FUNDAÇÃO GETULIO VARGAS
ESCOLA DE PÓS-GRADUAÇÃO EM ECONOMIA

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Essays on banking theory and history of financial arrangements

Rio de Janeiro
2014

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Tese para obtenção do grau de doutor apresentada à Escola de Pós-Graduação em Economia

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Ficha catalográfica elaborada pela Biblioteca Mario Henrique Simonsen/FGV

Ferreira, Murilo Resende
Essays on banking theory and history of financial arrangements / Murilo Resende Ferreira. – 2014.
75 f.

Tese (doutorado) - Fundação Getulio Vargas, Escola de Pós-Graduação em Economia.
Orientador: Ricardo de Oliveira Cavalcanti
Inclui bibliografia

1. Bancos. 2. Crise financeira. 3. Ciclos econômicos. I. Cavalcanti, Ricardo de Oliveira. II. Fundação Getulio Vargas. Escola de Pós- Graduação em Economia. III. Título.

CDD – 332.1

FGV

MURILO RESENDE FERREIRA

"ESSAYS ON BANKING THEORY AND HISTORY OF FINANCIAL ARRANGEMENTS"

Tese apresentada ao Curso de Doutorado em Economia da Escola de Pós-Graduação em Economia para obtenção do grau de Doutor em Economia.

Data da defesa: 27/06/2014

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Resumo

Essa tese contém dois capítulos, cada um lidando com a teoria e a história dos bancos e arranjos financeiros.

No capítulo 1, busca-se extender uma economia Diamond-Dybvig com monitoramento imperfeito dos saques antecipados e realizar uma comparação do bem estar social em cada uma das alocações possíveis, como proposto em Presscott and Weinberg(2003) [37]. Esse monitoramento imperfeito é implementado a partir da comunicação indireta (através de um meio de pagamento) entre os agentes e a máquina de depósitos e saques que é um agregado do setor produtivo e financeiro. A extensão consiste em estudar alocações onde uma fração dos agentes pode explorar o monitoramento imperfeito e fraudar a alocação contratada ao consumirem mais cedo além do limite, usando múltiplos meios de pagamento. Com a punição limitada no período de consumo tardio, essa nova alocação pode ser chamada de uma alocação separadora em contraste com as alocações agregadoras onde o agente com habilidade de fraudar é bloqueado por um meio de pagamento imune a fraude, mas custoso, ou por receber consumo futuro suficiente para tornar a fraude desinteressante. A comparação de bem estar na gama de parâmetros escolhida mostra que as alocações separadoras são ótimas para as economias com menor dotação e as agregadoras para as de nível intermediário e as ricas. O capítulo termina com um possível contexto histórico para o modelo, o qual se conecta com a narrativa histórica encontrada no capítulo 2.

No capítulo 2 são exploradas as propriedade quantitativas de um sistema de previsão antecedente para crises financeiras, com as váriaveis sendo escolhidas a partir de um arcabouço de “boom and bust” descrito mais detalhadamente no apêndice 1. As principais variáveis são: o crescimento real nos preços de imóveis e ações, o diferencial entre os juros dos títulos governamentais de 10 anos e a taxa de 3 meses no mercado inter-bancário e o crescimento nos ativos totais do setor bancário. Essas variáveis produzem uma taxa mais elevada de sinais corretos para as crises bancárias recentes (1984-2008) do que os sistemas de indicadores antecedentes comparáveis. Levar em conta um risco de base crescente (devido à tendência de acumulação de distorções no sistema de preços relativos em expansões anteriores) também provê informação e eleva o número de sinais corretos em países que não passaram por uma expansão creditícia e nos preços de ativos tão vigorosa.

Palavras-chave: crises financeiras, monitoramento imperfeito, sistema de indicadores antecedentes, corridas bancárias, ciclos de crédito, bolhas de ativos.

Abstract

This thesis contains two chapters, each one dealing with banking theory and the history of financial arrangements.

In Chapter 1, we extend a Diamond and Dybvig economy with imperfect monitoring of early withdrawals and make a welfare comparison between all possible allocations, as proposed by Prescott and Weinberg(2003) [37]. This imperfect monitoring is introduced by establishing indirect communication(trough a mean of payment) between the agents and the machine that is an aggregate of the financial and the productive sector.The extension consists in studying allocations where a fraction of the agents can exploit imperfect monitoring and defraud the contracted arrangement by consuming more in the early period trough multiple means of payment. With limited punishment in the period of late consumption, this new allocation is called a separating allocation in contrast with pooling allocations where the agent with the ability of fraud is blocked from it by a costly mean of payment or by receiving enough future consumption to make fraud unattractive. The welfare comparison in the chosen range of parameters show that separating allocations are optimal for poor economies and pooling allocations for intermediary and rich ones. We end with a possible historical context for this kind of model, which connects with the historical narrative in chapter 2.

In Chapter 2 we explore the quantitative properties of an early warning system for financial crises based on the boom and bust framework described in more detail in appendix 1. The main variables are: real growth in equity and housing prices, the yield spread between the 10-year government bond and the 3-month interbank rate and the growth in total banking system assets. These variables display a higher degree of correct signals for recent crises (1984-2008) than comparable early warning systems. Taking into account an increasing base-line risk (due to increasing rates of credit expansion , lower interest rates and the accumulation of distortions) also proves to be informative and to help signaling crises in countries that did not go trough a great boom in previous years.

