DISCUSSION PAPER SERIES

No. 8248

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FINANCIAL ECONOMICS and INTERNATIONAL MACROECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: www.cepr.org/pubs/dps/DP8248.asp

ISSN 0265-8003

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THE INTERACTION OF FINANCIAL REGULATION AND BAILOUT GUARANTEES

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Discussion Paper No. 8248
February 2011

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CEPR Discussion Paper No. 8248

February 2011

ABSTRACT

Financial Black-Holes:

The Interaction of Financial Regulation and Bailout Guarantees*

This paper argues that the U.S. financial crisis is a new type of crisis: a "financial black hole." Financial black holes are characterized by the breaking-up of credit market discipline and the large-scale financing of negative NPV projects. In a theoretical model, we explain how the combination of perceived government guarantees and the ability to issues catastrophe-bond-like liabilities generate financial black holes. We then show that the stylized facts of the U.S. economy are consistent with a financial black hole equilbrium.

JEL Classification: E22, E60, F34, G01 and G18
Keywords: bailout guarantees, derivatives, financial crisis and financial regulation

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* Paper prepared for the 11th Jacques Polak Annual Research Conference at the IMF. We thank Giovanni Dell'Aricia, Joe Ostroy, Ayhan Kose, Augustin Landier and Pierre Olivier Gourinchas for helpful comments.

Submitted 07 February 2011

1 Introduction

The recent U.S. crisis has shown that the financial system might occasionally go awry generating negative social returns. The U.S. experience stands in contrast with the experience of emerging markets following financial liberalization. These countries have also experienced financial crises–the so called '3^{rd} generation' or balance-sheet crises–and systemic risk-taking has been, on average, associated with higher long-run growth.[1]

Here, we argue that the recent U.S. crisis is a different kind of crisis that can be characterized as a *financial black-hole*, whereby there is a breakdown of financial discipline that results in a large-scale funding of negative NPV projects.[2] We then link the break-down of discipline to loose financial regulation, and argue that while improving regulation to prevent financial black-holes is desirable, overregulating in order to prevent all financial crises is not.

In the theoretical part we show that the *toxic cocktail* that generates black-holes is the combination of perceived government guarantees and the ability to issue, without collateral, catastrophe-bond-like liabilities that promise to repay little in good states and a large amount in crisis states. Under this *anything-goes regulatory regime* with no limits on the type of liabilities that can be issued, financial discipline breaks down, and lending conditions are not determined by the profitability of investment projects, but by the expected generosity of bailout guarantees. In the empirical part we show that the recent U.S. black-hole exhibited a prevalence of catastrophe-bond-like liabilities. A key difference with previous 3^{rd}-generation crises is that while in both cases guarantees were present, credit booms prior to previous crises were characterized by large amounts of risky standard debt, not by catastrophe-bonds instruments.

We consider a model economy where financial frictions interact with bailout guarantees. In this economy there are safe and risky entrepreneurs that obtain external financing through the issuance standard debt and catastrophe-bonds. Under the former the borrower commits to repay a fixed amount independently of the state of nature, while the latter promises to repay little in good states and a large amount in crisis states. In this setup financial regulation determines the menu of liabilities that can be issued, and the type of entrepreneurs to whom lenders can lend.

If bailout guarantees could be outlawed by irreversible decrees, regulation would not play a crucial role because lenders and borrowers would internalize the consequences of their lending deci-

[1] See for instance Ranciere, Tornell and Westermann (2008), and Ranciere, Tornell and Vamvakidis (2010).

[2] According to Wikipedia "A black-hole is a region of space from which nothing, not even light, can escape... Despite its invisible interior, a black hole can be observed through its interaction with other matter."

sions.[3] However, guarantees are better viewed as the outcome of a political-economy game in which authorities are ex-post forced to grant bailouts to avoid a meltdown, but there is no pressure to grant a bailout when an idiosyncratic default occurs.

How should financial regulation be designed in such a world of endogenous bailout guarantees? An overly restrictive financial regime that aims at eliminating all traces of financial fragility by allowing debt issuance only by safe entrepreneurs, limits credit access, reduces productive investment and hence growth. A shift to a liberalized financial regime that allows lending to risky entrepreneurs, but only allows standard debt, increases production efficiency, even though crises might occur from time to time. Importantly, in such regime, systemic bailout guarantees do not lead to a break-down of financial discipline: the financial system will self-regulate and fund only positive NPV projects, some of which might go bust. Discipline comes about because under standard debt: (i) promised repayments cannot be concentrated in a particular state of nature (e.g. crisis states), and (ii) bailouts are granted only in crisis states. These restrictions imply that lenders find it optimal to impose collateral constraints, which means that borrowers must risk their own equity, and so only positive NPV projects are funded.

As we described above, a black-hole arises if regulation removes all restrictions on the issuance of catastrophe-bonds. This is because with bailout guarantees, catastrophe-bonds allow borrowers to shift all their promised repayments to the crisis states without the need to post collateral. Thus, financial discipline breaks down: this anything-goes regime induces not only the funding of negative NPV projects, but it also induces 'safe' entrepreneurs with positive NPV technologies–that would otherwise never default–to over-leverage and take on insolvency risk via the excessive issuance of catastrophe-bonds.

In order to provide evidence that a black-hole developed in the US, we document the proliferation of financing instruments–such as interest-only mortgages–whose payoffs resemble those of catastrophe bonds, and show that the issuance of such mortgages was strongly correlated with (i)a sharp increase in the market share of private securitizers and (ii)the issuance of securities (such as CDOs and CDSs) that satisfied the regulatory requirements of institutional investors. We then show that the pricing of financial instruments loaded with catastrophic risk reflected the presence of systemic bailout guarantees, and provide evidence that the share of mortgages that were likely to have ex-ante negative NPV was increasing in the years 2003-2007.

[3] That is, there would be no need for intrusive financial regulation in a truly *laissez-faire regime*–i.e., a regime that limit itself to ensuring private agents abide by their bilateral financial contracts.

In order to assess whether financially liberalized regimes–distinct from an anything-goes regime–lead to more investment and faster growth paths punctuated by rare crises, we carry out two exercises. In one exercise we use BEEPS firm-level data to provide evidence of the microeconomic mechanism linking financial liberalization, risk taking and the relaxation of borrowing conditions: we estimate the effects of currency mismatch–a common way to take on insolvency risk–on firm's borrowing costs and growth. In the other exercise, we show that over the last four decades, countries that have liberalized financially–and thus have experienced subsequent financial crises–tend to grow faster than countries that have followed a smooth path.

The structure of the paper is as follows. In Section 2 we present a minimal model that shows how financial black holes can arise. In Section 3 we extend the model by considering mortgage origination and securitization. In Section 4 we consider social efficiency. In Section 5 we present the empirics. Lastly, in Section 6 we present the conclusions.

2 Model

We set up a minimal model that allows us to analyze the circumstances under which the financial system performs its disciplining function of allocating resources to productive activities, but refrains from funding unproductive activities. To do so we consider three production technologies: a safe one with positive net present value (NPV), a risky one that has positive NPV, and an inferior technology that has negative NPV. In the next section we present a mortgage-origination version of this model, where we identify these production technologies with mortgages granted to several types of homebuyers that differ in their likelihood to repay.

There are two states of nature next period: a good state ($\overline{s}$) and a bad state ($\underline{s}$) :

$$S_{t+1} = \begin{cases} \overline{s} & \text{with probability } u \\ \underline{s} & \text{with probability } 1-u \end{cases}$$

The safe technology returns σ in both states

$$q^{\sigma}_{t+1} = \sigma I_t, \qquad \sigma > 1 + r, \tag{1}$$

where $1 + r$ is the return on a storage technology. The risky technology has a return θ in the good state and zero in the bad state. The return θ is high enough so that this technology has positive

NPV

$$q^{\theta}_{t+1} = \begin{cases} \theta I_t, & \text{if } S_{t+1} = \overline{s} \\ 0 & \text{if } S_{t+1} = \underline{s} \end{cases}, \qquad u\theta > 1 + r \tag{2}$$

The inferior technology has a negative NPV.

$$q^{\varepsilon}_{t+1} = \begin{cases} \varepsilon I_t, & \text{if } S_{t+1} = \overline{s} \\ 0 & \text{if } S_{t+1} = \underline{s} \end{cases}, \qquad 0 < u\varepsilon < 1 + r \tag{3}$$

These production technologies have hard-wired insolvency risk. In a more elaborate setup, systemic risk would derive from mismatches between uncontingent promised debt repayments and contingent revenues (see Ranciere and Tornell (2010)).

There are three groups of entrepreneurs, each of which has access to one of the three production technologies, as well as to a storage technology that returns $1 + r$ in all states. Each group consists of two-period lived entrepreneurs of measure one. Each young entrepreneur starts with internal funds equal to w_t. If she commits to invest her internal funds in the production technology, she can borrow b_t from risk-neutral lenders that have an opportunity cost of r. Thus, the budget constraint of a young entrepreneur is

$$I_t + s_t = w_t + b_t, \tag{4}$$

where I_t is investment in the production technology and s_t is storage.

There are two types of liabilities that entrepreneurs can issue: *standard debt* and *catastrophe bonds*. Under a standard debt contract the borrower must repay next period under all circumstances. If she is unable to repay debt, she defaults and all revenues are lost–in bankruptcy procedures. That is, under a standard debt contract the promised repayment is

$$L^{sd}_{t+1} = b_t[1 + \rho^{sd}_t] \quad \text{for all } S_{t+1}, \tag{5}$$

where ρ^{sd}_t is the promised interest rate. Catastrophe bonds, in contrast, promise to repay zero in the good state and a large amount in the bad state. That is, they are similar to put contracts.

$$L^{cb}_{t+1} = \begin{cases} 0 & \text{if } S_{t+1} = \overline{s} \\ b^{cb}_t[1 + \rho^{cb}_t] & \text{if } S_{t+1} = \underline{s} \end{cases} \tag{6}$$

When old, the entrepreneur consumes her profits, which will equal $q_{t+1} - L_{t+1}$ if the promised debt repayment L_{t+1} is no greater than revenues q_{t+1}. If instead $q_{t+1} < L_{t+1}$, the entrepreneur defaults and all revenues are lost in bankruptcy procedures. It follows that expected profits are

$$\pi_{t+1} = E_t \left(\max\{0,\ q_{t+1} - L_{t+1}\} \right). \tag{7}$$

Financial Regulatory Regimes

Throughout the paper we define financial discipline as follows.

Financial Discipline The financial system performs its disciplinary role if lenders fund all positive NPV projects, but fund neither negative NPV projects nor diversion schemes.

In general, a sufficiently restrictive regulatory regime might succeed in inducing financial discipline, but at a high social cost in terms of underinvestment. In order to investigate the impact of a relaxation of the regulatory regime on the level of productive investment and on its ability–or lack of–to induce financial discipline, we consider three regulatory regimes.

Restrictive regime Lenders can only lend to entrepreneurs with access to the safe production technology, and only the issuance of standard debt is allowed.

Liberalized regime Lenders can lend to any type of entrepreneurs, but only standard debt can be issued.

Anything-goes regime Lenders can lend to any type of entrepreneurs, and any type of liability can be issued.[4]

Credit Market Imperfections

The model economy includes two imperfections that capture two opposing forces: (i) financial frictions that might generate borrowing constraints; and (ii) bailout guarantees that might induce insolvency risk-taking, the financing of negative NVP projects and of diversion scams.

In order to analyze how bailout guarantees can lead to a break-down of financial discipline, it is necessary to endogeneize borrowing constraints. Simply postulating exogenous borrowing constraints would not permit such analysis. Thus, we postulate the following agency problem between lender and borrower.

Contract enforceability problems If a borrower implements a diversion scheme at time t, she will be able to divert all funds at $t+1$ provided she is solvent. In order to implement a diversion scheme, the borrower has to incur at time t a diversion cost, proportional to her investable funds

$$\text{diversion cost} = h[w_t + b_t]$$

[4]Since there are bailout guarantees, the anything-goes regime is distinct from *laissez-faire*. Under laissez-faire agents face the consequences of the contracts they sign. Not so under anything-goes regime.

The parameter h indexes the degree of contract enforceability. The greater h, the more costly for a borrower to divert. A borrower will choose not to set up a diversion scheme if and only if the expected debt repayment is less than the diversion cost

$$\text{No diversion} \;\Leftrightarrow\; \text{borrower's expected debt repayment} \;\leq\; h[w_t + b_t] \tag{8}$$

To capture the stylized fact that bailouts are granted if there is a systemic financial crisis, but not otherwise, we consider the following bailout policy.

Systemic Bailout Guarantees If a critical mass of borrowers defaults and the bad state realizes, the government pays lenders of defaulting borrowers up to an amount $G_t = gw_{t-1}$ per borrower. If idiosyncratic defaults occur, the lenders are not bailed out.

Discussion

There a myriad ways to introduce financial frictions and bailout guarantees. In particular, one can postulate generous enough bailout policies that would destroy financial discipline even if borrowers were limited to issue only standard debt (i.e., there would be no discipline in any of the regulatory regimes described above). Such an exercise, however, would miss the key point that the set of permissible liabilities, drastically impact the ability to exploit bailout guarantees. This is why in order to carry out a meaningful analysis we need to restrict the class of bailout policies.

We have reduced the degrees of freedom by requiring that the interaction of the two imperfections is consistent with the stylized fact that countries that experience rare balance-sheet crises tend to grow faster than countries with smooth growth paths and tight credit conditions. These 3^{rd}-generation crises have characterized most emerging market crises in the last few decades, and have featured the issuance of standard debt not derivatives.[5] To generate this stylized fact in our setup, it is necessary that: (i) the financial friction gives rise to borrowing constraints under some conditions; and (ii) under the restrictive and the liberalized regimes bailout guarantees do not eliminate the discipline induced by borrowing constraints. Given that these requirements are satisfied, we will ask how is it that a shift to the anything-goes regime might lead to a breakdown of financial discipline.

Requirement (i) is satisfied in our framework because no-diversion condition (8) becomes a borrowing constraint only if it is binding in equilibrium for some positive b_t. This is the case only

[5] Ranciere, Tornell and Westermann (2008), and Ranciere, Tornell and Vamvakidis (2010).

if at the margin the diversion cost is smaller than the expected interest cost. Thus, in order for the economy to be financially constrained under standard debt we impose the following condition

$$h < [1 + r]u. \tag{9}$$

Granting a bailout only if a critical mass of borrowers is in default is necessary for requirement (ii) because only in this case the no-diversion condition might become a borrowing constraint. If a bailout were granted in the wake of any idiosyncratic default, then lenders would not find it optimal to impose borrowing limits: (8) would never become a borrowing constraint. In addition to being crucial for the argument, we consider that this "systemic" nature of the guarantees is realistic. Typically, governments don't just grant a bailout whenever a default occurs. They do so only when the risk of an imminent meltdown generates enough political pressure.[6]

3 Equilibria

An implication of the systemic nature of the guarantees is that coordination–implicit or explicit– among agents is necessary for bailout expectations to arise in equilibrium. If a majority of agents believe that no bailout will be granted under any circumstances, and this is common knowledge, there are no incentives for any type of entrepreneur to unilaterally undertake insolvency risk. In other words, there must be correlated risks in order to activate the guarantees.

In what follows we investigate when is it that guarantees can be activated, and we investigate conditions under which a relaxation of the regulatory regime might increase productive investment while not destroying financial discipline.

3.1 Restrictive Regulatory Regime

This regime directs lenders to lend only to σentrepreneurs with access to the safe technology. Under such regime, financial fragility would arise and bailouts would be triggered only if entrepreneurs issued excessive debt or they set up diversion schemes. The next proposition says that the are no incentives for such fragility-inducing actions.

Proposition 1 (Financial Discipline in a Restrictive Regime) *Under the restrictive regulatory regime:*

[6]For the endogeneity of bailout guarantees see Farhi and Tirole (2009), Chari and Kehoe (2010) and Schneider and Tornell (2004).

- *The financial system performs its disciplinary role by imposing borrowing constraints that ensure diversion schemes are not profitable.*
- *Agents have no incentives to induce bailouts.*

Consider the case where no bailout guarantees are expected. Lenders are willing to lend up to an amount that ensures borrowers will be able to repay debt and have no incentives to divert borrowed funds. Suppose for a moment that such a contract is feasible. Then lenders break even if the interest rate on debt equals the storage rate

$$1+\rho_t^{safe}=1+r \tag{10}$$

It follows that the no-diversion constraint (8) is

$$b_t[1+r]\leq h[w_t+b_t] \tag{11}$$

This no-diversion constraint becomes a borrowing constraint because contract enforceability problems are severe enough: $h<1+r$ (this condition is implied by (9)). It follows that borrowing and investment are

$$b_t^s=[m^s-1]\,w_t,\qquad I_t^s=m^s w_t,\qquad m^s\equiv\frac{1}{1-\frac{h}{1+r}} \tag{12}$$

The first equation shows that credit is constrained by internal funds. The second equation exhibits the familiar financial accelerator: investment equals the multiplier times internal funds. As we can see, the greater the degree of contract enforceability h, the greater the investment multiplier.

To verify that borrowers will be able to repay we replace (12) in (7), and find that the borrowing constraint ensures that revenues will be sufficient to repay debt (i.e., profits are always positive (because $\sigma>h$))

$$\pi_{t+1}^{\sigma}=\sigma m^s w_t-[m^s-1][1+r]w_t=[\sigma-h]m^s w_t. \tag{13}$$

Furthermore, under borrowing constraint (12) the entrepreneur does not gain by setting up a diversion scheme: he would get $\pi_{t+1}^{\sigma,\text{div}}=\sigma m^s w_t-h[w_t+b_t]=[\sigma-h]m^s w_t$, which is the same as his payoff under no diversion (13).

Lastly, notice that there are no incentives to exploit the bailout guarantees. In order to do so, entrepreneurs would have to issue high enough debt that would render them insolvent in the bad state. Under the standard debt requirement, however, this excessive debt implies that entrepreneurs would also default in the good state. Thus they would get zero profits in both states. In other words, standard debt induces financial discipline under a restrictive regime.

3.2 Liberalized Regime

A shift from the restrictive to the liberalized regime allows lenders to lend to any type of entrepreneur, but it preserves the restriction that only standard debt can be issued. The key point, made by the following proposition, is that even in the presence of bailout guarantees, liberalization does not destroy financial discipline. The latter is preserved by the requirement that debt must be repaid in all states of nature. Thus, on financial discipline grounds, the existence of guarantees is not sufficient to justify an overly restrictive regulatory regime that directs lending to specific type of borrowers.

Proposition 2 (Financial Discipline in a Liberalized Regime) *Under the financially liberalized regulatory regime–that restricts liabilities to standard debt contracts–*

- *There is a relaxation of borrowing constraints.*
- *Systemic bailout guarantees do not undermine financial discipline: negative NPV projects are not undertaken, while all entrepreneurs with positive NPV projects are funded and do not divert.*

Since a relaxation of borrowing constraints leads to more investment in positive NPV projects, this result underlies the stylized fact that countries that have experienced rare but severe balance-sheet crisis–and so exhibit a negatively skewed distribution of real credit growth–tend to grow faster than other countries.

