameroon-1995-99, Cameroon-1993-98, Cape Verde- 1988-99, Central African Republic- 1979-92, Chad- 1992-99, Congo, Rep.- 1987-98, Costa Rica-1988-91, Cote d'Ivoire- 1996-1999, Ecuador- 1989, El Salvador- 1991-94, Finland- 1982-99, Ghana- 1993, Guinea- 1995-97, Guinea-Bissau- 1992-94, Indonesia- 1998-99, Indonesia- 1990-93, Italy- 1994-99, Jamaica-1992-99, Japan- 1985-91, Kenya- 1997-99, Korea, Rep.-1985-88, Malaysia- 1997-99, Malaysia- 1987-88, Mali- 1984-91, Mauritania- 1994-99, Mexico- 1988-91, Nepal- 1983-90, Niger- 1990-95, Nigeria- 1987-93, Norway- 1988-89, Panama- 1989-99, Papua New Guinea- 1995-99, Paraguay- 1998-99, Philippines- 1981-91, Philippines- 1983-91, Senegal- 1990-99, Sierra Leone- 1988-93 Sri Lanka- 1995, Swaziland- 1991-94, Sweden- 1984-87, Thailand- 1997-99, Thailand- 1993, Togo- 1982-93 Trinidad and Tobago- 1990-98, Uganda- 1981-83, Uruguay- 1993-99, Venezuela- 1996, Zambia- 1995-99 Zimbabwe.

Observations with $R(3)_{i,t} = 1$

Bahamas, 1981- Botswana,1981-92- Cameroon, 1986-87- Congo, Rep.,1983- Cyprus, 1981- Dominica, 1985- Egypt, 1984-86- Guyana,1996-98- Iceland, 1981- Indonesia, 1991-97- Ireland, 1999- Korea, Rep. 1986-97- Malaysia, 1981-97- Malta, 1981-82- Malta, 1992-98- Mauritius 1990-99- Oman, 1986- Portugal, 1991-92- Singapore, 1981-82- Singapore,1992-98- Sri Lanka, 1982- Thailand 1989- 97.

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