Keywords: financial crises, imperfect monitoring, early warning systems, bank runs, credit cycles, asset bubbles.

Contents

1 Chapter 1 - A Diamond Dybvig Economy with Imperfect Monitoring of Early Withdrawals

1.1 Introduction

We propose a two-period Diamond and Dybvig economy where there is an imperfect monitoring of early withdrawals. This possibility was first studied by Prescott and Weinberg (2003) [37]. They first end the direct contact of deposit machine and agent: now there is contact only trough a mean of payment that can only be produced by a coalition of agents ("bank"). Then it is introduced the possibility of some agents being able to visit the machine more than one time in the period of early consumption, using multiple payment instruments. As one of the means of payment is a sort of block of blank check, and the banking arrangement only learns that an individual exceeded his wealth limit by withdrawing more than one time in the future , an allocation that prevents multiple visits and is symmetric in the number of visits an agent makes can only be achieved trough a constraint (no binge constraint) that imposes enough future consumption in order to make the only punishment (accepting that the marginal utility of zero consumption is bounded) available, that of zero consumption in the future, really threatening. This is how they introduce the imperfect monitoring of agents visits by the machine. The other payment is a "draft" an instrument that at a cost is able to prevent any fraud. If these costs are low enough, there is a poorer wealth range where a pure draft economy is optimal and a richer one where the pure check economy is optimal.

We extend this economy by considering separating allocations in the capability of making multiple visits. The hypothesis is that for a certain set of parameters the separating allocations may prove to be optimal in comparison with draft and check economies. These allocations are such that a fraction or the totality of agents with an ability to binge will be specialized in early consumption, receiving a limited punishment of zero utility in the period of late consumption. Our first result is that separating allocations are optimal for poorer economies, where the cost of producing a payment instrument immune to fraud is prohibitive and the marginal utility of consuming more in the present is so high that giving enough future consumption to agents is welfare-reducing compared to allowing frauds.The second result is that this is valid for a greater wealth range if an economy has a substantial difference between the liquidity preference of agents, low real productivity (in the sense that it is closer to the liquidity preference of the patient agent), and a small population of possible bingers. Then we discuss , with historical examples, the different settings where this distinction between means of payment could apply.

1.2 Literature Review

Diamond and Dybvig (1983) [17] proposed a new approach in dealing with problems of money and banking. By a simplification of the environment (two period, single resource

economy) it achieves a simpler way to talk about liquidity problems. But simpler in relation to what? According to Cavalcanti (2010) [11] the previous tradition in money and banking is best characterized by the works of Shubik and Wilson (1977) [44] and Bryant (1980) [8]. These works are located inside the more ample general equilibrium literature, and build on models where the price mechanism works well,introducing an external financial sector, much like the cash in advance literature. Working on the two period economy, Diamond and Dybvig (1983) introduce a concept that is capable of joining liquidity and fragility: the sequential service constraint. The machine is the instrument in this economy which permits the agents in to achieve a non autarkic allocation, by way of depositing their endowments (in a period 0 before the two relevant periods) in this machine which has a general rule for withdrawals to prevent lies about time preference types, which is the equivalent in this economy to bank runs. The non autarkic allocation is interesting because it allows insurance for a privately observed preference shock. Also important is the isolation of agents and the capability of visiting the machine only once. These are considered good approximations in a discrete time model for the fact that in the real world of continuous time people visit the bank in different times and do not actually communicate about what they did. If there is no uncertainty about the distribution of preference shocks the general rule that prevents bank runs is payment suspension in period 1 after the withdrawals exceed the total amount allocated to the high time preference type. If there is uncertainty, it is alleged that a deposit insurance arrangement can provide a no run allocation.Wallace (1988) [51] shows that this is not possible in the environment described. If the sequential service constraint and isolation are taken seriously (so that the machine cannot wait all announcements of types before distributing allocations) the deposit insurance of Diamond and Dybvig is not feasible. Isolation is essential, because if it did not exist agents could simply unite at period 1 and declare their types, not needing the machine for anything.They could also create a credit market in this period, which is shown to be incompatible with illiquid banking arrangements. This literature knew developments that revolved mainly around the theme of the importance of the sequential service constraint and the order into which people visit the machine. But the development that concern us is the one initiated by Prescott and Weinberg (2003) [37].