Case a. No bailout guarantees are expected

The problem of a lender lending to a σentrepreneur is the same problem as the one under the restrictive regime, and so credit and investment are as in (12). Consider a lender that lends to a θentrepreneur with access to the risky technology. Since she will default with probability $1 - u$, lenders require an interest rate that allows them to break even

$$1 + \rho_t^{risky,NG} = \frac{1+r}{u} \tag{14}$$

Since the expected debt repayment by the entrepreneur is $ub_t[1 + \rho_t]$, the no-diversion constraint is

$$\begin{aligned} h[w_t + b_t] &\leq ub_t[1 + \rho_t] \\ &= b_t[1 + r] \end{aligned} \tag{15}$$

A comparison of borrowing constraints (11) and (15) reveals that in a liberalized regime with no guarantees, the θentrepreneur can borrow and invest the same amounts as the σentrepreneur under the restrictive regime (they are given by b_t^s and I_t^s in (12)).

How about εentrepreneurs with access to the inferior technology? Since their productivity is too low ($u\varepsilon < 1 + r$), in the absence of guarantees they prefer to store their funds.

To sum up, under a liberalized regime, in the absence of guarantees, the financial market imposes discipline into investment decisions: the interest rates charged to entrepreneurs and the borrowing constraints imposed on them internalize the risks taken on by entrepreneurs. Thus, only entrepreneurs with positive NPV projects are funded.

Case b. Bailout guarantees are expected

In this case, lenders impose the same interest rate on risky entrepreneurs as that for safe entrepreneurs because from the lender's perspective loans to θentrepreneurs are safe: either they will be repaid by the borrower if $S_{t+1} = \bar{s}$ or by the government if $S_{t+1} = \underline{s}$. That is, the interest rate to risky borrowers reflects the guarantee

$$1 + \rho_t^{risky,G} = 1 + r.$$

Since the expected debt repayment by the entrepreneur is $ub_t[1 + \rho_t]$, the no-diversion constraint is

$$h[w_t + b_t] \leq ub_t[1 + r]. \tag{16}$$

It follows that with generous guarantees, borrowing and investment by θentrepreneurs are

$$b_t^r = [m^r - 1]\, w_t, \qquad I_t = m^r w_t, \qquad m^r \equiv \frac{1}{1 - \frac{1}{u}\frac{h}{1+r}} \tag{17}$$

By generous guarantees we mean that the upper limit on the bailout is high enough, so that it is not binding in a risky equilibrium

$$G_{t+1} = gw_t, \qquad g > \frac{1}{\frac{1}{h} - \frac{1}{u}\frac{1}{1+r}} \tag{18}$$

We impose this condition throughout the paper.

Shifting from a no-guarantees' regime to a guarantee's regime has two benefits for a θentrepreneur: it reduces the interest rate from $\frac{1+r}{u}$ to $1 + r$, and it relaxes her borrowing constraint, which allows for greater leverage and investment (the investment multiplier increases from m^s to m^r). This relaxation of borrowing constraints comes about because lower expected interest payments reduce the incentives to divert. One can thus interpret the bailout guarantees as an implicit investment subsidy that can be cashed in only by taking on insolvency risk.

A θentrepreneur can choose to store her equity w_t rather than invest in the risky technology. In the former case she will get $w_t[1+r]$ for sure, while in the latter case the entrepreneur might default and loose her equity w_t. Thus, she will take on insolvency-risk only if the benefits are high enough so that $w_t[1+r]$ is lower than expected profits, which are

$$\pi_{t+1}^{risky,BG} = u\left\{\theta m^r w_t - [m^r - 1][1+r]w_t\right\} = [u\theta - h]m^r w_t.$$

The benefits of taking on risk outweigh the default costs $\pi_{t+1}^{risky,BG} > w_t[1+r]$ if and only if $h > [1 + r - u\theta]\frac{u}{1-u}$. This inequality necessarily holds for all $h > 0$ because the risky technology has positive NPV $(1 + r < u\theta)$.

Do bailouts induce the adoption of the inferior technology in a liberalized regime? No. To see why, suppose that an εentrepreneur issues standard debt and invests in the ε-technology. A lender would charge the εentrepreneur an interest rate r, and lend her an amount that satisfies both the no-diversion constraint $ub[1+r] \leq h[w+b]$ and allows the borrower to repay in full in the good state $q^\varepsilon - b[1+r] \geq 0$. Even though lenders are willing to lend to an εentrepreneur, she has no incentives to risk her funds w_t because her opportunity cost is greater than her expected return. Thus, guarantees do not activate the inferior technology when financial regulation restricts liabilities to standard debt contracts. To see this notice that expected profits $\pi_{t+1}^{\varepsilon} = [u\varepsilon - h]m^r w_t$ are lower than the storage returns $w_t[1+r]$ if and only if $h < [1+r-u\varepsilon]\frac{u}{1-u}$. This condition necessarily holds when crises are rare events $(u \to 1)$ because $u\varepsilon < 1 + r$.

3.2.1 Anything-Goes Regime

Under this regime lenders are allowed to fund any class of entrepreneurs, as in the liberalized regime. In addition, regulation allows not only for the issuance of standard debt, but also permits the issuance of catastrophe bonds with no collateral.

As detailed in the next proposition, discipline need not break down. It is only the toxic combination of the anything-goes regulatory regime with generous systemic bailout guarantees that breaks financial discipline and generates financial black holes. Absent bailout guarantees, under an anything-goes regime lenders would internalize the consequences of their lending decisions and only positive NPV project would be funded. That is, there would be no need for financial regulation in a truly laissez-faire regime.

Proposition 3 (Anything-Goes Regime) *In an anything-goes regulatory regime, where catastrophe bonds can be issued without collateral, the disciplining role of the financial system is determined by the generosity of bailout guarantees:*

- *Financial discipline breaks down if bailout guarantees are generous: (i)negative NPV production technologies are funded; and (ii) entrepreneurs that would otherwise have zero likelihood of default, take on insolvency risk via an excessive issuance of catastrophe bonds.*
- *In the absence of generous bailout guarantees there is financial discipline: (i)only positive NPV technologies are funded; (ii) there is no diversion; and (iii)all catastrophe bonds issued are repaid for sure by the issuer.*

Case a. No bailout guarantees are expected

Recall that with a catastrophe bond an entrepreneur receives b_t^{cb} at time t from a lender for a promise to repay zero in the good state, and $L_{t+1}^{cb} = b_t^{cb}[1+\rho_t^{cb}]$ in the bad state. In the absence of guarantees, no lender is willing to buy catastrophe bonds issued by either θentrepreneurs or εentrepreneurs because it is known that they will default in the bad state. Therefore, the lender will be paid zero in both states for sure. A lender, however, is willing to buy a catastrophe bond issued by safe σentrepreneurs up to an amount that satisfies the no-diversion condition $[1-u]b_t^{cb}[1+\rho_t^{cb}] \leq h[w_t + b_t^{cb}]$. Since the interest rate that allows the lender to break even is $\rho_t^{cb} = \frac{1+r}{1-u}$, the no-diversion condition implies that the largest loan amount consistent with no diversion is $b_t^{cb} = m^s w_t$. Notice that this amount coincides with the amount of standard debt that the σentrepreneur can issue (see (12)). Furthermore, her expected profits are the same under both types of liabilities. Thus, in the absence of guarantees, the σentrepreneur is indifferent between issuing catastrophe bonds and standard debt.

In sum, in the absence of guarantees a shift from a liberalized regime to an anything-goes regulatory regime does not undermine the disciplinary role of the financial system. In fact, if the relaxation of regulation leads to the issuance of catastrophe bonds, they will be repaid for sure by the issuer. If we define laissez-faire as a situation with an anything-goes regulatory regime and the absence of guarantees, we can say that laissez-faire does not undermine the disciplinary role of the financial system.[7]

Case b. Bailout guarantees are expected

[7]Opponents of restrictions on OTC derivatives trading have such a laissez-faire regime in mind.

Recall that with a catastrophe bond the promised repayment is concentrated in the bad state, while it is zero in the good state. In the bad state, although an εentrepreneur will default, the lender expects to be repaid by the government. A key implication is that the disciplinary role of the financial system breaks down: the lender does not care whether the investment project is profitable or the borrower will set up a diversion scheme. Thus, contract enforceability problems do not give rise to borrowing constraints. Rather, if the bailout generosity is high enough ($g > g^*$), the lender and the entrepreneur will enter a catastrophe debt contract that *fully exploits the bailout guarantee*: since the maximum bailout is $G_{t+1} = gw_t$, the lender lends up to

$$b_t^{cb} = \frac{1-u}{1+r} g w_t, \tag{19}$$

and the εentrepreneur invests all her funds in the ε-technology

$$I_t^\varepsilon = \left[1 + \frac{1-u}{1+r} g\right] w_t \qquad \text{if } g > g^* \equiv \left[\frac{1+r}{u\varepsilon} - 1\right] \frac{1+r}{1-u}$$

Condition $g > g^*$ ensures that the expected profits of investing in the ε-technology ($\pi_{t+1}^{\varepsilon,cb} = u\varepsilon[1 + \frac{1-u}{1+r} g] w_t$) are greater than the storage return $[1+r]w_t$.

Will θentrepreneurs issue standard debt or catastrophe bonds? If she issued catastrophe bonds, the borrowing constraint would be determined by the bailout guarantee not by the no-diversion condition. Thus, the θentrepreneur could borrow up to (19) and her expected profits would be $\pi_{t+1}^{\theta,cb} = u\theta[1 + \frac{1-u}{1+r} g] w_t$. If instead she issues standard debt, the borrowing constraint is determined by the no-diversion condition–as in the liberalized regime–and so her expected profits are $\pi_{t+1}^{risky,BG} = [u\theta - h] m^r w_t$, which were derived above. A comparison of these expected profits reveals that θentrepreneurs prefer to issue catastrophe bonds over standard debt if the bailout generosity is high enough ($g > g^{**}$)

$$g^{**} \equiv \left[\frac{[u\theta - h]\, m^r}{u\theta} - 1\right] \frac{1+r}{1-u}.$$

Lastly, σentrepreneurs also prefer to issue catastrophe bonds over standard debt if the bailout generosity is high enough ($g > g^{***}$)

$$g^{***} \equiv \left[\frac{[\sigma - h]\, m^s}{u\theta} - 1\right] \frac{1+r}{1-u}.$$

If g is high enough, it behooves a σentrepreneur to shift from a strategy that never defaults–and yields $\pi_{t+1}^{\sigma,safe} = [\sigma - h] m^s w_t$–into a strategy that leads to default in the bad state by issuing an excessive amount of catastrophe bonds, so that promised debt repayments in the bad state surpass revenues. The latter strategy yields an expected profit of $\pi_{t+1}^{\theta,cb} = u\sigma[1 + \frac{1-u}{1+r} g] w_t$.

The essential reason for the breakdown of discipline across safe entrepreneurs is that the σentrepreneur can increase her bad state debt repayment without being forced to increase her good state repayment.

4 Opening the Box: Mortgage Origination and Securitization

Here, we open the box by replacing the entrepreneurs and lenders with mortgage originators, securitizers, insurers and pension funds. We consider a setup where homebuyers get loans from mortgage originators, who fund themselves by selling mortgages to securitizers. The securitizers in turn bundle mortgages into bonds, and repackage them into so called collateralized debt obligations (CDOs). Senior tranches of these CDOs, in combination with insurance instruments (credit default swaps (CDS)) are then purchased by regulated investors that most hold prime-grade securities in their balance sheet. This setup will not add any new insight, but will allow us to link the abstract concepts–such as catastrophe bonds–to financial instruments used in the real world, and connect the financial black-hole equilibrium to the recent US housing boom-bust cycle.

Instead of the entrepreneurs of the last section, consider originators that act as mortgage originators and securitizers. Originators extend one-period mortgages to homebuyers that will repay the mortgage next period by using two sources of funds: a refinancing loan and his disposable income y^i. Thus, a homebuyer will repay the mortgage provided his disposable income plus the mortgage refinancing are greater than his committed mortgage repayment. Otherwise, the house will be foreclosed and the entire value of the mortgage will be lost in bankruptcy procedures.

Mortgages have a zero down payment and require the homebuyer to repay next period the loan plus a mortgage rate μ, which includes a markup over the riskless rate r. The house price equals 1 at time t, and might go up or down at $t+1$.[8]

$$p_{t+1} = \begin{cases} \overline{p} > 1 & \text{with probability } u \\ \underline{p} < 1 & \text{with probability } 1-u \end{cases}$$

It follows that the time t mortgage is 1, the promised $t+1$ repayment is $[1+\mu]$, and the refinancing amount will equal p_{t+1}.

[8] Prices are exogenous in this paper. Ranciere and Tornell (2010) consider a model with endogenous prices.

There are three groups of homebuyers: safe, risky and no-doc. The safe homebuyers have a high and steady disposable income (y^σ) that will allow them to repay the mortgage in full even if house prices fall: $y^\sigma > 1+\mu$. The risky and the no-doc homebuyers have a low and random disposable income: it might be either $\widetilde{y} < 1+\mu-\underline{p}$ or 0. Thus, they can repay the mortgage only if their income is positive and the home price goes up. That is,

$$\widetilde{y} + \overline{p} > 1+\mu > \widetilde{y} + \underline{p}.$$

Risky and no-doc homebuyers are differentiated by the probability that their income will be positive: θ and ε, respectively.

There are three types of mortgage *originators* $\{\sigma, \theta, \varepsilon\}$, each specializing in extending mortgages to one of the three homebuyers' types. These originators also act as *securitizers* that package mortgages into bonds and sell them. At time t, a representative j-type mortgage originator lends 1 to a j-type homebuyer. At $t+1$ the j-homebuyer will repay $1+\mu$ if he is solvent or 0 otherwise. In order to link the originators' payoff to the entrepreneurs in the original model denote by I^j the number of mortgages originated by a j-originator. It follows that the repayments next period are:

σ-originator: $\quad q^\sigma_{t+1} = I^\sigma[1+\mu]$

ρ-originator: $\quad q^\theta_{t+1} = \begin{cases} I^\theta[1+\mu] & \text{if } p_{t+1} = \overline{p} \text{ and } y^\theta_{t+1} = \widetilde{y} \\ 0 & \text{if } p_{t+1} = \underline{p} \text{ or } y^\theta_{t+1} = 0 \end{cases}$

ε-originator: $\quad q^\varepsilon_{t+1} = \begin{cases} I^\varepsilon[1+\mu] & \text{if } p_{t+1} = \overline{p} \text{ and } y^\varepsilon_{t+1} = \widetilde{y} \\ 0 & \text{if } p_{t+1} = \underline{p} \text{ or } y^\varepsilon_{t+1} = 0 \end{cases}$

It follows that the expected repayment of the three homebuyers' types are

$$E(q^\sigma_{t+1}) = [1+\mu], \qquad E(q^\theta_{t+1}) = \theta u[1+\mu], \qquad E(q^\varepsilon_{t+1}) = \varepsilon u[1+\mu], \quad \text{where} \quad \varepsilon < \theta.$$

In order to have the same ranking of expected returns as in the original model we set

$$\varepsilon u[1+\mu] < 1+r < \theta u[1+\mu] < 1+\mu$$

The upshot is that mortgages to σ- and θ- homebuyers have positive NPV, while ε-mortgages have negative NPV.

We can think of the risky homebuyers as workers with steady jobs that will be employed with a high probability θ, while the no-doc homebuyers have transitory jobs that will be employed with low probability ε. Safe homebuyers can be thought of as wealthy individuals that can always repay their mortgages. We can then interpret ε-mortgages as Alt-A mortgages in which the required repayment is low during the first few years of the loan, but then might jump up. As long as house prices will increase fast enough, the borrower will be able at that future date to get a new Alt-A mortgage, and repay the original mortgage. This process can go on and on until house prices stop rising, at which point the borrower will default.

Mortgage Financing

We introduce two additional risk neutral agents with an opportunity cost of capital r: funds and insurers. Funds are required by regulation to hold safe net positions in their balance sheets (i.e., they should be rated as prime-grade). Insurers specialize in trading put-like instruments. In particular, insurers trade p*ut contracts* that have a promised repayment of the form

$$L^{cb}_{t+1} = \begin{cases} 0 & \text{if } p_{t+1} = p^a \\ x & \text{if } p_{t+1} = p^b, \end{cases}$$

where p^a and p^b can be either $\underline{p}$ or $\overline{p}$.

Mortgage originators fund themselves by repackaging mortgages into *CDOs* and selling the senior tranches of the CDOs to funds. In our model economy a CDO is a bundle of mortgages with two tranches: a senior tranche that promises an interest rate ρ, and a junior tranche that has an equity-like payoff. That is, the senior tranche is the first to receive its repayment from the mortgage pool, and only after it gets paid in full, the junior tranche starts getting repayment.

Originators sell to the funds the senior tranches of the CDOs (b_t) and keep the junior tranches (w_t). In particular, a $\theta-$mortgage originator with internal funds w_t that sells b_t senior CDO tranches to the funds, originates $w_t + b_t$ θ-mortgages at time t. Next period, if $p_{t+1} = \overline{p}$, a share θ of the mortgages will repay $1 + \mu$, while a share $1 - \theta$ will default. In this case the fund (that holds the senior CDO tranche) will receive $b_t[1 + \rho]$, while the originator (that holds the junior CDO tranche) absorbs the losses and receives only $\theta[w_t + b_t][1 + \mu]$. If instead the bad state realizes ($p_{t+1} = \underline{p}$) then all θ-mortgages default and both CDO tranches get zero.[9]

In order to manufacture a prime-grade security that pays for sure $b_t[1 + \rho]$ in all states next period, the funds can buy from insurers a put that pays 0 if $p_{t+1} = \overline{p}$ and $b_t[1 + \rho]$ if $p_{t+1} = \underline{p}$.[10] It follows that, from the funds' and the regulator's perspectives, the senior tranche of the CDO plus the put constitute a AAA security that will pay $b_t[1 + \rho]$ in every state.

[9] Notice that buying a senior CDO tranche is like buying a call option that will pay only in the good state.

[10] In the literature catastrophe bonds are sometimes assumed to be call-like instruments: they pay 0 in the bad state and a positive amount in the good state. In this paper catastrophe bonds are puts.

Whether originators can replicate the catastrophe bonds of the original model or only issue standard debt is determined by the regulations on derivatives trading.[11] Analogous to the original model, we consider three regulatory regimes.

Restrictive regime. Funds must hold prime-grade securities, and trade in puts is not allowed.

Liberalized regime. Funds must hold prime-grade securities. Insurers can only sell protective puts to holders of standard debt.

Anything-goes regime. Funds must hold prime-grade securities. Insurers can enter into any option contract with no collateral.