1.3 A review and extension of the model in Prescott and Weinberg(2003)

The main theme in this model is that of imperfect monitoring of the withdrawals of agents. The authors introduce this by the concept of means of payment (checks and drafts) and a spatial dimension as in Townsend(1987,1989) [48] [49]. In Prescott and Weinberg (2003) (PW for now on) the counterparts to the agents in Wallace(1988) are called buyers and have total utility of the form $\theta u(x) + v(y)$, where x stands for period 1 and y for period 2 consumption and v(0)=0. Buyers have an endowment of a storable good that will be transformed into rw units of y in period 2. There are two information

shocks: in period 1(allocations are chosen in period 0) the "buyer" discovers if he has high or low liquidity preference(θ^h or θ^l) and how many sellers (1 or 2) he can visit when he travels to the sellers location (For the sake of simplicity we are only going to consider two liquidity-preference types (high and low) and a maximum of two visits to the machine). The probability of shock θ is $p(\theta)$, and of the ability to make two visits simply s((1-s) for only one visit), with realizations independent across agents. Each seller sells a part of the composite good x (present consumption) and receives y(future consumption) in exchange, so that a buyer with preference for diversity will have the utility reduced if he cannot visit all the sellers. Sellers have linear utility in y and linear disutility x from producing x units of the period 1 consumption good. From this we can see that the sellers work exactly like the machine in Wallace(1988), if we take away the direct communication between agent and machine and introduce the ability to restrain single withdrawals to the contracted allocations. So, from now on we will talk about the model in PW as situated in the environment of Wallace(1988). In sum, the main elements are: imperfect monitoring of withdrawals at t=1, limited punishment in t=2 and indirect communication between the agent and the machine.

The machine receives deposits of the endowment in t=0 , and can process z units of it in z units of period 1 consumption and rz units of period 2 consumption. The technology is irreversible, that is, withdrawals made at t=1 cannot be reinvested. Its return r in t=2 is such that $\theta^l < r < \theta^h$. The machine is centrally located, but the agents differ in terms of the number of visits they can make to it. The agent informs its endowment with a mean of payment, but can announce its realized liquidity preference to the machine. To this information the machine answers with the correspondent contracted allocation. The machine does not maintain a record of the identity of previous visitors in t=1, and there are agents that can use another payment instrument in a second visit. But the environment is such that at t=2 this second visit is identifiable and punishable with zero consumption. In this environment the machine is actually able to limit withdrawals to the contracted allocations in t=0, eliminating the problem of an actual run. There is also no autarkic production: the only way to obtain consumption in t=1 and t=2 is to join the general process of production. But indirect communication between the agent and the machine and imperfect monitoring of previous visits in t=1 generate the need for a payment instrument. Truthful revelation of liquidity preference is insured by defining allocations in t=0 that guarantee a true announcement in t=1. A "draft" is an instrument that is immune to multiple withdrawals, but is costly to create. They are important because in this model buyers cannot commit to creating personal payment obligations that are limited to their own entitlement, that is, they cannot communicate a credible information directly to the machine. But the "bank", which is a deposit coalition created by agents in period 0, can create checks and drafts. We hypothesize that the aggregate cost D is a fraction of the total potential productivity (rw) of the economy in t=0. The basis of this is the idea that in a richer economy there is an

increased number of transactions, and an increased need of monitoring and investing to make drafts fool-proof. PW rationalizes this by postulating a consumer with a taste for diversity, which can only be met by multiple vendors of different products, who demand different face-values for the drafts. We can postulate here that the machine demands different draft values for each good in a composite bundle x of consumption in t=1. A "check" is a costless payment instrument, but which is prone to fraud when the agent has access to multiple checks, due to the already cited fact that the machine can't store the previous history of visits. It can only identify them in period 2, where a limited punishment of zero utility is enforceable. One solution to this is to define an allocation in t=0 that prevents any welfare gain in multiple visits (or binging) for the individual agent. Here we only consider the public wealth case, that is, the payment instrument correctly informs the endowment of the agent in any single visit. This allows us to treat each wealth level as a separate problem.

As the explanations shows, PW only consider allocations that are symmetric along the number of visits to the machine an agent can do. That is, it analyzes a pooling allocation of the model. The pure check economy demands that the bank imposes a no binge constraint to prevent overdrawing. For a sufficiently high level of wealth this constraint is not binding. In this case the check economy is identical to the draft economy without the costs of implementation (Full commitment allocation). Our extension is to define and simulate separating allocations where either both liquidity preference types are specialized in present consumption by binging, or only the impatient type is (only those with the capability of multiple visits). If the no-binge restriction in the check economy is sufficiently strict and the costs of monitoring in the draft economy are sufficiently high, there should exist a wealth range where a pure separating allocation is optimal. This happens when the welfare loss from setting aside present consumption for bingers is smaller than that of setting enough future consumption and monitoring investment to deter binging.

1.4 Pooling Allocations

1.4.1 Draft Economy

We state the general form of the problem and enunciate the results linked with it in lemmas or by a clear indication. Other results are obtained (and only narrated at the main text) by simulating a specific utility form in parameter ranges that will be detailed in the welfare comparison section. This functional form is $u(x) = v(x) = ln(1+x)$. The program for the pure draft economy is:

$$\underset{x^h,x^l,y^h,y^l}{\text{Maximize}} \quad \text{p}[\theta^h u(x^h)+v(y^h)]+(1-p)[\theta^l u(x^l)+v(y^l)]$$

s.t

$$py^h+(1-p)y^l+D \le r(w-px^h-(1-p)x^l) \tag{1}$$
$$\theta^l u(x^l)+v(y^l) \ge \theta^l u(x^h)+v(y^h) \tag{2}$$
$$\theta^h u(x^h)+v(y^h) \ge \theta^h u(x^l)+v(y^l) \tag{3}$$