Notice that in the liberalized regime puts only serve as hedging instrument. In contrast, this is not true in the anything-goes regime. As we shall see, under the latter, trade in puts will allow agents to finance negative NPV mortgages.

The rest of the setup is as in the original model: there are contract enforceability problems and systemic bailout guarantees. In particular, a mortgage originator cannot commit to repay debt: by incurring a cost $h[w_t + b_t]$ she can set up a diversion scheme and divert all funds next period. Furthermore, if a majority of mortgages defaults, the government pays out all the obligations up to $G_t = gw_{t-1}$ per creditor. However, if only a small share of mortgages default, no bailout is granted.

4.1 Equilibria

Notice that the setup is isomorphic to the original model. In particular, the mortgage repayments have the same form as production technologies (1)-(3). Furthermore, since a bailout is granted only if a majority of originators defaults, a bailout occurs in the original model only in the bad state ($S_{t+1} = \underline{s}$), and only if house prices are low ($p_{t+1} = \underline{p}$) in this model. In particular, a bailout would not be granted if $p_{t+1} = \overline{p}$ even if all ε-originators defaulted. It follows that the propositions derived in the original model apply to this mortgage origination setup if we replace the state (S_{t+1}) by

[11] Under a standard debt contract the originator must repay next period under all circumstances, regardless of the house price realization. A catastrophe bond, in contrast, promises to repay zero if house prices rise ($p_{t+1} = \overline{p}$), and a large amount if house prices fall ($p_{t+1} = \underline{p}$). Thus, the promised repayments under these two liabilities are as in the original model substituting the realization of the price p_{t+1} for the realization of the state S_{t+1} (given by (5) and (6)).

house prices (p_{t+1}). In what follows we use results in those propositions to describe the equilibrium outcomes under the three regulatory regimes.

In the restrictive regime funds only buy CDOs issued by σ-originators and defaults do not occur. Thus, the interest rate of the senior CDO tranche ρ is equal to r, the funds opportunity cost. Since both σ-mortgages have positive NPV and the internal funds of the representative originator are w_t, it follows that $I^{\sigma} = m^s w_t$ σ-mortgages are originated. Since funds cannot buy CDOs formed with risky θ-mortgages even though they have positive NPV, only a small amount of θ-mortgages are originated ($I^{\theta} = w_t$).

4.1.1 Liberalized Regime

The effect of a shift to the liberalized regime is to allow funds to buy senior CDO tranches issued by θ-originators. Even though θ-CDOs default with probability $1 - u$, funds can create a synthetic riskless bond that will repay $b_t[1 + \rho]$ in all states by buying a senior θ-CDO tranche, and a put that will pay-off $b_t[1 + \rho]$ if $p_{t+1} = \underline{p}$. Of course, such AAA security might have a very low expected return because of the cost of insurance. As we shall see, here is where systemic bailout guarantees kick in.

To determine the price of this put notice that since the systemic bailout guarantee is activated if $p_{t+1} = \underline{p}$, the taxpayer ends up paying the promised put repayment. Since insurers are risk neutral and competitive, the guarantee makes the time t price of the protective put go to zero. It then follows that the risk neutral funds will accept an interest rate ρ equal to the riskless rate r. The results in the original model then imply that a fund will θ-CDOs up to an amount that makes diversion by the θ-originator non-optimal: $b_t = [m^r - 1]w_t$. Thus, $I^{\theta} = m^r w_t$ θ-mortgages are originated.

Notice that θ-originators' find it optimal to originate θ-mortgages because the expected return on their equity (w_t) is greater than the riskless return: $\theta u[1 + \mu] > 1 + r$. Lastly, under a liberalized regime ε-mortgages are not originated because the ε-originators' expected returns on their equity are lower than the riskless return: $\varepsilon u[1 + \mu] < 1 + r$. That is, the financial system performs its disciplinary role.

4.1.2 Anything-Goes Regime

Here, we illustrate how an elimination of regulatory restrictions on derivatives trading can generate a financial black-hole, by describing an array of derivatives contracts that support the issuance of ε-

mortgages with a negative NPV. Like in the original model, the lethal cocktail is the combination of systemic bailout guarantees and lax regulation that allows for the creation of catastrophe-bond-like instruments.

Because there are no restrictions on the option contracts that can be traded, originators-securitizers are able to de-facto shift all their promised repayments from the good state to the crisis state, and in this way manufacture synthetic catastrophe bonds. Because there are systemic bailout guarantees the puts necessary to manufacture these catastrophe bonds are dirt cheap.

Recall that with catastrophe bonds, originators promise to repay zero if $p_{t+1} = \overline{p}$, and promise a high amount if $p_{t+1} = \underline{p}$. These repayment profiles can be reproduced by the following array of CDOs and put contracts: (i) the ε-originator purchases from an insurer a put contract that promises $b_t[1+r]$ if $p_{t+1} = \overline{p}$ and 0 otherwise; (ii) the ε-originator pays the insurer with a put that promises $b_t[1+r][\frac{1-u}{u}]$ if $p_{t+1} = \underline{p}$ and 0 otherwise; (iii) funds pay b_t to ε-originators for a senior CDO tranche that promises $b_t[1+r]$ and the right to the payments of the put contract described in (i); lastly, (iv) funds buy from insurers put contracts that promise to pay $b_t[1+r]$ if $p_{t+1} = \underline{p}$ and 0 otherwise.

At time $t+1$ the payoffs are as follows. If $p_{t+1} = \overline{p}$, funds will receive $b_t[1+r]$ from insurers as payment for the put attached to the CDO, and so originators will pocket the mortgage repayments $\varepsilon[1+\mu]$. If instead $p_{t+1} = \underline{p}$, funds will get a bailout payment associated with their puts, and insurers will get a bailout payment associated with their put contract with originators. Since there are bailout guarantees, no collateral constraints and insurers are risk neutral, the price of these puts is zero. Thus, funds are willing to buy senior tranches of ε-CDOs that promise an interest rate r.

The upshot is that under this array of payoffs ε-originators are not required to make any net repayments if $p_{t+1} = \overline{p}$. Thus, we obtain the same payoff structure as in the original model's anything-goes regime. In particular, the diversion constraint is not binding (because $0 < h(w_t + b_t)$). As a consequence, funds set b_t so as to maximize the bailout payment they will extract, disregarding the no-diversion constraint. Furthermore, notice that originators have incentives to originate ε-mortgages because they do not need to risk their own equity.

For future reference we sum-up in the next Corollary

Corollary 4 *A financial black-hole develops if and only if (i) there are systemic bailout guarantees and (ii) catastrophe-bond-like securities can be issued. If there is a shift to a black-hole equilibrium:*

1. *There is an increase in the origination of mortgages with very low required repayments during the first years, followed by a jump in repayments latter on (i.e., the so called interest-only,*

negative amortization, option ARM, etc).

2. *There is an increase in the share of subprime and Alt-A mortgages issued to borrowers with a low ability–or none–to repay in the absence of house-price increases.*

3. *There is a massive increase in securitization vehicles–such as CDOs–and financial insurance instruments–such as CDSs.*

4. *Financial insurance is underpriced and is insensitive to mortgage default rates.*

Implication 1 reflects the existence of catastrophe bonds. Implication 2 reflects the issuance of negative NPV mortgages. Implication 3 reflects the fact that origination of negative NPV mortgages requires funding instruments with catastrophe-bonds payoff characteristics. Implication 4 reflects the expectation that creditors will be bailed out in case of massive defaults. Notice that in equilibrium it is a necessary condition that a critical mass of borrowers is at the brink of default in order to induce a systemic bailout guarantee–i.e., force the government to grant a bailout.

4.2 Social Efficiency

In the financially constrained economy we have characterized, the side effects of higher expected output are the undertaking of insolvency risk and the consequent bailouts during default episodes. Thus, an appropriate criterion of social efficiency should consider the implicit bailout costs that are born out by the taxpayer. To this end, we define the "social profits" generated by a $j$entrepreneur as her expected private profits net of expected bailout costs.[12]

$$W^j \equiv E(\pi^j - BG^j) \tag{20}$$

Using (20) we define the "social efficiency" of a regulatory regime as the sum of social profits over all entrepreneurs: $W = \sum_j w^j$, and we define a black-hole as follows.

[12] In a dynamic setup the government could finance the bailout scheme by issuing debt and repaying it via taxes during good times. In the two-period setup we consider here, we can think of an insurance contract between the government and an international organization by which the government pays the agency in the good state and receives a payment to finance the bailout in the bad state. The government would then impose lump-sum taxes to finnace this contract.

Financial Black Hole Is a situation where an increase in credit to a group of entrepreneurs is associated with a reduction in social profits (i.e., a fall in expected private profits net of bailout costs).

Here, we ask whether social efficiency is greater in a restrictive regime, in a liberalized regime or in an anything-goes regime. The economy's original sin is the credit market imperfection that generates borrowing constraints and underinvestment. Thus, the economy would benefit from more investment. The first best policy is for a central planner to allocate all investable resources to the most productive entrepreneurs. A second best policy is to implement a *judicial reform* that improves contract enforceability (h) and in this way relaxes borrowing constraints. Here we ask whether, in the absence of such policies, a relaxation of financial regulation helps to bring greater social efficiency.

We address two issues. First, can there be an increase in social efficiency by shifting from a restrictive regime–that only allows lending to agents that will never default–to a liberalized regime that allows lenders to lend to whomever they choose, but that only permits the issuance of standard debt? Second, what is the effect on social efficiency of a shift from a liberalized to an anything-goes regime–that eliminates the restriction to issue only standard debt. The following proposition states that, in the presence of generous guarantees, some deregulation increases productive investment, but excessive deregulation generates *financial black holes.*

Proposition 5 (Social Efficiency and Financial Black-holes) *In an economy with borrowing constraints and generous bailout guarantees:*

1. *A shift from a restrictive to a liberalized regime increases the likelihood of financial crises, but it also increases social efficiency.*

2. *A shift from a liberalized to an anything-goes regime generates financial black holes as financial discipline breaks down: (i) production technologies with negative NPV are funded; and (ii) entrepreneurs with access to positive NPV technologies–even those that would have never defaulted under other regimes–choose to take on insolvency risk by issuing excessive catastrophe bonds as a means to exploit the bailout guarantees.*

For the first point we compare expected social profits across the restrictive and the liberalized regimes. Recall that in both regimes σentrepreneurs attain the same investment level, and that εentrepreneurs cannot obtain external funds. The only effect of the regime shift is to allow θentrepreneurs to receive external funds. Since, in a restrictive regime θentrepreneurs' contribution to social profits equal their private expected profits $E_t\left(\pi_{t+1}^{\theta,restrictive}\right) = u\theta w_t$, while in the liberalized regime their social profits must subtract the bailout costs: $E_t\left(q_{t+1}^{\theta,BG} - BG_{t+1}\right) = u\theta m^r w_t - [1-u][m^r-1][1+r]w_t$. The right hand side of this equation equals $u\theta m^r w_t - [1-u]hm^r w_t$, which is unambiguously positive because the θ-technology has positive NPV ($u\theta > 1+r$) and borrowing constraints bind ($h < u[1+r]$). It follows that, the regime shift generates an increase in the social net contribution of θentrepreneurs:

$$W^{\theta,liberalized} - W^{\theta,restrictive} = \left[\frac{u\theta}{1+r} - [1-u]\right] hm^r w_t.$$

This expression is positive for all positive probabilities of the good state u because the θ-technology has positive NPV ($u\theta > 1+r$). A shift to a liberalized regime has two effects. First, it allows the funding of a new class of entrepreneurs with risky but positive NPV production technologies. Second, it activates the bailout guarantees, which act as an implicit investment subsidy that allows entrepreneurs to leverage up more and invest more, but entail fiscal costs. Importantly, since the financial system performs its discipline role under a liberalized regime, only positive expected NPV projects are undertaken–θentrepreneurs are funded but εentrepreneurs are not–and so the increased expected output more than compensates for the expected bailout costs.[13]

To establish the second point of the proposition recall that a financial black hole is a situation where more financial intermediation is associated with less net expected output. There are two channels by which financial black holes are generated by a shift from a liberalized to an anything-goes regime if guarantees are generous: (i) it activates negative NPV production technologies; and (ii) it induces entrepreneurs with positive NPV technologies–that would otherwise never default–to overleverage and take on insolvency risk.

For (i) consider the case $g > g^*$, so that εentrepreneurs choose to invest in the ε-technology in an anything-goes regime. The social profits of εentrepreneurs in an anything-goes regime are $u\varepsilon\left[1 + \frac{1-u}{1+r}g\right] w_t - [1-u]gw_t$. Comparing this expression with the storage return $[1+r]w_t$ obtained by εentrepreneurs in alternative regimes, it follows that the change in the εentrepreneurs' social

[13] One could ask whether a liberalized no-guarantees regime generates more expected net output than a regime with guarantees. Recall that in the abscence of guarantees θ-entrepreneurs' investment is $I_t^{\theta,noBG} = m^s w_t$, while in the presence of guarantees it is $I_t^{\theta,BG} = m^r w_t$. Thus, expected net output is greater in a liberalized economy with bailout guarantees if $E_t\left(q_{t+1}^{\theta,BG} - BG_{t+1}\right) > E_t\left(q_{t+1}^{\theta,noBG}\right) = u\theta m^r w_t - [1-u][m^r-1][1+r]w_t > u\theta m^s w_t$. This condition holds if h is high enough.

profits brought about by the shift from a liberalized to an anything-goes regime is

$$W^{\varepsilon,AnythingGoes} - W^{\varepsilon,Liberalized} = g[1-u]\left[\frac{u\varepsilon}{1+r}-1\right]w_t + \left[u\varepsilon-(1+r)\right]w_t,$$

which is unambiguously negative because the ε-technology has negative NPV. The shift to an anything-goes regime brings about not only the activation of a negative NPV production technology, but also the social cost associated with the bailout.

For (ii) recall that the shift to an anything-goes regime induces safe σentrepreneurs to issue an excessive amount of catastrophe bonds and default in the bad state if $g > g^{***}$. This is because the increase in leverage and profits in the good state dominates the potential losses associated with default in the bad state. This strategy shift might or might not reduce expected social profits as more leverage is traded off against bankruptcy costs: under a safe strategy social profits are $\sigma m^s w_t$, while under the insolvency risk strategy they are $u\sigma\left[1+\frac{1-u}{1+r}g\right]w_t - [1-u]gw_t$. The difference is

$$W^{\sigma,AnythingGoes} - W^{\sigma,Liberalized} = \sigma\left(\left[1+\frac{1-u}{1+r}g\right]u - m^s\right)w_t - g[1-u]w_t$$

This expression has an ambiguous sign. On the one hand the regime shift allows for greater investment in a positive NPV technology. On the other hand it generates insolvency risk, and so with probability $1-u$ the economy incurs bailout costs and bankruptcy costs–all output is lost in bankruptcy procedures. The first term captures the change in expected output and the second term captures bailout costs. If the likelihood of the bad state $1-u$ is high enough or the degree of contract enforceability h is high enough, so that borrowing constraints are not very restrictive, then a regime shift generates a *financial black hole* in the otherwise safe σ-sector. Notice that $\lim_{h\to 1+r} m^s = \infty$.[14]

Lastly, if the guarantees are very generous ($g > g^{**}$), θentrepreneurs will also issue catastrophe bonds. The change in their contribution to social profits is

$$W^{\theta,AnythingGoes} - W^{\theta,Liberalized} = hm^r\left[1-\frac{\theta}{1+r}\right]w_t - g[1-u]\left[\frac{u\theta}{1+r}-1\right]w_t$$

We can see that a regime shift unambiguously generates a *financial black hole* in the θ-sector because $\theta > u\theta > 1+r$.

To sum up, a shift to an anything-goes regulatory regime combined with generous bailout guarantees generates *financial black holes* across the three groups of entrepreneurs because the financial

[14] This strategy shift is not simply a theoretical curiosity. It captures the excessive issuace of currency puts by AAA-rated companies in the boom preceding the 2008 crisis, such as Comercial Mexicana and Cemex in Mexico, and Aracruz in Brazil.

system stops imposing discipline into investment decisions. Thus, (i) production technologies with negative NPV become funded; and (ii) entrepreneurs with access to positive NPV technologies–even those that would have never defaulted under other regimes–choose to take on insolvency risk by issuing excessive catastrophe bonds as a means to exploit the bailout guarantee.

4.3 Efficiency and Fragility in the Mortgage Origination Model

Let us identify the original model's increase in production efficiency with an increase in positive NPV mortgages. Then two conclusions follow.

First, a shift from the restrictive to the liberalized regime that allows trade in put options, but restricts them to be used only as hedging instruments might increase efficiency as well as financial fragility. In our setup this liberalization means that puts can only be purchased by the holders of standard debt. The ability to buy puts(CDSs) allows funds (that can only invest in prime-graded securities) to buy the senior tranches of CDOs formed by packaging together mortgages to risky θ-homebuyers. This in turn allows for the origination of θ-mortgages to risky homebuyers, which increases efficiency. At the same time, the issuance of θ-mortgages implies that a rare systemic crisis can occur. That is, there is a trade-off between efficiency and financial fragility.

Second, in an anything-goes regime, there is no restriction on the type of puts that can be traded and no collateral requirements. Since bailout guarantees are present, instead of increasing efficiency, the expanded set of feasible option trades facilitates the issuance of negative NPV mortgages. In other words, with guarantees, a larger set of financial instruments allows financial agents to better coordinate in reaping off the taxpayer.

5 Empirics

Here, we present evidence that addresses the three key conclusions of our model. The first part relates to the anything-goes regulatory regime. We present recent US data that provide evidence for the implications of a financial black-hole described in Corollary 4. In the second part we consider the growth-financial fragility link that arises in a financially liberalized regime. We use firm-level data to determine whether there is evidence for the mechanism that links insolvency risk taking and investment in the presence of bailout guarantees. Then, we use cross-country data to see whether, relative to a restrictive financial regime, liberalization–and the subsequent greater incidence of crises–is associated with higher long-term average growth in a cross section of countries.

5.1 A Financial Black-Hole in the US

Here, we provide evidence that supports the view that the recent US crisis reflects a financial black-hole rather than a typical third-generation banking crisis. We have argued that under a black-hole, financial deepening is associated with funding of unproductive activities, while under the latter it is associated with productive activities and so financial fragility leads to more growth.

Recall that the toxic cocktail necessary for the emergence of black-holes is the combination of systemic bailout guarantees and the ability to issue catastrophe-bonds that promise to repay little in good states and a large amount in bad states.[15] Unfortunately, no direct evidence exists on either guarantees or catastrophe bonds. Thus, our empirical strategy is to bring indirect evidence for the implications of a black-hole equilibrium, which are listed in the Corollary in the "opening the box" Section.

First, we document the development of financing instruments–such as Interest-only mortgages–whose payoffs resemble those of catastrophe bonds. Second, we show that the issuance of such mortgages was strongly correlated with (i)the increase in the market share of private securitizers and the reduction in the share of Government Sponsored Enterprises (Fannie Mae, Freddie Mac), and (ii)the issuance of securities (such as CDOs and ABSs) that satisfied the regulatory requirements of institutional investors (i.e., pension funds). Third, we ask whether the pricing of financial instruments loaded with catastrophic risk reflected the presence of systemic bailout guarantees. Fourth, we provide evidence that the share of mortgages that were likely to have ex-ante negative NPV was increasing in the years 2003-2007. Fifth, we provide an ex-post perspective on the funding of negative NPV mortgages by assessing the abnormally high defaults of certain subprime mortgages.

Fact 1: Catastrophe-Bond-like Mortgage Instruments.

The model's catastrophe bonds are abstract objects, not instruments that are directly observable. Here we provide indirect evidence by analyzing non-conventional mortgages with a payoff structure that is similar to the payoff of catastrophe-bonds. As our model shows, the financing of such mortgages implies the existence of catastrophe-bond-like financing instruments along the securitization chain. These non-conventional mortgages include interest-only, negative-amortization and option-ARM loans and were for the most part developed by subprime lenders. Interest-only mortgages carry low interest rates for an initial period of 24, 36 or 60 months followed by a sharp

[15] In a black-hole there is a breakdown of financial discipline and projects with negative NPV are funded.

increase afterwards as amortization starts. However, because agents are able to continuously refinance when house prices are going up, they can avoid amortizing in the good state of the world and keep rolling with low mortgage payments. Therefore, large net repayments are triggered only in the bad state of the world where house prices stop rising. In this case, the borrower is likely to default.

Figure 1 plots the share of interest only mortgages in both the aggregate US market and in the portfolio of New Century, one of the largest mortgage originators that went bust in 2007. From 0% in 2002, the share of interest-only loans in the total number of originated mortgages went up to 15% in 2005 and 18% in 2007. The rise was even more dramatic for New Century originations, where it went from 0% in 2002 to 30% in 2006.[16]

Fact 2: Securitization of Catastrophe-bond-like instruments and Subprime Loans

The originators of mortgages sell them to securitizers, who in turn package them into mortgage backed securities (MBS), and then repackage them into cascade-like instruments: Collateralized Debt Obligations (CDOs) for mortgages, and Asset Backed Securities (ABSs) for home equity loans. The senior tranches of CDOs get paid first, so under some conditions they are rated 'prime-grade' by rating agencies, and can be purchased by regulated investors. Thus, the key determinant of whether originators are willing to originate non-conventional and subprime mortgages is whether securitizers are willing to buy and repackage them.

Until 2003, the securitization market was dominated by the Government Sponsored Enterprises (GSEs) Fannie Mae, Freddie Mac and Government Enterprise Ginnie Mae. These agencies had very strict standards on the loans they accepted for securitization: loans needed to be conventional (standard amortizing loans), and conforming (below a maximum loan amount limit). In addition, they mostly funded prime loans. The dominance of GSEs imposed discipline in the underlying mortgage origination process. However, starting in 2004 there was a sharp shift in the securitization market from GSEs to private securitizers ("private label") that accepted subprime and non-conventional mortgages.[17] Figure 2 plots the market share in the issuance of Mortgage Backed Securities (MBS) and Collateralized Mortgage Obligations (CMOs) of the GSEs+Ginnie Mae and of the private label securitizers. Until 2003, the market share of GSEs+Ginnie Mae was relatively stable between 85%

[16] See Landier, Saez and Thesmar (2010) for an analysis of the role of Interest-Only mortgages in New Century's fall.

[17] The GSE accounting scandals in 2003 are often invoked as the cause of the GSEs retreat from the securitization market. Perhaps more fundamental market forces contributed to this retreat.

and 90%. However, starting in 2004 this share dropped dramatically from 86% to 56% in 2006.

Figure 3 exhibits a stark correspondence between the share of interest-only mortgages and the financial instruments that supported the origination of these catastrophe-bond like mortgages. As we can see there is an almost perfect correspondence between the components of this food-chain, from the share of interest-only mortgages to the issuance of private label mortgage-related securities, and ultimately to CDOs for mortgages and ABSs for home-equity loans. Figure 4 exhibits a similar correspondence with the number of subprime and Alt-A mortgages originated.

In terms of our model, one can link the sharp increase in the share of private-label securitization and interest-only mortgages in Figures 2-4 to a shift from a no-bailout to a bailout equilibrium. To see this notice that if only a few entrepreneurs issue catastrophe bonds, bailout expectations are likely to be absent. In this case, the financial system plays its disciplinary role and ensure the issuers of these catastrophe bonds have the ability and incentives to repay them. However, as the issuance of catastrophe bonds crosses some critical level and their combined risk becomes systemic, a tipping point might be reached beyond which a perception of bailout guarantees is likely to arise. Beyond this tipping point, there is a break-down of financial discipline in an anything-goes regulatory regime and financial black holes arise.

Fact 3: Catastrophic Risk underpricing and Systemic Bailout Guarantees.

Systemic bailout guarantees are unobservable. Here, we present three facts that signal they have been present in the U.S. First, as the model implies, in the presence of guarantees, puts against catastrophic risk are underpriced and are insensitive to increases in the mortgage defaults. This underpricing of insurance instruments supports the issuance of CDOs.

Figure 5 plots the delinquency rate of subprime mortgages along with the spread–the insurance premium–implied by the CMBX.AAA index. This index corresponds to CDS contracts on either "AAA" CMBS bonds or on "AAA" tranches of CMOs.[18] As we can see, until July 2007, the insurance premium was below 0.1%, (a tenth of a percent), which means that these securities were considered almost as safe as US Treasuries in the very same period where defaults on subprime loans started to increase sharply. In fact, during 2006 and the first half of 2007, the spread actually declined from 0.1% to around 0.05%. During the second half of 2007 the spread increased significantly but was only at around 100 bps in early November 2008 (after the failure of Lehman Brothers and the government take-over of AIG). It actually declined between August 2008 (1.5%) and the

[18] These indexes are associated with commercial and multi-familty mortgage-backed securities.

end of October 2008 (1%) before jumping up in the last two months of 2008. From the middle of 2009, as the rate of delinquency started to plateau, the CMBX spread started to mean-revert and went down to 0.8% in September 2010

Second, parallel to the insurance premium's insensitivity, the issuance of housing financing instruments was largely insensitive to early warning signals of abnormal default rates in the mortgage market. Figure 6 plots the issuance of CDOs and the rate of subprime mortgages past due. As we can see, the period of booming issuance of CDOs (2005-2007) corresponds to a period where delinquencies on subprime mortgages were trending up significantly (from 10% in 2004 to 17% in 2007).

Third, there was a measurable underlying political-economy rationale behind bailout expectations that derived from the government's mandates to foster home ownership among poor and minority households. In particular, since the mid-nineties Fannie Mae and Freddie Mac were directed to increase their purchase of mortgage backed securities that [which] included loans to low income borrowers. In 1996, the government asked Freddie and Fannie to provide at least 42% of their mortgage financing to borrowers with income below the median in their area. This target was increased to 50% in 2000 and 52% in 2005. As a result, borrowing by minorities increased dramatically, as well as their rate of home ownership. Arguably, such mandates signalled that the government would not let a meltdown occur if house prices stopped growing.

Figure 7 , left panel, plots the dollar share of loans issued to minorities in the total amount of mortgage originated in a given year. Between 1998 and 2006, the dollar share of loans extended to Hispanics almost tripled from 6.4% to 16.4% and the share of loans extended to African-Americans increased from 5.2% to 8.5% . The volume of loans to African-Americans doubled while the volume of loans to whites increased by 50%. Overall the share of minorities doubled from 12.5% in 1998 to 25% in 2006. Figure 7 right panel plots the rate of home ownership across the same ethnic groups and displays a mirror image of the distribution mortgage borrowing by race. Between 1996 and 2006, home ownership across Hispanic increased from 42% to 50% and home ownership across African-Americans increased from 44% to 48%. The rate of home ownership **of** Whites increased in the same period from 69% to 72%.

Fact 4: Ex-ante Funding of Negative Net-Present Value Mortgages.

Indirect evidence of the funding of negative net present value mortgages is provided by the shift of mortgage origination towards borrowers with unverified income and little initial equity. These borrowers' repayment capacity depended critically on the continuous increase of home prices, like the $\varepsilon-$borrowers of our model. The portfolio of New Century, one of the largest US mortgage originators that went broke in 2007, offers ample evidence of the shift towards borrowers with low probability of repayment. Figure 8 presents the characteristics of New Century borrowers between 2002 and 2006. The share of borrowers with unverified–stated–income increased from 25% in 2000 to 47.2% in 2006 The share of borrowers with no downpayment increased from 9% to 34.8%.

At the macroeconomic level, the trend towards borrowers with low repayment capacity can be measured by the increasing share of subprime loans, and the rise in the mortgage-related leverage ratio for low net worth borrowers. Figure 9 plots the number of prime and subprime mortgages serviced (left scale) and the relative share of subprime mortgage (right scale). Between 2001 and 2006, the share of subprime mortgages increased from 3.4% to 15.1% of the total number of mortgage serviced. Using data from the Survey of Consumer Finances, Figure 10 plots the ratio of mortgage debt to income and mortgage debt to net worth for this household group (the poor and the lower middle-class). From 2004 to 2007, the mortgage debt-to-income ratio increases from 47% to 97% and the mortgage debt-to-net worth ratio from 85% to 132%. These patterns offer clear evidence of excess mortgage lending to a financially fragile population whose repayment ability was dependent on a continuing increase in house prices.

One could ask: if house prices were expected to be on the rise, would subprime loans still have negative NPV? Of course, conditional on ever rising prices at a sufficiently high rate, the answer is no. But this is a very big IF. For instance, even in such an over-optimistic scenario, how would one evaluate the probability of repayment and therefore the rating of a loan to a low FICO individual with 0% collateral and with no income documentation? These type of questions are currently being addressed in the courts as many investors are trying to put back mortgage securitizers under the representation and warranties principle. Investors are arguing that originators misrepresented the shoddy quality of the mortgages they put into the securities they sold. The estimated losses for the securitizers range from $23 billion to $180 billion.[19]

The county-level analysis of Mian and Sufi (2009) offers additional evidence of the rise of negative NPV mortgages during the US boom (2002-2005). They partition U.S. counties into subprime and prime counties based on the 1996 fraction of subprime borrowers–i.e. with a FICO score inferior to 660–and find that between 2002 and 2005 subprime counties exhibited both a higher credit growth and a lower income growth than prime counties. This is evidence that mortgage credit was extended disproportionately more to counties with a larger share of borrowers with low repayment ability.

[19] in Wall Street Journal, "Banks Face Another Mortgage Crisis," November 20, 2010.

Furthermore, these subprime counties also exhibited higher rates of mortgage securitization than prime countries. Ex-post, the disproportionately larger credit growth in counties with low income growth resulted in much higher default rates than in prime counties. These facts suggest an increase in the financing of negative NPV projects, that was fueled by securitization and resulted in much higher default rates.

Fact 6: Abnormally high defaults

After 2006, the foreclosure rate increases significantly and appears to be driven by an entirely different data generating process than the pre-2006 process. As we can see in Figure 11 total mortgage foreclosures exploded starting in 2006 and brought the foreclosure rate from 1.8% to 5.4%. This increase is unprecedented in the last 40 years of history.

Figure 12 plots the rate of mortgage foreclosures for different categories of mortgage products. The graph makes clear that even before 2002–the onset of the pre-crisis wave of subprime mortgage origination–subprime loans exhibited a rate of foreclosure 5 to 10 times higher than prime loans.[20] Note also that foreclosure rates were already up in 2006 for adjustable-rate prime and subprime mortgages.

Another way to assess the trend towards mortgages more likely to default is to look at cumulative default rates across yearly vintages of originated mortgages. Figure 13 plots those default rates for the pool of mortgages bought by Fannie Mae. From 2003 to 2007, each subsequent yearly vintage exhibits a higher cumulative default rate than the previous year vintage at all time horizons since origination. In particular, the more recent vintages were experiencing higher rates of delinquency even before the financial crisis.[21]

Fact 7: Mortgage-Related Systemic Risk

A key ingredient of a bailout equilibrium is that a critical mass of agents loads on to the same insolvency risk factor, so that there is a source of systemic risk that can affect the whole economy. In order to see this, we look at the ratio of mortgage debt to GDP and the ratio of Financial Sector

[20] See Figure 3.

[21] Note that Fannie Mae's cumulative default rates actually understate the severity of the deterioration of the mortgage portfolio between 2003 and 2006. Following accounting fraud, Fannie Mae and Freddie Mac were forced by OFHEO to reduce substantially their purchasing share of newly issued mortgages. The decline of the GSEs was partly compensated by the Private Label MBS Issuers which typically had much lower standards to admit mortgage loans in their securitized pool. See Farber (2010) for description of this market structure shift and Fannie Mae (2008) for evidence that Private Label mortgage pool experience much larger cumulative default rate.

Debt to GDP. As we can see in Figure 14, both series exhibit a remarkable parallel upward trend. Between 1995 and 2006, both debt ratios almost doubled from around 60% to around 105%. As a consequence, risks associated to the mortgage market in case of a fall in house prices was high and likely to be very much amplified because of the high leverage financial institutions had incurred to finance these mortgage loans. An other way to assess the loading systemic risk is to look at the expansion of subprime mortgage credit. Between 2003 and 2007, about USD 2.3 Trillions of subprime loans were originated, which is equivalent 18% of GDP.[22] By the end of 2009, 25 percent of mortgage loans were past due and 16% were in foreclosure.

5.2 Bailout Guarantees and Borrowing Conditions

In emerging markets, systemic risk takes often the form of currency mismatches in banks' and firms' balance sheets. At the individual level, a firm is said to have a currency mismatch if it has debt denominated in foreign currency that is not backed by foreign assets or revenues. Our theoretical mechanism predicts that in presence of systemic bailout guarantee firms with currency mismatch should: (i) face lower interest rates; and (ii) invest more and grow faster in tranquil times than similar firms with no currency mismatch. We test these predictions using a sample of around 10,000 firms in Central and Eastern Europe and in former Soviet republics, surveyed by the EBRD in 2005 and 2008 through the Business Environment and Enterprise Performance Survey (BEEPS).[23] An advantage of the BEEPS survey over existing stock-market based data sets is that it is representative of all sectors in the economy and covers stock-market listed as well as non-listed firms. The 2005 EBRD survey reports only the currency denomination of the last loan for firms that have at least one loan on their books. We therefore assume that the denomination of the last loan reflects the denomination of the debt stock.

We restrict the sample to firms with debt on their books and consider two subsamples of those firms: (i) firms with all sales revenues coming from the non-tradables sectors and (ii) firms with all sales revenues coming from the tradable sector. Firms exhibit a currency mismatch if they belong to the non-tradables sample and have foreign currency debt on their books.

We first test whether currency mismatch helps reduce interest costs (as implied by Proposition

[22] This number is computed by multiplying the number of mortgage loans using data from the Mortgage Banker Association by the average dollar value of mortgage loans from Home Mortgage Disclosure Act filings.

[23] In 2004, the countries in the survey are classified as financially liberalized.

2).[24] We do so by regressing the interest rate on a dummy variable equal to 1 if the firm's last loan is denominated in foreign currency, and a set of firm-specific and loan-specific variables. The regressions are performed using two sets of control variables. The simple set include firm's age and size and loan maturity. The more comprehensive set contains also a set of variables related to the collateralization of the loans. In addition, we control alternatively for country-specific fixed effects, industry-specific fixed effects and, in the most stringent configuration, for country-industry fixed effects. The latter fixed effects control for the demand for goods and services in a specific industry and in a specific country.

Table 1 presents the result of the interest rate regressions for the set of non-tradable firms. Our estimates indicate that non-tradables firms borrowing in foreign currency face an interest rate around 2 percentage points lower than similar firms borrowing in domestic currency. These estimates are significant at the one percent level in the three fixed-effects configurations. The control variables have the expected sign, with larger and older firms paying a lower interest rate, and shorter maturity loan carrying a lower (but not significantly so) interest rate. Additional controls capturing the effect of collateral reduce the estimated difference between foreign and domestic currency interest rates by only 0.3 percentage points.

Table 2 presents the result of the interest rate regressions performed on the set of tradable firms. The estimates show that tradables firms borrowing in foreign currency enjoyed a interest rate around 2.5 percent lower than those borrowing in domestic currency. In order to compare the estimates across the sample of non-tradable and tradable firms, we run a series of chow tests under the null hypothesis that the estimated spread between domestic and foreign interest is the same across the two samples of firms . Results are presented in Table 3 and indicate that the null hypothesis of equal spread can never be rejected. This finding implies that while currency risk associated with

[24]For the firm-level regressions to be consistent with the model, it is necessary that in equilibrium firms with similar characteristics chose different levels of currency mismatch. This dichotomy emerges in the risky equilibrium of our model because in such equilibrium there can exist a small subset of borrowers that choose not to take on currency mismatch. This is because while a majority of borrowers expect a bailout in case of crisis, this minority set does not expect a bailout. As long as this subset is small enough, a risky equilibrium exists because a bailout will indeed be granted during a crisis—as a critical mass of borrowers will default. It follows that in a risky equilibrium there can be two firms with the same observable characteristics, but with different bailout expectations. One firm will take on currency-mismatch and enjoy lower interest rates than the other firm that does not take on currency mismatch, and so will be able to grow faster during no-crisis times. The firm-level regressions in this section assess whether this difference in interest rates and growth is present in the data, after controlling for a large number of observable firm characteristics.

domestic debt denomination seems to be priced in the interest rate, risk-taking through currency mismatch seems not. This is strong evidence of the presence–at least implicit–of systemic bailout guarantees, which results in an implicit subsidy for firms with currency mismatch.

In order to test whether currency mismatch allows firms to borrow and grow more (Proposition 2), we run a series of standard growth regressions. We regress the three year average growth in firm's sales between 2001 and 2004 on a dummy variable equal to 1 if the firm's last loan is denominated in foreign currency, and two sets of alternative controls under the three fixed effects configurations alluded to above. The simple control set includes firm's years of operations and initial sales. The comprehensive control set includes also initial productivity, the share of foreign inputs in total production inputs and two measures of the quality of the workforce: the share of skilled workers and the share of workers with a university degree.

Table 4 presents the results of the growth regressions for the set of tradable firms. The estimates indicate that firms with currency mismatch exhibit an annualized growth in sales between 1.9 and 2.8 percentage points higher than firms without currency mismatch on their books. The estimates are significant at one percent (five percent) confidence interval in the regression using the simple (comprehensive) set of controls. Table 5 presents the results of similar regressions for the set of tradable firms. In sharp contrast with non-tradable firms, we cannot reject that tradable firms borrowing in foreign currency grow at the same rate than tradable firms borrowing in domestic currency. This result indicates that while undertaking risk through currency mismatch does yield growth benefits, simply borrowing in foreign currency does not.