Optimal allocations are identical to a full-commitment economy, only with an aggregate cost D for guaranteeing that the draft instrument can´t be forged, producing an economy where visiting the machine more than one time is impossible. In this draft allocation $\theta^l u'(x^l)=v'(y^l)$ (general result), and the truth telling constraint of θ^l is always binding(general result), which implies that (3) is always slack. This reflects the fact that in a First Best allocation, the chosen consumption for type θ^h leads to a violation of (2), but not (3). Revelation of truth demands a reallocation of resources from θ^h to θ^l, and the consumption of θ^h is distorted by reducing x^h less than y^h, that is, $rv'(y^h)>\theta^h u'(x^h)$ (general result). It is also valid that $v'(y^h)>v'(y^l)$ (this last inequality is present in all other economies).

1.4.2 Check Economy

The program for the check economy is:

$$\underset{x^h,x^l,y^h,y^l}{\text{Maximize}} \quad \text{p}[\theta^h u(x^h)+v(y^h)]+(1-p)[\theta^l u(x^l)+v(y^l)]$$

s.t

$$py^h+(1-p)y^l \le r(w-px^h-(1-p)x^l) \tag{4}$$
$$\theta^l u(x^l)+v(y^l) \ge \theta^l u(x^h)+v(y^h) \tag{5}$$
$$\theta^h u(x^h)+v(y^h) \ge \theta^h u(x^l)+v(y^l) \tag{6}$$
$$\theta^h u(x^h)+v(y^h) \ge \theta^h u(2x^h) \tag{7}$$
$$\theta^h u(x^h)+v(y^h) \ge \theta^h u(2x^l) \tag{8}$$
$$\theta^l u(x^l)+v(y^l) \ge \theta^h u(2x^h) \tag{9}$$
$$\theta^l u(x^l)+v(y^l) \ge \theta^h u(2x^l) \tag{10}$$

It is clear that for all allocations where $x^h \ge x^l$, when (7) and (9) are satisfied, (8) and (10) also are. But there is no possibility of x$^l > x^h$. In the case of a very poor economy $x^l=x^h$ and $y^l=y^h$. In this case (7) and (9) obviously are both binding. Again the truth telling of θ^l is always binding. Moreover:

Lemma 1. *Any allocation that satisfies (5),(6) and (7), also satisfies with strict inequality (9).*

Proof. The right hand side of (7) declines more rapidly with a move from θ^h to θ^l, implying that $\theta^l u(x^h) + v(y^h) > \theta^l u(2x^h)$. But (5) means that $\theta^l u(x^l) + v(y^l) > \theta^l u(2x^h)$. ■

Following *PW* we define allocations by three different wealth levels. In the rich wealth level the no-binge constraint for θ^h(7) is not binding. The planner is able to arrange the full commitment allocation for this economy, without costs D, and $rv'(y^h) \geq \theta^h u'(x^h)$ (general result) . In the intermediate wealth level (7) is binding, $\theta^l u'(x^l) = v'(y^l)$(general result) and $\theta^h u'(x^h) > rv'(y^h)$ (general result). This reversion of the relation between the marginal utilities of x^h and y^h is due to the need of allocating enough future consumption to deter the impatient type from making multiple visits. In the poor economy allocations collapse to $y^h = y^l > x^l = x^h$, as present consumption must be drastically reduced to stop multiple visits.

1.5 Separating Allocations

1.5.1 Two bingers economy

There are two possibilities for a separating allocation in the ability to visit the machine two times: one where the two liquidity-preference types chose to binge if they have the ability, and another where only the impatient one chooses to do so. The great change comes from the introduction of a new allocation: $2x^h$. The specialized binger will only consume this, and the maximum allocation of present consumption will always be directed do θ^h. As there is no way for the planner to restrict the patient binger to x^l, if he chooses to binge he will always lie about his liquidity preference. The program for the economy with two types of bingers is[1]:

$$\underset{x^h,x^l,y^h,y^l}{\text{Maximize}} \quad \sum^i \pi^i [s\theta^i u(2x^h) + (1-s)(\theta^i u(x^i) + v(y^i))]; \pi^i \in [p,(1-p)], i \in [h,l]$$

s.t

$$p(1-s)y^h + (1-p)(1-s)y^l \leq r(w - s2x^h - p(1-s)x^h - (1-p)(1-s)x^l) \tag{11}$$

$$\theta^l u(x^l) + v(y^l) \geq \theta^l u(x^h) + v(y^h) \tag{12}$$

$$\theta^h u(x^h) + v(y^h) \geq \theta^h u(x^l) + v(y^l) \tag{13}$$

$$\theta^h u(2x^h) \geq \theta^h u(x^h) + v(y^h) \tag{14}$$

$$\theta^l u(2x^h) \geq \theta^l u(x^l) + v(y^l) \tag{15}$$

[1] Due to formatting issues we display the long objective function in sum notation, but in other problems we prefer to display the full equation to facilitate numbering and visualization.

Lemma 2. *If (15) is satisfied, (14) is always satisfied with strict inequality.*

Proof. Suppose (14) is binding. The left hand side of it declines faster with a move from θ^h to θ^l, and so $\theta^l u(2x^h) < \theta^l u(x^h) + v(y^h)$. But by (12) we have that $\theta^l u(2x^h) < \theta^l u(x^l) + v(y^l)$, a violation of (15).

■

The truth telling constraint of θ^l is always binding, leaving us with only (12) and (15). (15) is not binding at the poorer wealth levels, and this range increases the smaller is $\frac{\theta^l}{\theta^h}$ and the higher is the population of bingers. These lower wealth levels are also the range where $\theta^h u(x^h) > rv'(y^h)$. At the higher wealth levels the reverse relation always holds. The equality between the marginal utilities of x^l and y^l is still valid. In this economy all other allocations are heavily distorted in order to guarantee enough x^h to specialize both types of bingers in present consumption. At low enough wealth levels, time preference and scarcity are enough to make (15) slack, allowing comparatively higher levels of y^h. In the higher wealth levels (15) becomes very strict, imposing $x^h > y^h + x^l + y^l$ and y^h almost fixed in a very low level.

1.5.2 Impatient binger economy

This downside suggests that specializing the impatient in present consumption can be welfare-enhancing. The program for this economy with only one type of binger is:

$$\underset{x^h,x^l,y^h,y^l}{\text{Maximize}} \quad \text{p}[s\theta^h u(2x^h) + (1-s)(\theta^h u(x^h) + v(y^h))] + (1-p)(\theta^l u(x^l) + v(y^l))$$

s.t

$$p(1-s)y^h + (1-p)y^l \le r(w - ps2x^h - p(1-s)x^h - (1-p)x^l) \tag{16}$$

$$\theta^l u(x^l) + v(y^l) \ge \theta^l u(x^h) + v(y^h) \tag{17}$$

$$\theta^h u(x^h) + v(y^h) \ge \theta^h u(x^l) + v(y^l) \tag{18}$$

$$\theta^h u(2x^h) \ge \theta^h u(x^h) + v(y^h) \tag{19}$$

$$\theta^l u(x^l) + v(y^l) \ge \theta^l u(2x^h) \tag{20}$$

At some extreme choice of parameters the truth telling of θ^h may become binding at very low wealth levels. But the most common and important case is that where the truth telling of θ^l is binding. The following is also valid:

Lemma 3. *If (19) or (20) is binding, than the other one is valid with strict inequality.*

Proof. If (20) is binding, then the fact that the right hand side increases faster with a move from θ^l to θ^h leads to $\theta^h u(2x^h) > \theta^h u(x^l) + v(y^l)$. But by (18) we have that $\theta^h u(2x^h) > \theta^h u(x^h) + v(y^h)$. The reverse is valid for the occasion when (19) is binding, only now (17) is used to achieve the result.

■

If θ^l is low enough the main result is that (20) is binding only for the lowest wealth levels, even for a vast range of the parameters. If θ^h is large enough, (19) is binding only at the richer wealth levels. If not, it can be binding even at poor wealth levels, beginning at the point where (20) is slack. In this kind of economy, (19) becomes strict to the point of making both truth telling constraints slack for all but the poor wealth levels. We have that $\theta^l u'(x^l) = rv'(y^l)$ and again $\theta^h u'(x^h) > rv'(y^h)$ in the lowest wealth levels. The lower that $\frac{\theta^l}{\theta^h}$ is, the lower will be the wealth levels where $\theta^h u'(x^h) \leq rv'(y^h)$. But this inequality is much smaller in this case than in the one with two types of bingers, allowing much more consumption of y^h, x^l and y^l at higher wealth levels. From now on we also refer to the draft, the check, the two bingers and the impatient binger economy as model 1, model 2, model 3 and model 4 respectively.

1.6 Welfare Comparison Simulation

The first thing that must be accounted in the simulation of these models is the value of the liquidity preference parameters. This is not a realistic calibration, but empirical estimations of time preference can be taken as limiting and guiding facts. The values of θ^h and θ^l compatible with a considerable range of wealth where separating allocations prove to be welfare-maximizing would imply astounding rates of time preference in a short-run context like that of PW. The absolute value of the parameters and also a significant difference between them(a small $\frac{\theta^l}{\theta^h}$) are better motivated in the context of a full life-cycle or the transition from working years to retirement. Taking this into account, the following result can be stated:

Result 1. *Let $V^1(w,D), V^2(w), V^3(w,s), V^4(w,s)$ be the value functions of the draft, the check, the two bingers and the one binger economy respectively. Define w_0 as the first point where the no-binge constraint constraint of θ^l in model 4 is not binding and w_1 as the first point where the no-binge constraint of θ^h in model 2 is not binding. Then, for an economy with a substantial difference between the liquidity-preference of agents , productivity closer to θ^l($r < \frac{\theta^h+\theta^l}{2}$), and a similar population of impatient and patient agents, the following statements are valid: there $\exists s^*$,D^* and $w_2 \in (0, w_0)$ such that for $w \in (0,w_0)$, if $w \leq w_2$, then $V^3(w,s) \geq V^4(w,s), V^2(w), V^1(w,D)$. This same s^*, D^* is such that there exists $w_3 \in (w_2, w_4)$ and $w_4 \in (w_3, w_1)$, such that for $w_2 < w < w_3$, $V^4(w,s) \geq V^3(w,s), V^2(w), V^1(w,D)$, for $w_3 < w < w_4$, $V^1(w,D) \geq V^4(w,s), V^3(w), V^2(w)$ and for $w > w_4$, $V^2(w) \geq V^4(w,s), V^3(w,s), V^1(w,D)$. That is, separating allocations are optimal for poor and lower intermediary economies, while monitoring is appropriate for intermediary levels and checks for higher intermediary and rich economies.*