To sum up, the tests performed on the sample of Eastern European firms confirms the mechanism at work in our model. Under a financially liberalized regime with systemic bailout guarantees, firms loading on systemic risk benefit from an implicit interest rate subsidy and grow faster in tranquil times than similar firms unexposed to systemic risk.

5.3 Financial Liberalization, Crises and Growth

Proposition 5 states that a shift from a restrictive to a liberalized regime increases expected output net of social bailout costs even if it leads to occasional financial crises. This increase in social efficiency occurs because the regime shift allows for the funding of a new set of risky entrepreneurs with positive NPV projects, but does not destroy financial discipline. Starting in the 1970s there has been a wave of financial liberalization, specially among middle income countries. Such liberalization episodes have allowed agents to freely direct funding and to take on risk. Among emerging markets, a big portion of the resulting financial flows took the form of bank lending, equity investment and FDI, not the form of instruments akin to the catastrophe bonds of our model. We can thus consider the liberalization policies during the period 1970-2000 as a shift from what our model calls a restrictive regime to a liberalized regime. We must add the caveat that these are analytic categories and aren't watertight.

We investigate whether countries that have liberalized and experienced the consequent financial crises, have grown faster than other countries over the period 1970-2008. We consider all countries with available data and exclude those that have experienced either a severe war or a large terms of trade deterioration, reducing the sample from 83 to 58 countries. To measure the incidence of financial crises we use the negative skewness of credit growth rather than the variance. This measure captures rare and sharp declines in credit growth, which is a key characteristic of financial crises: they occur rarely and have severe effects on new credit. The variance, in contrast, captures both rare-severe falls in credit as well as garden variety bussines-cycle frequency credit growth fluctuations. Thus, unlike negative skewness, high variance does not isolate the volatility generated by financial crises.

We run cross-country growth regressions where we add the three first moments of credit growth to the standard controls in the literature.

$$\ln(y_{i,1}) - \ln(y_{i,0}) = \sum_{k=1}^{3} \boldsymbol{\alpha}_k \mu_k(\gamma r_i) + \boldsymbol{\beta} * \mathbf{Z}_{i,0} + \varepsilon_i$$

where $y_{i,0}$ and $y_{i,1}$ are GDP per-capita at the beginning and the end of the sample period, $\mu_k(\gamma r_i)$ denotes the first three of moments of each country's sample distribution of real credit growth (mean, variance and skewness), $Z_{i,0}$ is a vector of predetermined variables including initial per-capita GDP and initial average number of year of secondary schooling to proxy for initial physical and human capital, and ε_i is an error term. Our preferred sample period is 1970-2008. The period is long enough to encompass the transition to financial liberalization and most of the financial crises. As a robustness check, we repeat the regression on two alternative sample periods: 1960-2008 and 1980-2008, as well as on the full set of 83 countries.

Table 6 contains our estimation results. In regression 6.1, performed on 1970-2008, skewness enters with a negative sign and statistically significant at the 1% level. Consistent with the literature, the mean of credit growth enters positively and significantly, while the variance enters negatively although not significantly. The initial controls have the expected sign but are not significant. To give an economic interpretation consider two countries one with zero skewness and the other with skewness of minus one. Our point estimate of -0.654 means that the negatively skewed country will grow 0.654 per year more than the country on a safe path with no financial crises. Over the course of 38 years this growth differential leads to a difference in GDP per capita of around 25 percent between the "risky" and the "safe" countries. Figure 14 presents the partial correlation plots for each of the three moment of credit growth. Regression 6.2 and regression 6.3 present robustness results for alternative sample periods. They confirm our findings, but the coefficients on skewness are lower and only significant at 5% and 10% confidence interval. Regression 6.4 replicates the regression on the full sample of countries. In this case, the effect of skewness persists but its coefficient is a bit smaller.

6 Literature Review

[to be added]

7 Conclusion

[to be added]

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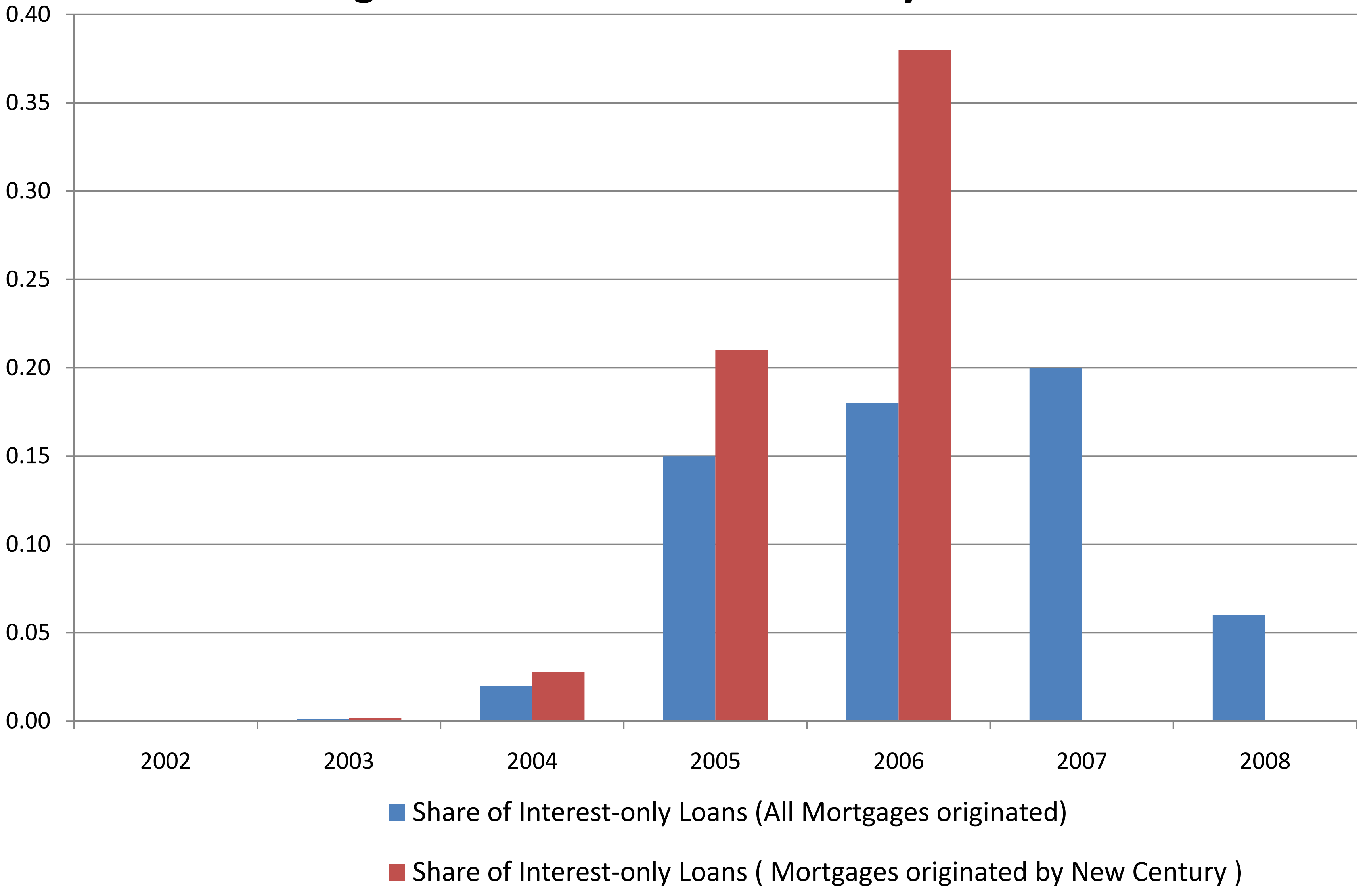
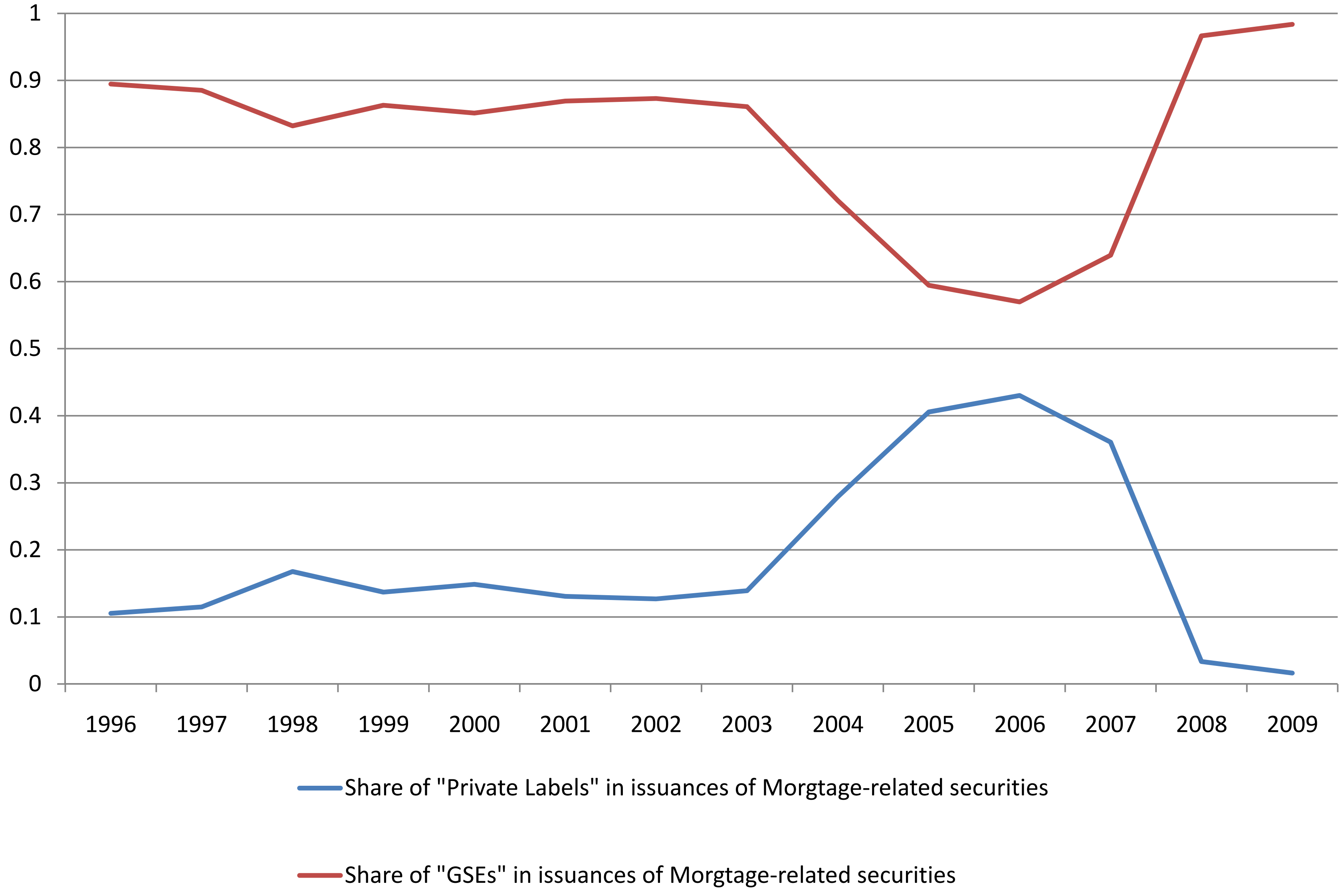
Figure 1. Share of Interest-Only Loans



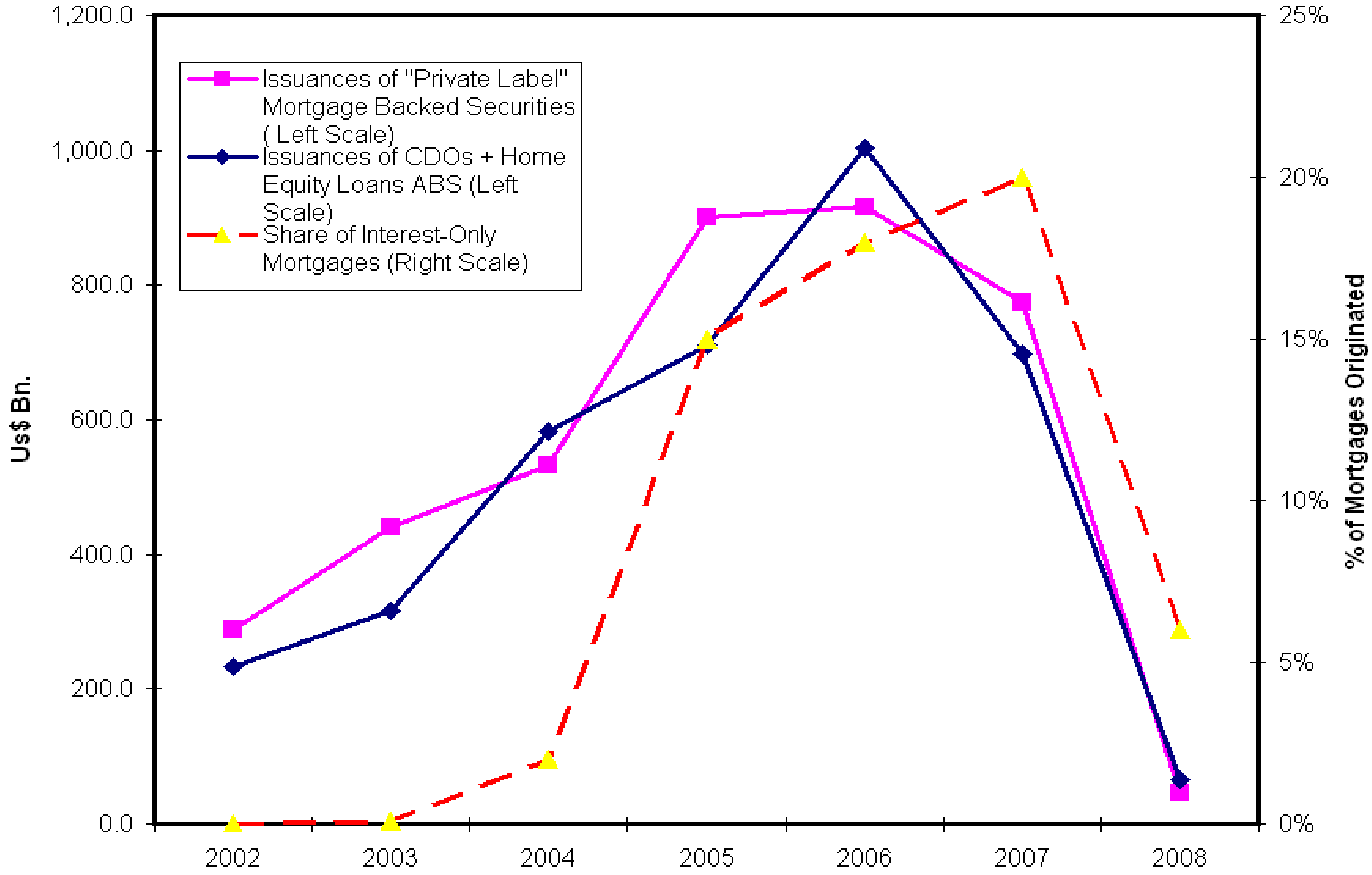
Source: Inside Mortgage Finance and New Century Bankruptcy Report

Figure 2. Issuances of Mortgage-Related Securities "Private Labels" vs. GSEs.



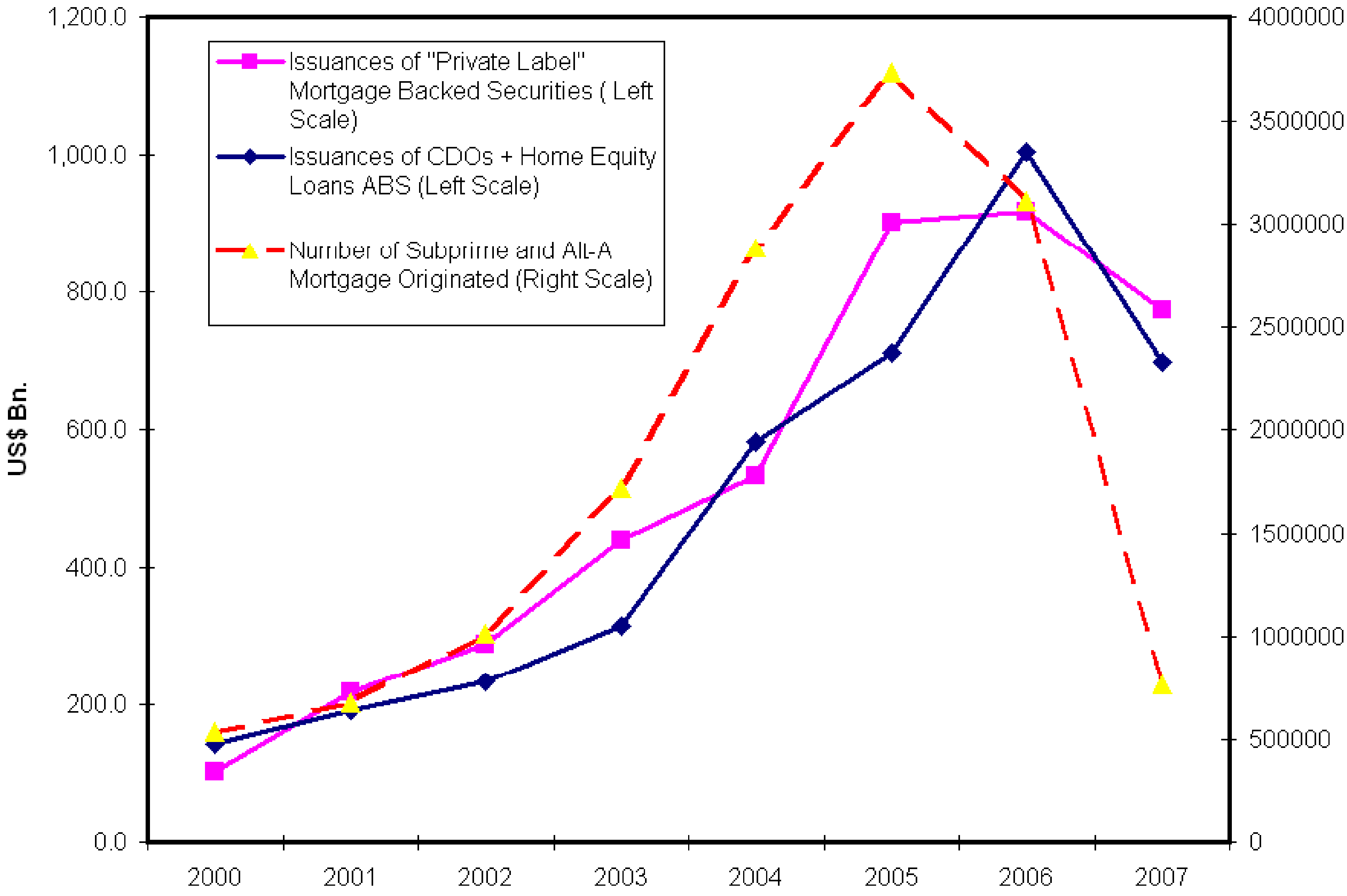
Source: Securities Industry and Financial Markets Association (SIFMA)

Figure 3. Share of Interest-Only Loans, "Private Label" MBS Issuances, CDOs+ Home Equity Loan ABS Issuances.