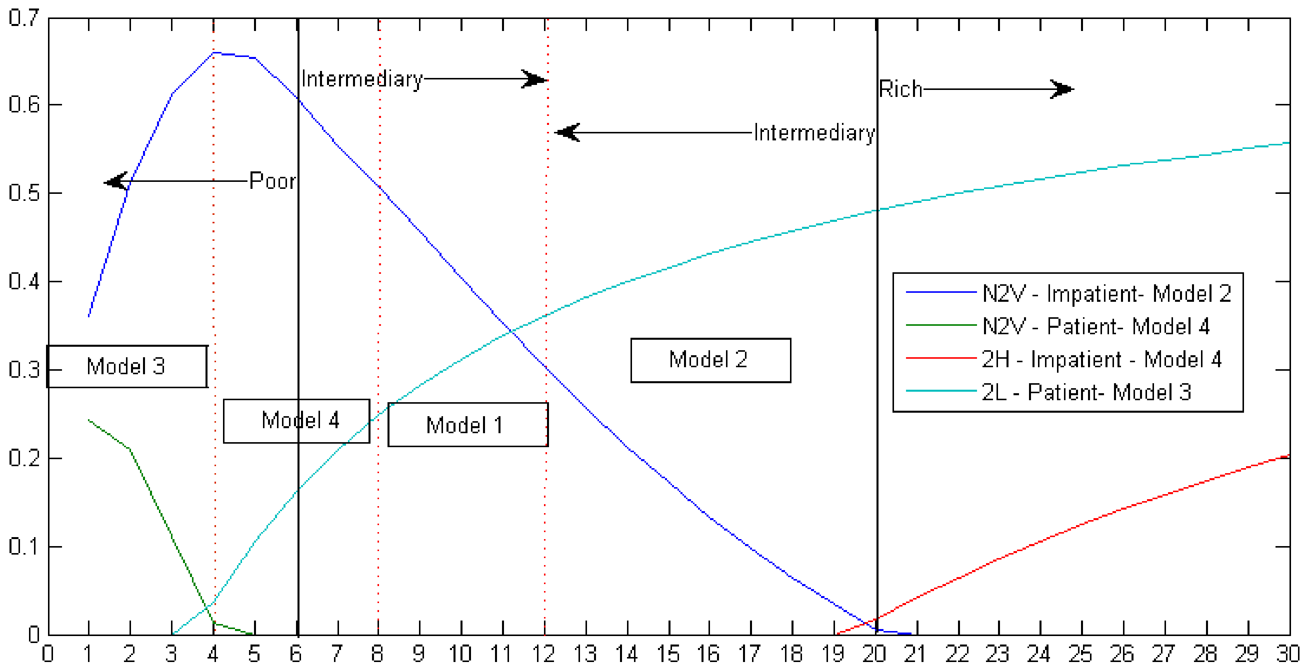
We exemplify this with what we call our base simulation: θ^l is set at 1.2, θ^h at 3 and r at 1.5 and p at 0.5. The wealth range goes from $w = 1$ to $w = 30$. Then we set the population of bingers at 0.1, 0.3 and 0.5 and find the highest cost D that is compatible with a welfare-optimizing role for all four models in these levels. The results are shown in figures 1,2 and 3, in the end of this section. As s grows, the draft economy can display higher costs of monitoring and still play an optimal role between the separating and the check allocations. The role of model 3 is diminished until at s=0.5 it is not optimal even with w=1. This reflects the fact that a large population of bingers, with binge allowance for both types of liquidity preference, demands a substantial allocation of resources for the specialization in present consumption. Nonetheless, there is still a role for model 4 from w=1 to w=5. The maximum cost of monitoring compatible with a medium wealth role for model 1 ranges from two percent to six percent of rw. By varying $\frac{\theta^l}{\theta^h}$ and r and p we can state the following result, which has a natural continuity with the first:

Result 2. *Take* $V^{sep} = max(V^3(w,s);V^4(w,s))$ *and* $V^{pool} = max(V^1(w,D);V^2(w))$ *The smaller* $\frac{\theta^l}{\theta^h}$ *and r, the higher will be the values of w and s, and the smaller the values of D compatible with* $V^{sep} \geq V^{pool}$*. Moreover, if* $\frac{\theta^l}{\theta^h}$ *is small enough, s big enough, and p small enough it will always be valid that* $V^4(w,s) \geq V^3(w,s)$ *for these wealth levels. That is, in a economy with a substantial difference between the liquidity preference of agents, productivity closer to* θ^l*, a high enough proportion of possible bingers, and a small enough proportion of impatient agents, it is optimal to specialize the impatient binger in present consumption for an increasing range of wealth and monitoring costs.*

This can be exemplified by returning to our base case, only now we vary θ^h to 2.5 , and afterward θ^l and r to 1.5 and 2.25 respectively, all other parameters fixed, and compare the result to the base case with $\theta^h = 3$. The results are displayed in figures 4, and 5 . It is clear that a smaller θ^h and/or a increased θ^l and r greatly restricts an optimal role for the draft and the separating allocations. Moreover, the rich wealth level starts at w=11 when $\theta^h = 2.5$ and at $w = 12$ when $\theta^l = 1.5$ and $r = 2.25$. We do not display the graphic results here, but by decreasing and increasing the population of impatient agents from 0.5 we get the following result: the smaller this population is, the larger the welfare optimizing role of the impatient binger economy in comparison with all others. For $p = 0.3$(base model), for example, and with costs of monitoring at two percent of rw, model 4 is optimal from $w = 2$ until $w = 14$ and from then on it is model 2. And the higher this population, the larger the welfare optimizing role for the two bingers and the draft economy. With $p = 0.7$, for example, model 3 is optimal from $w = 1$ to $w = 7$, model 1 from $w = 8$ to $w = 12$, and model 2 from then on. This is expected: the smaller the population linked with a certain restriction, the easier it is to adjust allocations with a smaller resource cost. A smaller p significantly decreases the cost of the impatient binger allocation, while a higher one increases it and decreases that of the patient binger, while also making the no-binge restriction in model 2 more strict.

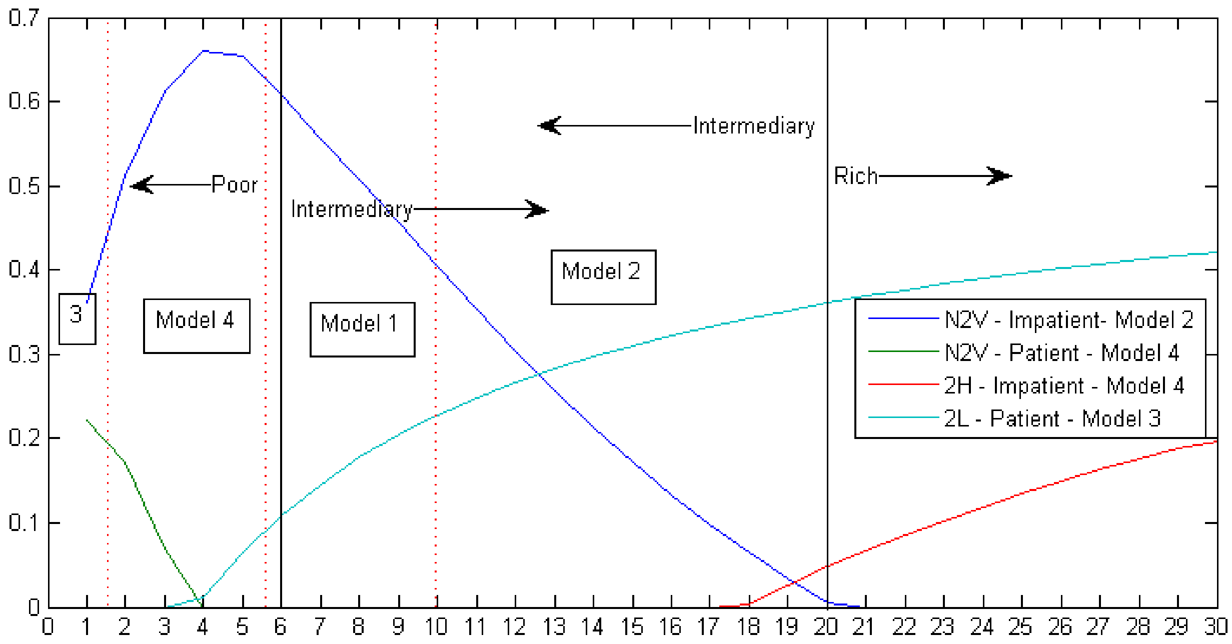
A similar population of patient and impatient agents leads to an optimal role for all models in a vaster range of parameters and the simulation centered exactly around the idea of finding the parameters that would imply an optimal role for all models in a significant wealth range. The strongest limitations on the parameters relate to the liquidity preference and the existence of a limited population of bingers. Both imply a high degree of heterogeneity between agents in all wealth levels.

Figure 1: $(\theta^h = 3, \theta^l = 1.2, r = 1.5, s = 0.1, D = 0.02rw)$ [a]