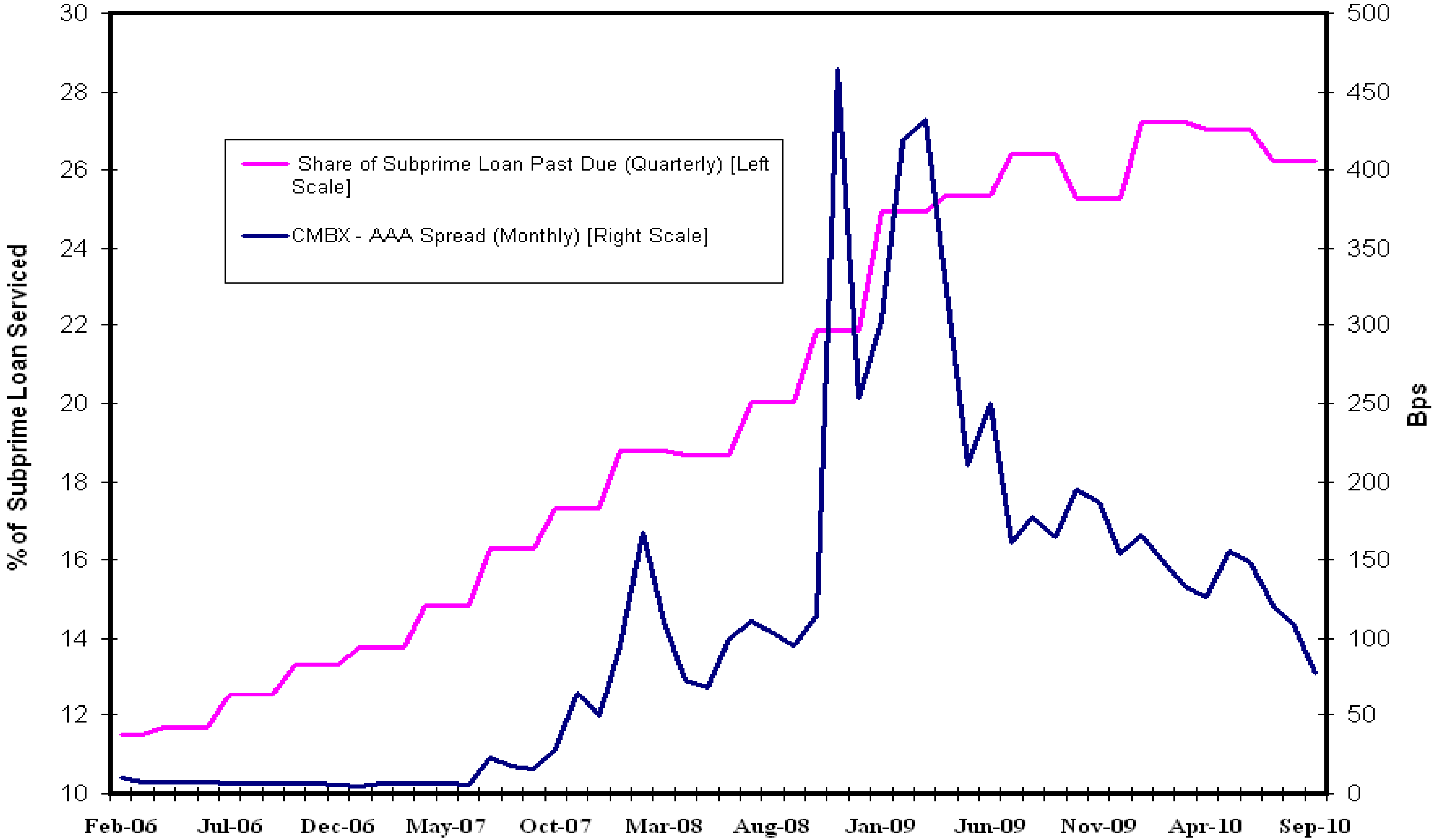
Source: Securities Industry and Financial Markets Association (SIFMA) and Inside Mortgage Finance.

Figure 4. Issuances of Subprime Loans + Alt-A loans. "Private Label" MBS Issuance, CDOs+Home Equity ABS Issuances



Source: Securities Industry and Financial Markets Association (SIFMA) and Loan Peformance.

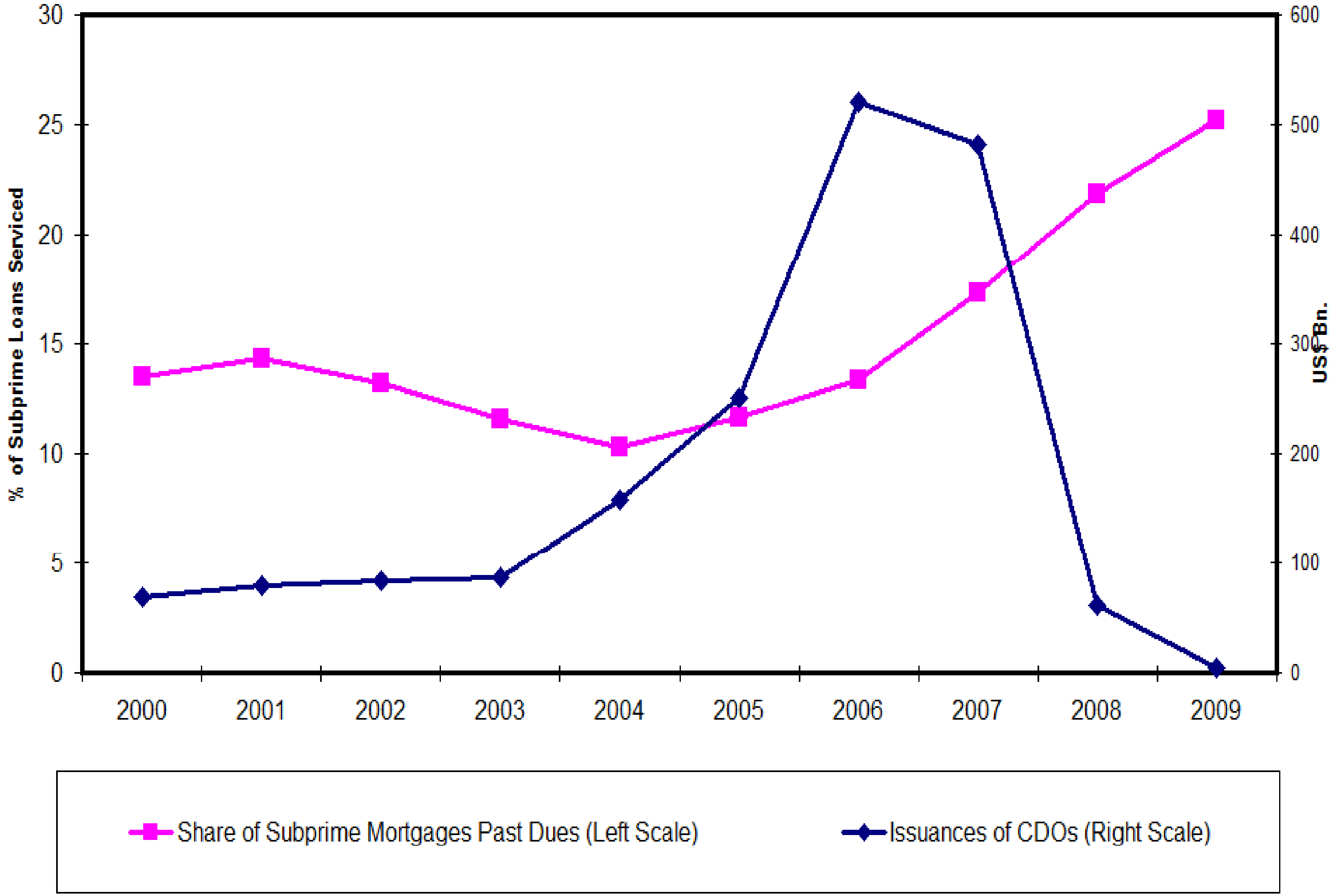
Figure 5. Subprime Loans Delinquency and CMBX Spread



Source: JP Morgan and Mortgage Banker Association.

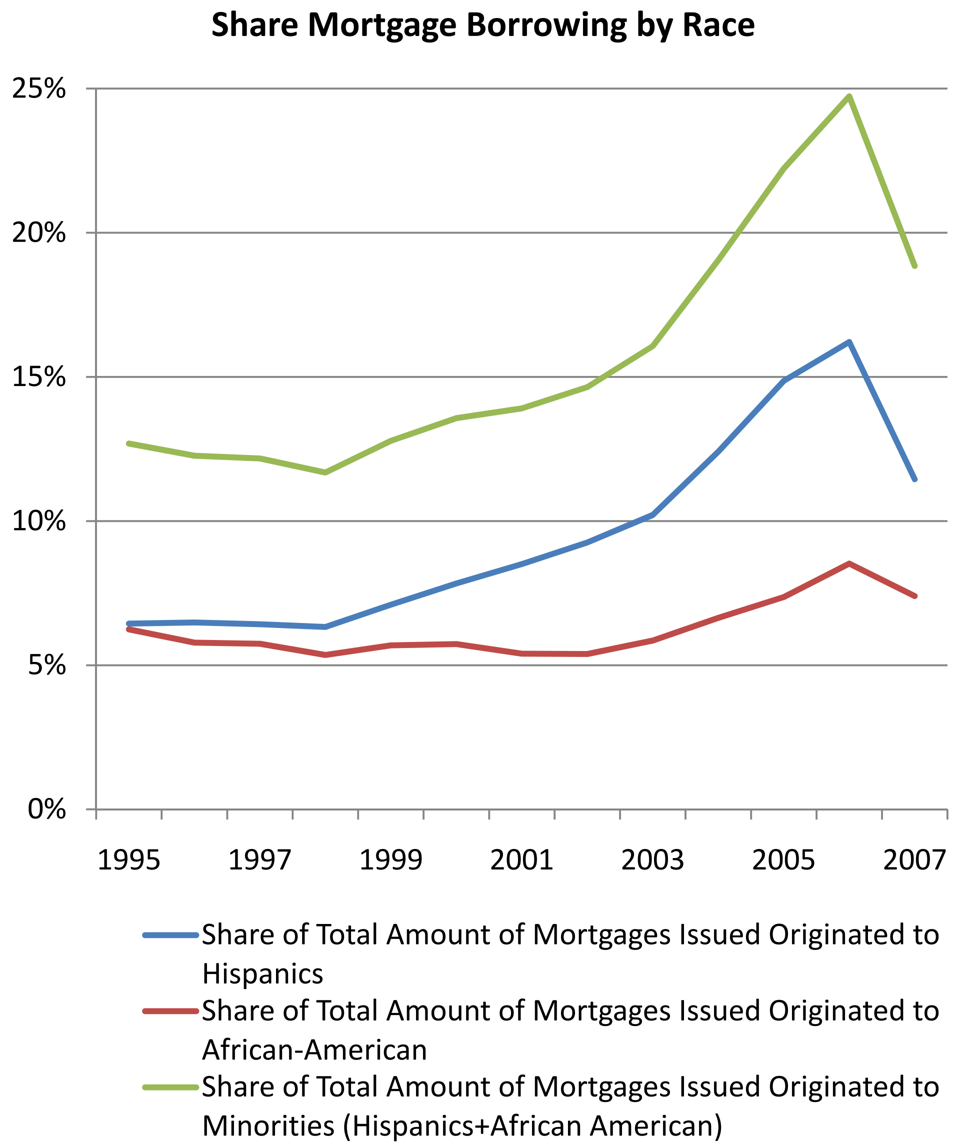
Note: The Markit ABX index is a synthetic tradeable index referencing a basket of 20 commercial and multi-family mortgage-backed securities allowing investors to take positions on commerical and multi-family mortgage-backed securities via CDS contracts. The CMBX spread is the Credit Default Swap protection premium implied by the CMBX index.

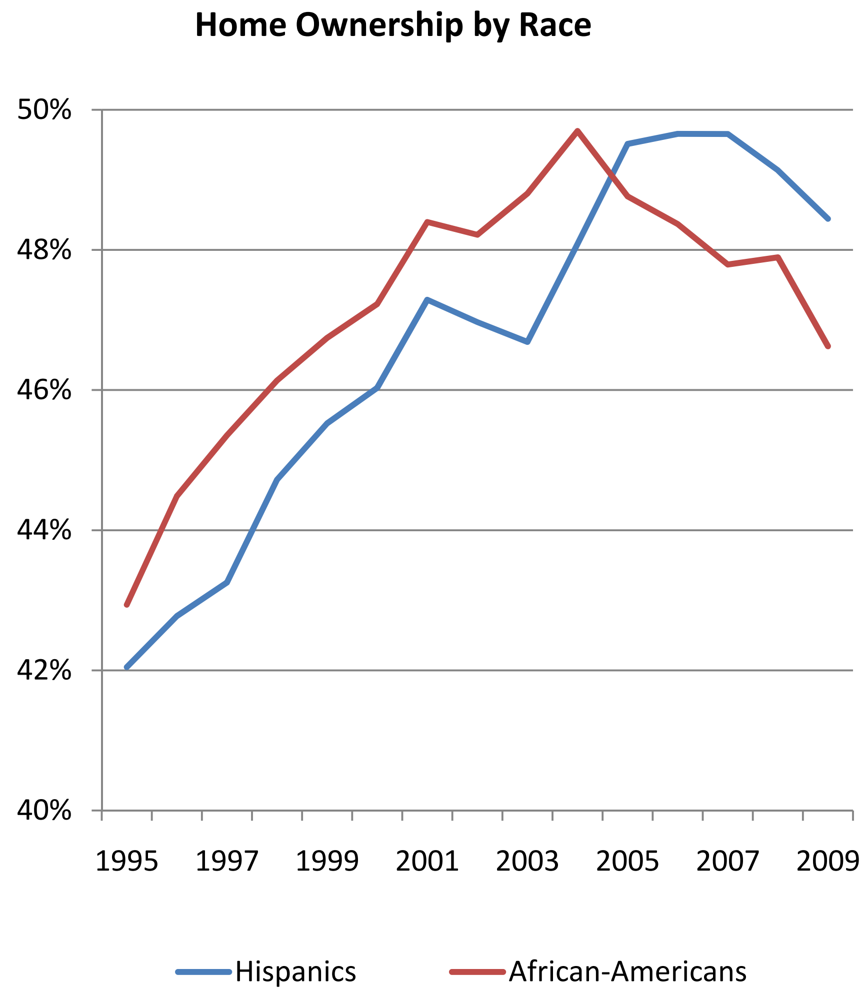
Figure 6. Subprime Loans Delinquency and CDOs Issuances



Source: Securities Industry and Financial Markets Association (SIFMA) and Mortgage Banker Association.

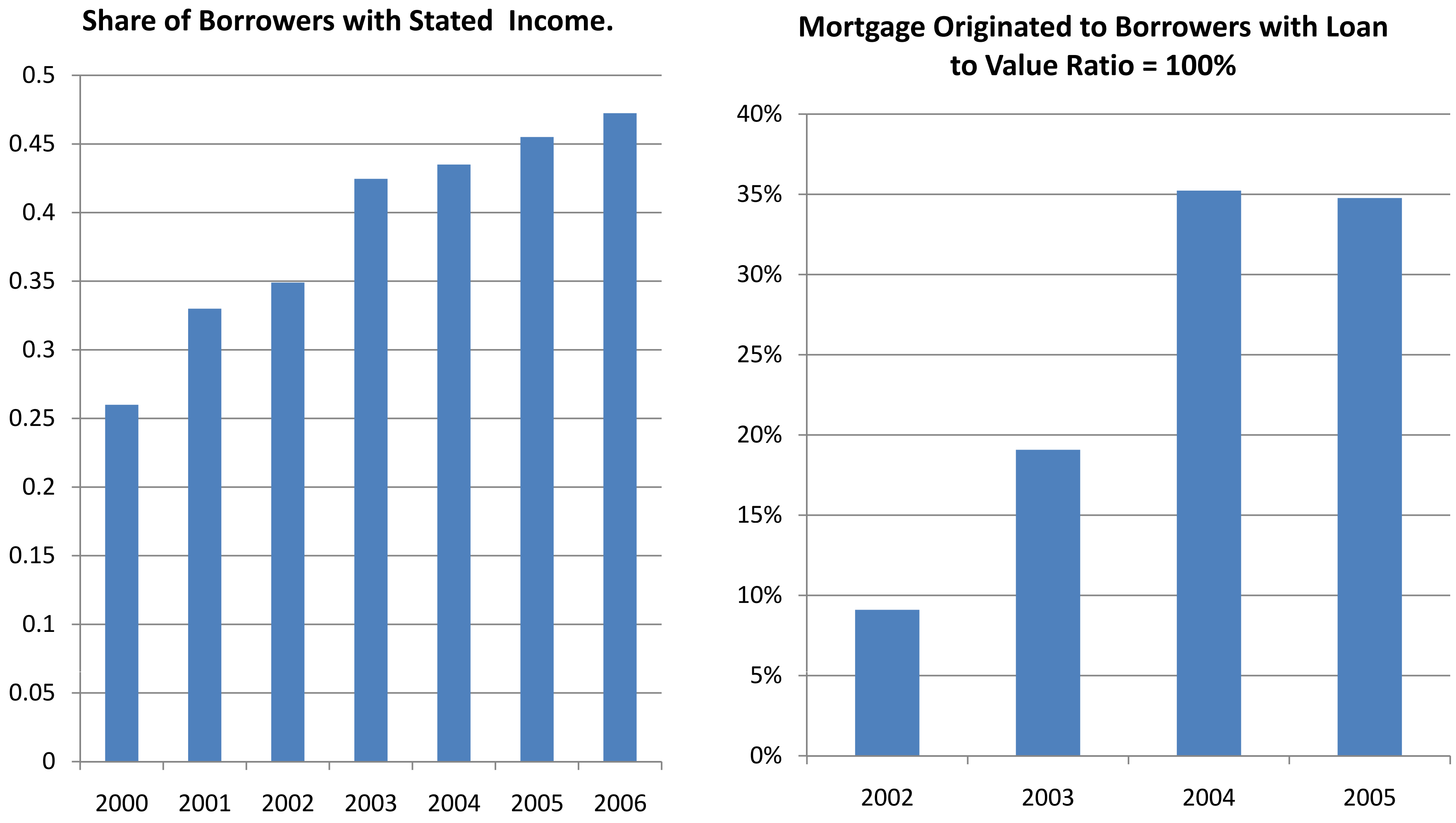
Figure 7. Minority Borrowing and Home Ownership Rates.





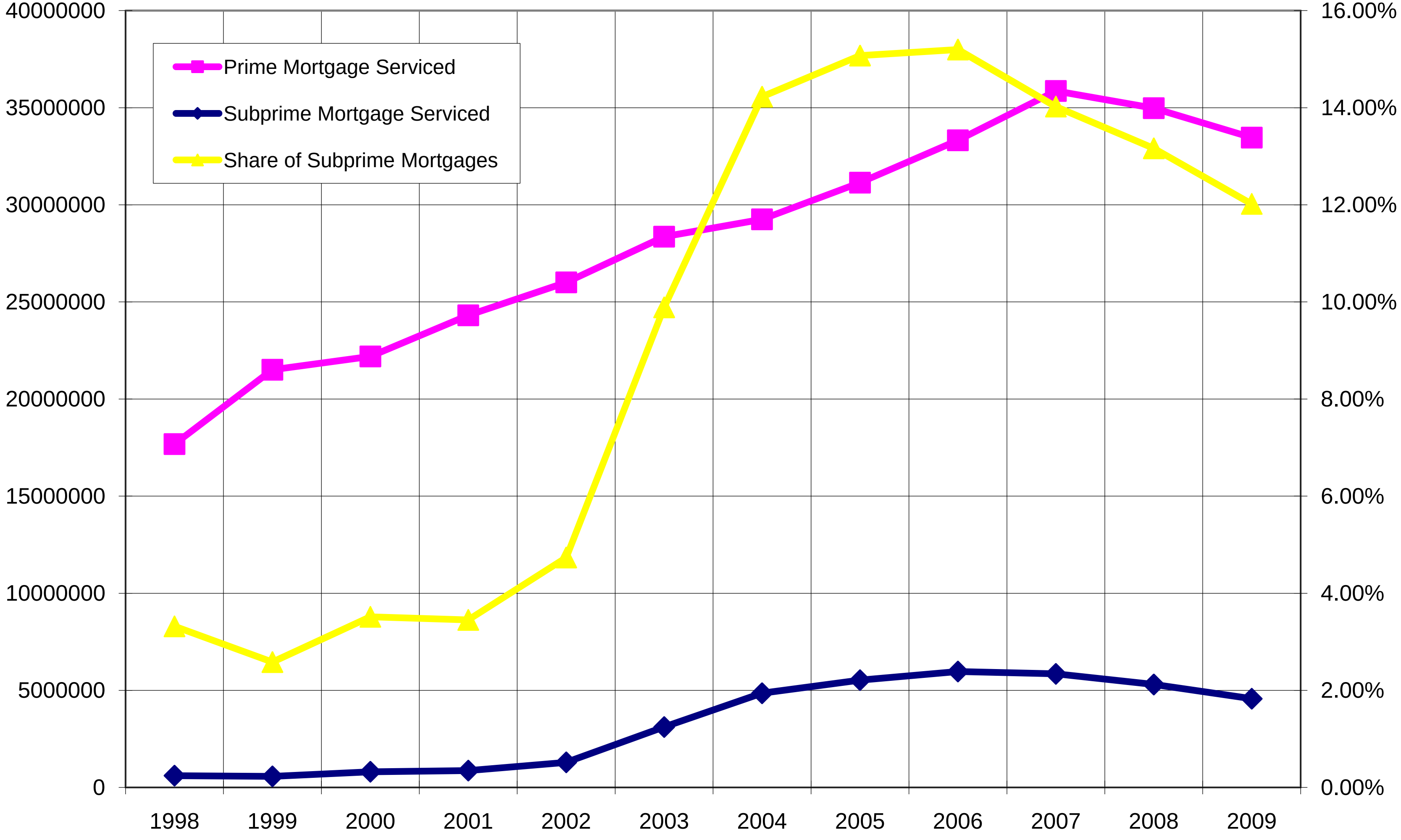
Sources: HMDA for Mortgage Borrowing and Census for Share of Home Ownership Rates

Figure 8. New Century Borrowers



Source: New Century Bankruptcy Report

Figure 9. Number of Prime and Subprime Mortgage Serviced



source: Mortgage Banker Association

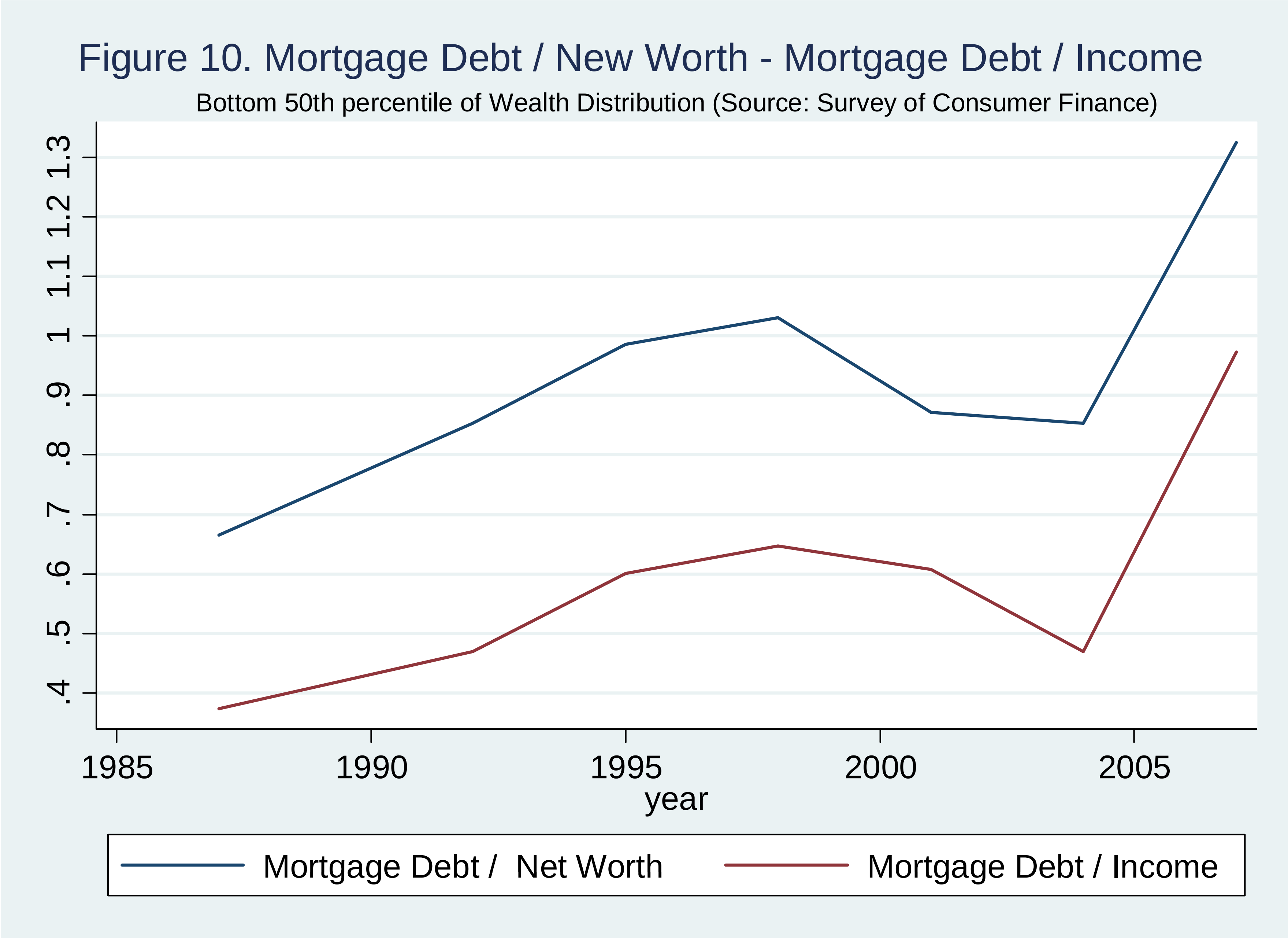
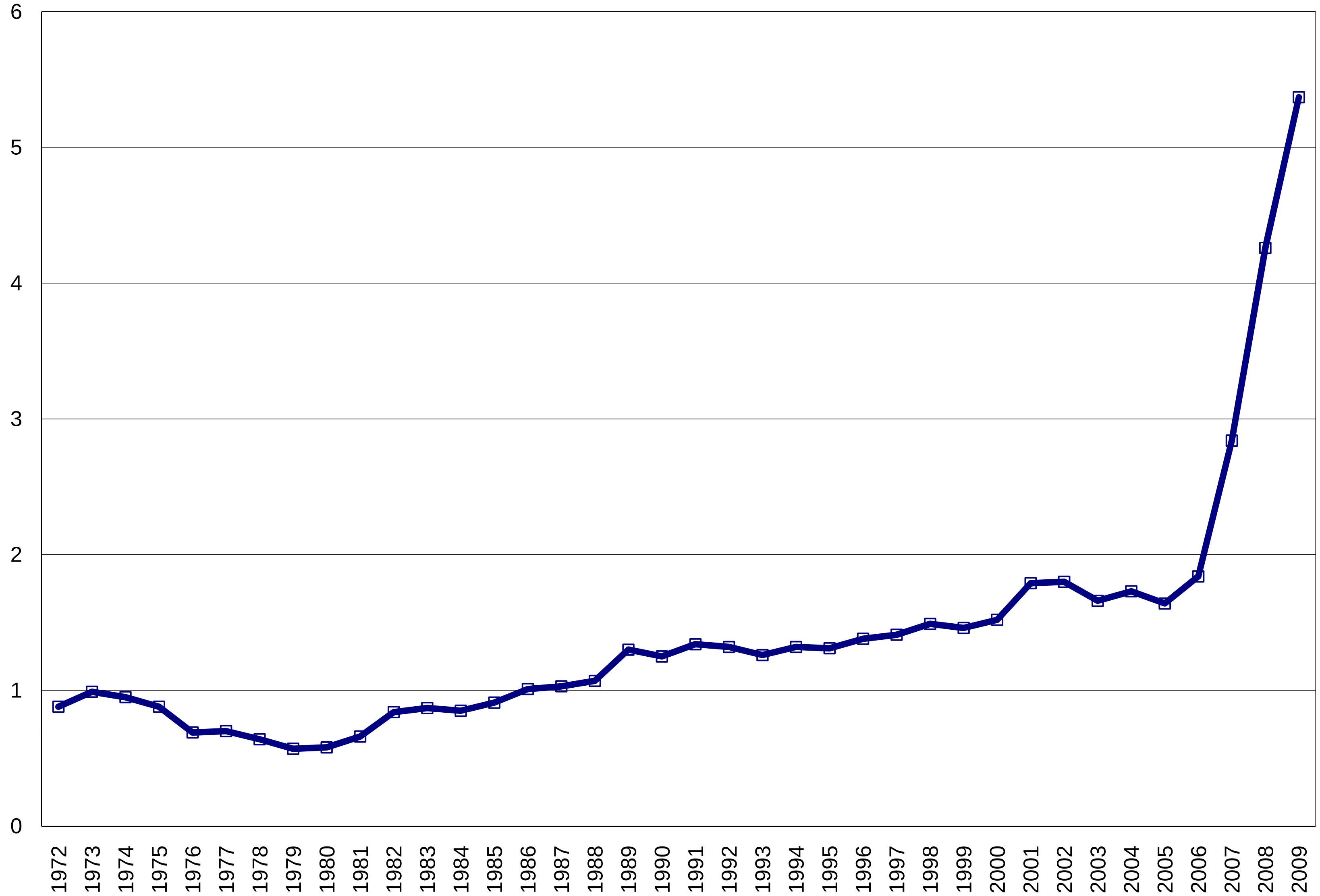


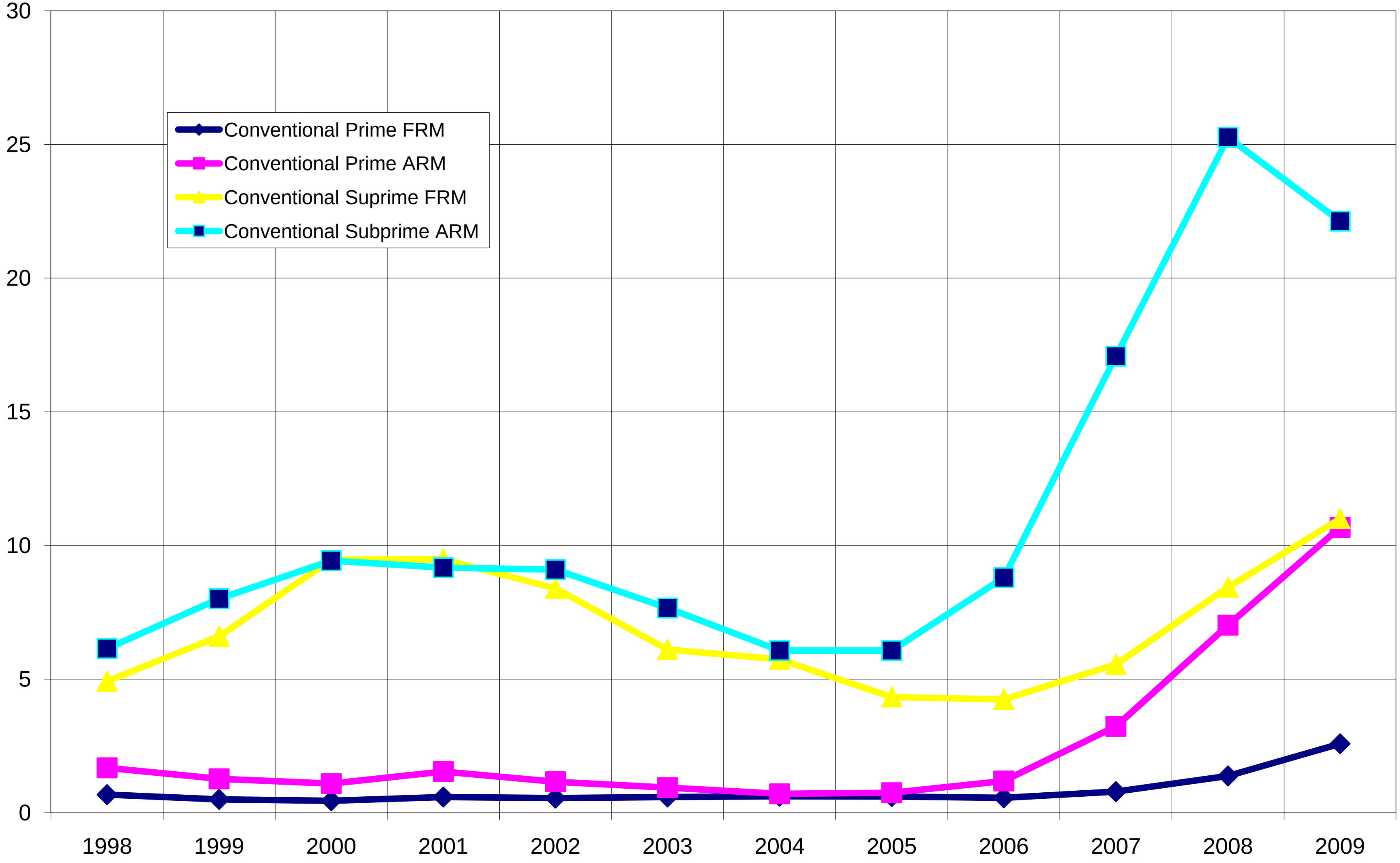
Figure 10. Mortgage Debt / New Worth - Mortgage Debt / Income
Bottom 50th percentile of Wealth Distribution (Source: Survey of Consumer Finance)
.4
.5
.6
.7
.8
.9
1
1.1
1.2
1.3
1985
1990
1995
2000
2005
year
Mortgage Debt / Net Worth
Mortgage Debt / Income

Figure 11. Foreclosure Rate for All Mortgages.



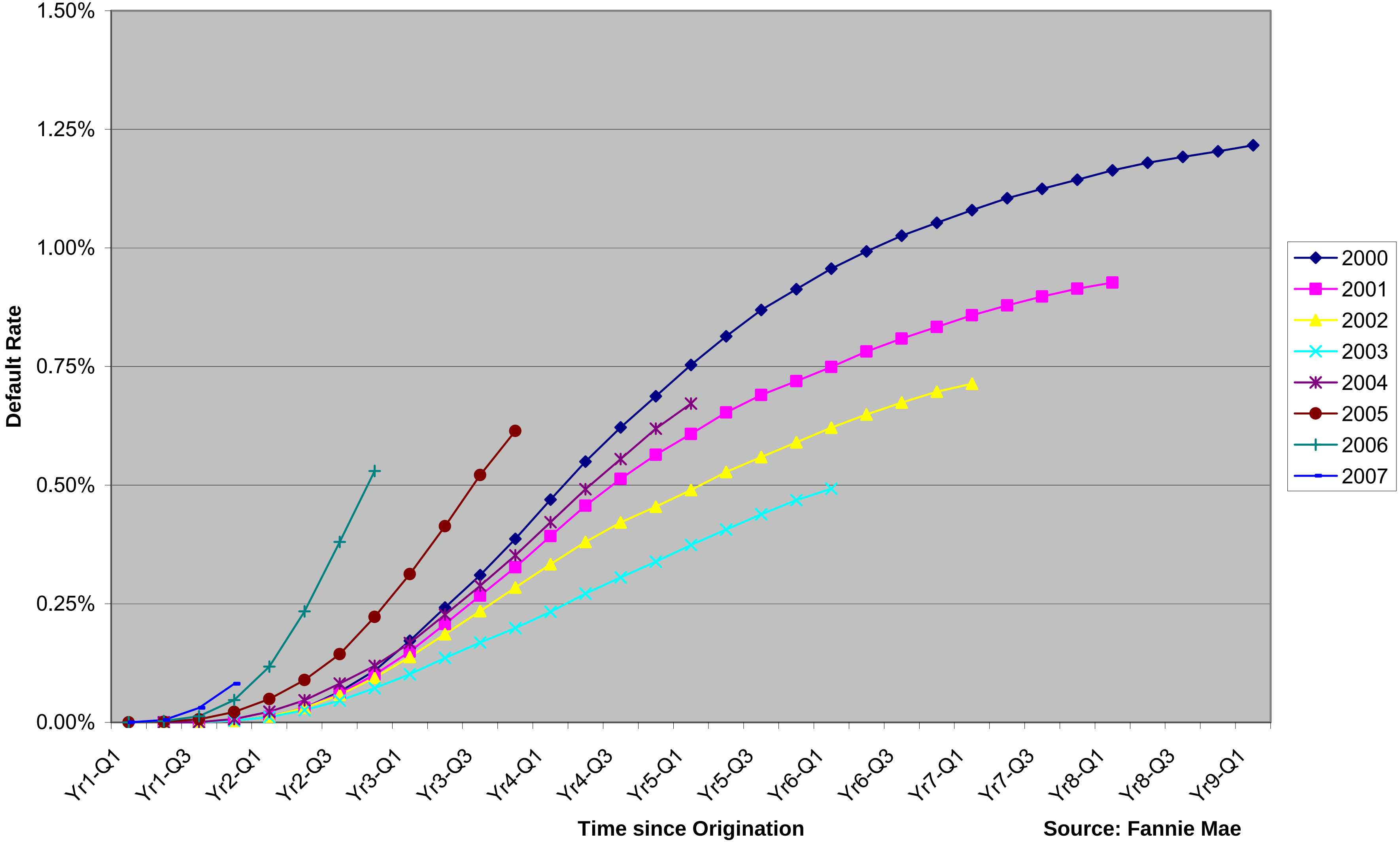
source: Mortgage Banker Association

Figure 12. Foreclosure Rates by Mortgage Instruments



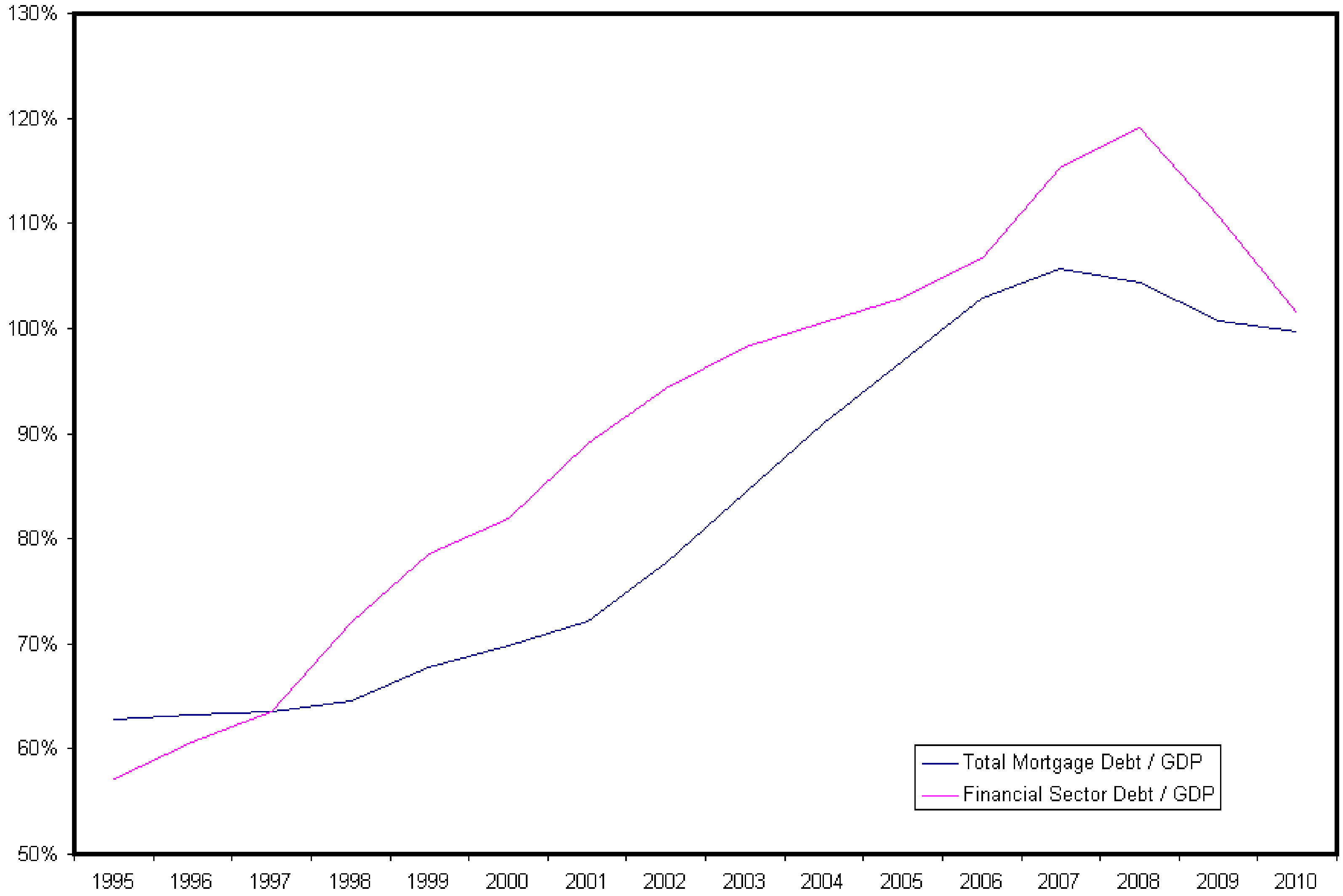
source: Mortgage Banker Association

Figure 13. Cumulative Default Rates Overall Originations from 2000 through 2007



Source: Fannie Mae

Figure 14. Mortgage Debt to GDP and Financial Sector Debt to GDP



Source: Flows of Funds, Federal Reserve Board

Figure 15. Moments of Real Credit Growth and Per Capita Growth (1970-2008)
Partial Regression Plots corresponding to Table 5. Col 1

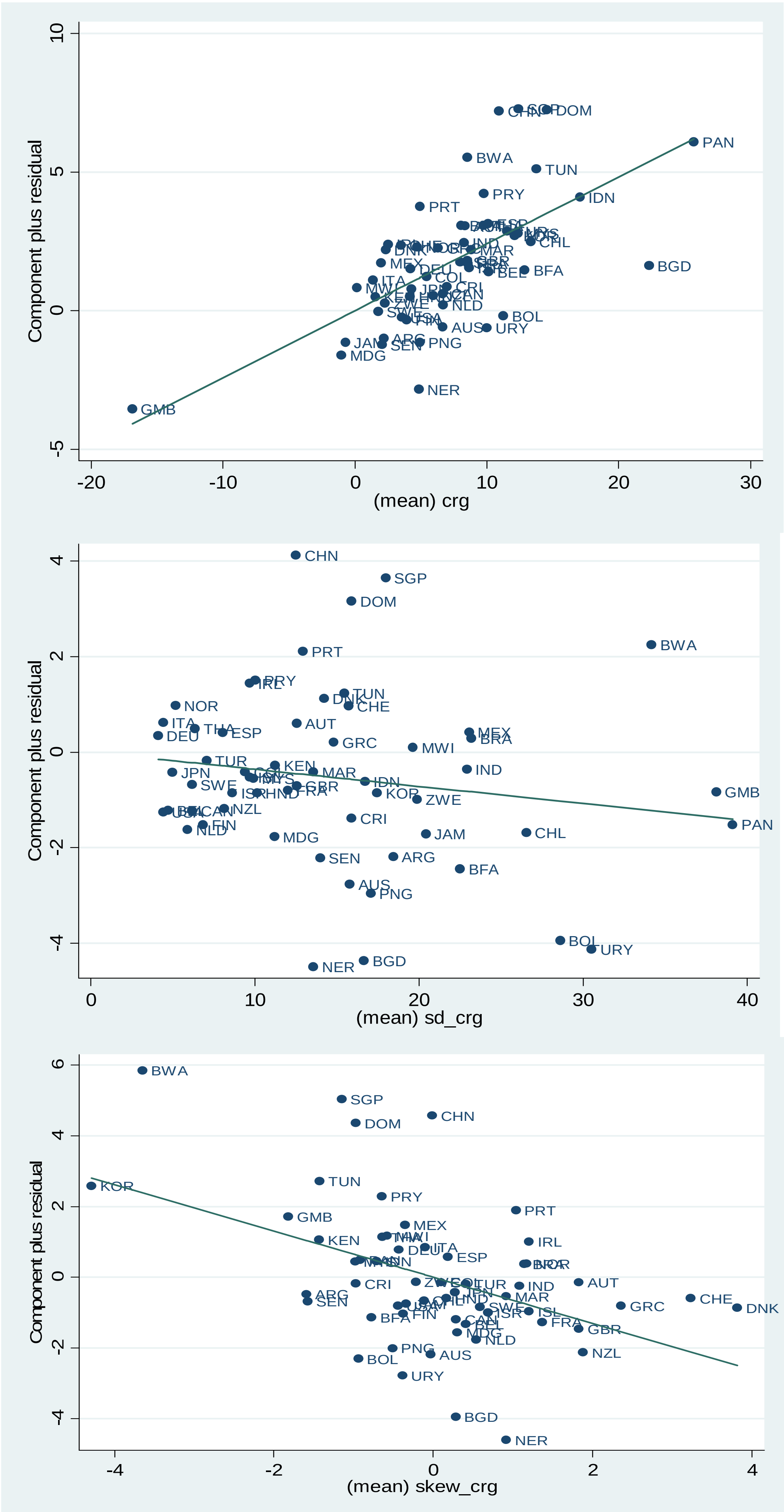


Table 1. Loan Interest Rate and Foreign Currency Borrowing.

Dependant Variable	Interest Rate on Last Loan Reported in 2005 BEEPS Survey					
Sample	Firms in Non-Tradables Sectors					
Estimation	OLS					
Foreign Currency Borrowing Dummy	-1.97***	-1.96***	-1.92***	-1.75***	-1.73***	-1.71***
	(0.37)	(0.37)	(0.41)	(0.40)	(0.41)	(0.45)
Log of Sales (2004)	-0.27***	-0.29***	-0.32***	-0.28**	-0.29**	-0.33**
	(0.10)	(0.10)	(0.11)	(0.12)	(0.12)	(0.13)
Log of Years in Operation	-0.65***	-0.63***	-0.49*	-0.52*	-0.50*	-0.28
	(0.24)	(0.24)	(0.26)	(0.27)	(0.27)	(0.30)
Maturity (in Months)	-0.0033	-0.0021	-0.00093	-0.0035	-0.0025	-0.000023
	-0.0037	-0.0037	-0.0037	-0.0039	-0.0039	-0.0039
Collateral Dummy for:						
Land or Building				0.43	0.42	0.62
				(0.34)	(0.34)	(0.38)
Equipment				-0.14	-0.16	-0.078
				(0.45)	(0.45)	(0.48)
Accounts Receivable				-0.3	-0.26	-0.36
				(1.45)	(1.45)	(1.62)
Personal Assets				-0.83	-0.82	-0.53
				(0.65)	(0.67)	(0.57)
Other Collateral				-0.08	-0.083	0.23
				(0.56)	(0.55)	(0.62)
Number of Firms	1184	1182	1182	997	995	995
Adjusted R-squared	0.597	0.596	0.605	0.586	0.584	0.595
Country Fixed Effects	Yes	Yes	No	Yes	Yes	No
Industry Fixed Effects	No	Yes	No	No	Yes	No
Country-Industry Fixed Effects	No	No	Yes	No	No	Yes

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

Notes: the foreign currency borrowing dummy is equal to 1 if last loan is denominated in foreign currency and 0 if last loan is denominated in domestic currency. The list of non-tradables sector is presented in Table A.1 in the unpublished appendix. Heteroskedasticity robust standard errors are reported.

Table 2. Loan Interest Rate and Foreign Currency Borrowing

Dependant Variable	Interest Rate on Last Loan Reported in 2005 BEEPS Survey					
Sample	Firms in Tradables Sectors					
Estimation	OLS					
Foreign Currency Borrowing Dummy	-2.52***	-2.51***	-2.50***	-2.53***	-2.55***	-2.52***
	(0.37)	(0.37)	(0.38)	(0.41)	(0.41)	(0.42)
Log of Sales (2004)	-0.38***	-0.41***	-0.42***	-0.47***	-0.47***	-0.48***
	(0.09)	(0.10)	(0.10)	(0.10)	(0.11)	(0.11)
Log of Years in Operation	0.11	0.095	0.091	0.26	0.26	0.23
	(0.21)	(0.21)	(0.21)	(0.22)	(0.22)	(0.22)
Maturity (in Months)	-0.0042	-0.0043	-0.004	-0.0018	-0.002	-0.0023
	-0.0048	-0.0049	-0.005	-0.005	-0.005	-0.0053
Collateral Dummy for:						
Land or Building				0.5	0.5	0.56
				(0.41)	(0.41)	(0.42)
Equipment				-0.8	-0.81	-0.87*
				(0.50)	(0.50)	(0.53)
Accounts Receivable				1.99**	1.97**	1.92**
				(0.88)	(0.88)	(0.91)
Personal Assets				0.93	0.95	0.94
				(0.75)	(0.75)	(0.77)
Other Collateral				-0.063	-0.1	-0.043
				(0.83)	(0.83)	(0.91)
Number of Firms	987	987	987	866	866	866
Adjusted R-squared	0.47	0.47	0.469	0.461	0.46	0.45
Country Fixed Effects	Yes	Yes	No	Yes	Yes	No
Industry Fixed Effects	No	Yes	No	No	Yes	No
Country-Industry Fixed Effects	No	No	Yes	No	No	Yes

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

Notes: the foreign currency borrowing dummy is equal to 1 if last loan is denominated in foreign currency and 0 if last loan is denominated in domestic currency. The list of tradables sector is presented in Table A.1 in the unpublished appendix. Heteroskedasticity robust standard errors are reported.

Table 3. Testing the Difference in the Effect of Foreign Borrowing on Interest Rate between the Tradable and Non-Tradable Sample

	H0 Foreign Currency Borrowing Coef (NT Firms)=Foreign Currency Borrowing Coef (T Firms)					
Difference in Foreign Borrowing Coefficients (T minus NT)	0.55	0.55	0.58	0.78	0.81	0.82
Chow Statistics	1.14	1.2	1.97	2.05	2.17	2.17
P_value	0.28	0.27	0.16	0.15	0.14	0.14
Set Control	Simple	Simple	Simple	Full	Full	Full
Country Fixed Effects	Yes	Yes	No	Yes	Yes	No
Industry Fixed Effects	No	Yes	No	No	Yes	No
Country-Industry Fixed Effects	No	No	Yes	No	No	Yes

Table 4. Growth in Sales and Foreign Currency Borrowing.

Dependant Variable	Growth in Sales between 2001 and 2004					
Sample	Firms in Non-Tradables Sectors					
Estimation	OLS					
Foreign Currency Borrowing	0.026***	0.025***	0.028***	0.019**	0.020**	0.022**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Initial Log of Sales (2001)	-0.0062***	-0.0066***	-0.0075***	0.0014	0.00045	-0.00047
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log of Years in Operation	-0.011*	-0.012*	-0.012*	-0.022***	-0.022***	-0.020**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Initial Labor Productivity				-0.027***	-0.026***	-0.026***
Log(Sales/Employement) in 2001				(0.01)	(0.01)	(0.01)
Share of Foreign Input in Production				0.00036***	0.00038***	0.00039***
				(0.00)	(0.00)	(0.00)
Share of Employees with a University Degree				0.00042***	0.00040***	0.00033**
				(0.00)	(0.00)	(0.00)
Share of Skilled Workers				0.0054	0.0038	-0.0039
				(0.01)	(0.01)	(0.02)
Number of Firms	1243	1241	1241	1174	1172	1172
Adjusted R-squared	0.047	0.05	0.055	0.084	0.083	0.083
Country Fixed Effects	Yes	Yes	No	Yes	Yes	No
Industry Fixed Effectd	No	Yes	No	No	Yes	No
Country-Industry Fixed Effects	No	No	Yes	No	No	Yes
* significant at 10%; ** significant at 5%; *** significant at 1%						

Notes: growth in sales is defined as log difference in sales between 2004 and 2001. the currency mismatch dummy is equal to 1 if last loan is denominated in foreign currency and 0 if last loan is denominated in domestic currency. The list of non-tradables sectors is presented in Table A.1 in the unpublished appendix. Heteroskedasticity robust standard errors are reported.

Table 5 Growth in Sales and Foreign Currency Borrowing

Dependant Variable	Growth in Sales between 2001 and 2004					
Sample	Firms in Tradables Sectors					
Estimation	OLS					
Foreign Currency Borrowing	0.011	0.011	0.0094	0.0076	0.0073	0.0058
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Initial Log of Sales (2001)	-0.0025	-0.003	-0.0027	0.0041	0.0041	0.0046*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log of Years in Operation	-0.010**	-0.010**	-0.0098*	-0.018***	-0.018***	-0.018***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Initial Labor Productivity				-0.026***	-0.026***	-0.027***
Log(Sales/Employement) in 2001				(0.01)	(0.01)	(0.01)
Share of Foreign Input in Production				0.00024**	0.00023**	0.00021*
				(0.00)	(0.00)	(0.00)
Share of Employees with a University Degree				-0.00036	-0.00035	-0.00033
				(0.00)	(0.00)	(0.00)
Share of Skilled Workers				0.0027	0.0037	0.0083
				(0.02)	(0.02)	(0.02)
Number of Firms	1033	1033	1033	978	978	978
Adjusted R-squared	0.033	0.034	0.042	0.069	0.069	0.076
Country Fixed Effects	Yes	Yes	No	Yes	Yes	No
Industry Fixed Effectd	No	Yes	No	No	Yes	No
Country-Industry Fixed Effects	No	No	Yes	No	No	Yes
* significant at 10%; ** significant at 5%; *** significant at 1%						

Notes: growth in sales is defined as log difference in sales between 2004 and 2001. the currency mismatch dummy is equal to 1 if last loan is denominated in foreign currency and 0 if last loan is denominated in domestic currency. The list of non-tradables sectors is presented in Table A.1 in the unpublished appendix. Heteroskedasticity robust standard errors are reported.

Table 6. Skewness and Growth in Cross-Country Regressions

	6.1	6.2	6.3	6.4
Dependent Variable	Real Per Capita Growth			
Time Period	1970-2008	1980-2008	1960-2008	1970-2008
Country Sample	58	58	58	83
Estimation	OLS	OLS	OLS	OLS
Initial Number of Years of Secondary Schooling	0.0336	0.0325	0.0416*	0.0476**
	[0.0224]	[0.0223]	[0.0216]	[0.0191]
Initial GDP per Capita	-0.218	-0.455	-0.291	-0.541
	[0.475]	[0.435]	[0.420]	[0.397]
Real Credit Growth, Mean	0.241***	0.269***	0.141***	0.206***
	[0.0380]	[0.0384]	[0.0349]	[0.0312]
Real Credit Growth, Standard Deviation	-0.0358	0.0165	-0.0556**	-0.0613**
	[0.0324]	[0.0221]	[0.0267]	[0.0244]
Real Credit Growth, Skewness	-0.654***	-0.311**	-0.281*	-0.565***
	[0.206]	[0.127]	[0.165]	[0.206]
Constant	1.528	1.941	2.93	4.095
	[3.167]	[2.499]	[2.829]	[2.662]
R-squared	0.495	0.59	0.454	0.429

Robust standard errors in brackets below estimaties. *** p<0.01, ** p<0.05, * p<0.1