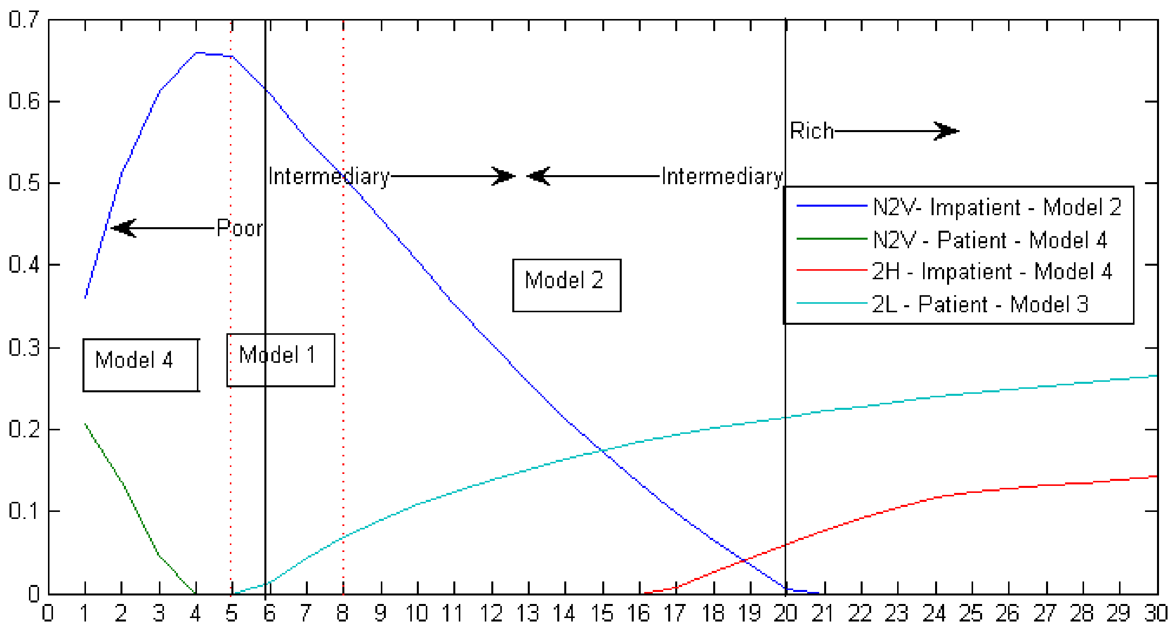
[a]The solid black line indicates the transition from poor to intermediary and rich wealth levels; the dashed red line indicates the transition from one model to the other, each one being designated at the text boxes.The drawn functions are the values of the Kuhn-Tucker multipliers of the restrictions. In the figures we call the no binge restrictions N2V, the binge restriction of the impatient 2H and that of the patient 2L.

Figure 2: $(\theta^h = 3, \theta^l = 1.2, r = 1.5, s = 0.3, D = 0.04rw)$ [a]



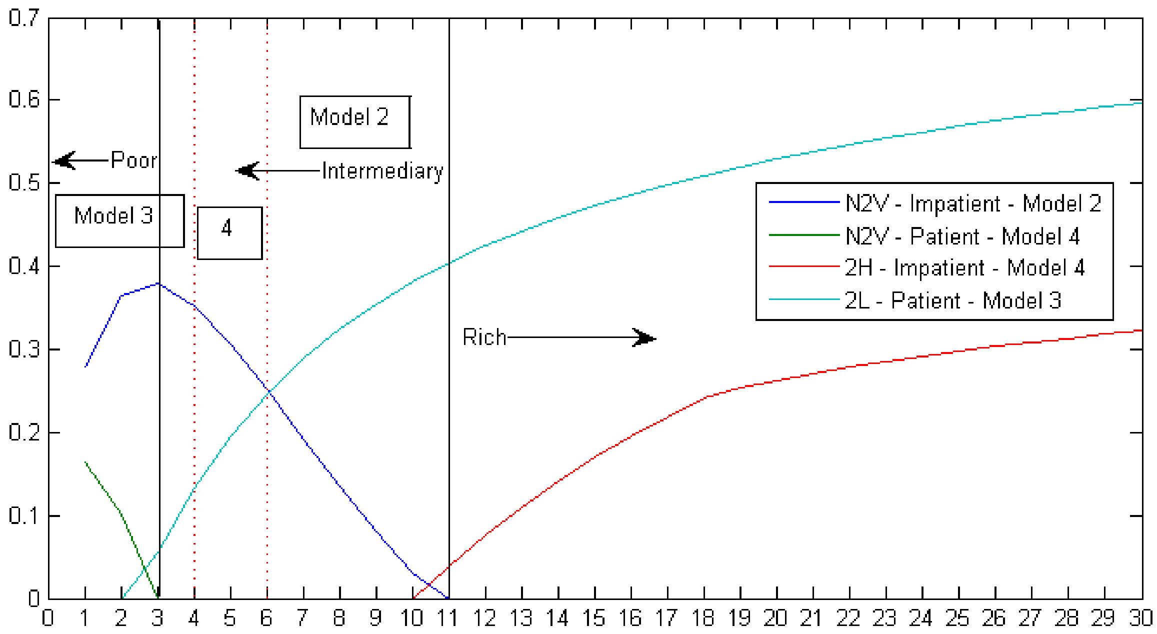
[a] The solid black line indicates the transition from poor to intermediary and rich wealth levels; the dashed red line indicates the end of an optimal role for a model, which is shown in the small boxes.The drawn functions are the values of the Kuhn-Tucker multipliers of the restrictions. In the figures we call the no binge restrictions N2V, the binge restriction of the impatient 2H and that of the patient 2L.

Figure 3: $(\theta^h = 3, \theta^l = 1.2, r = 1.5, s = 0.5, D = 0.06rw)$ [a]



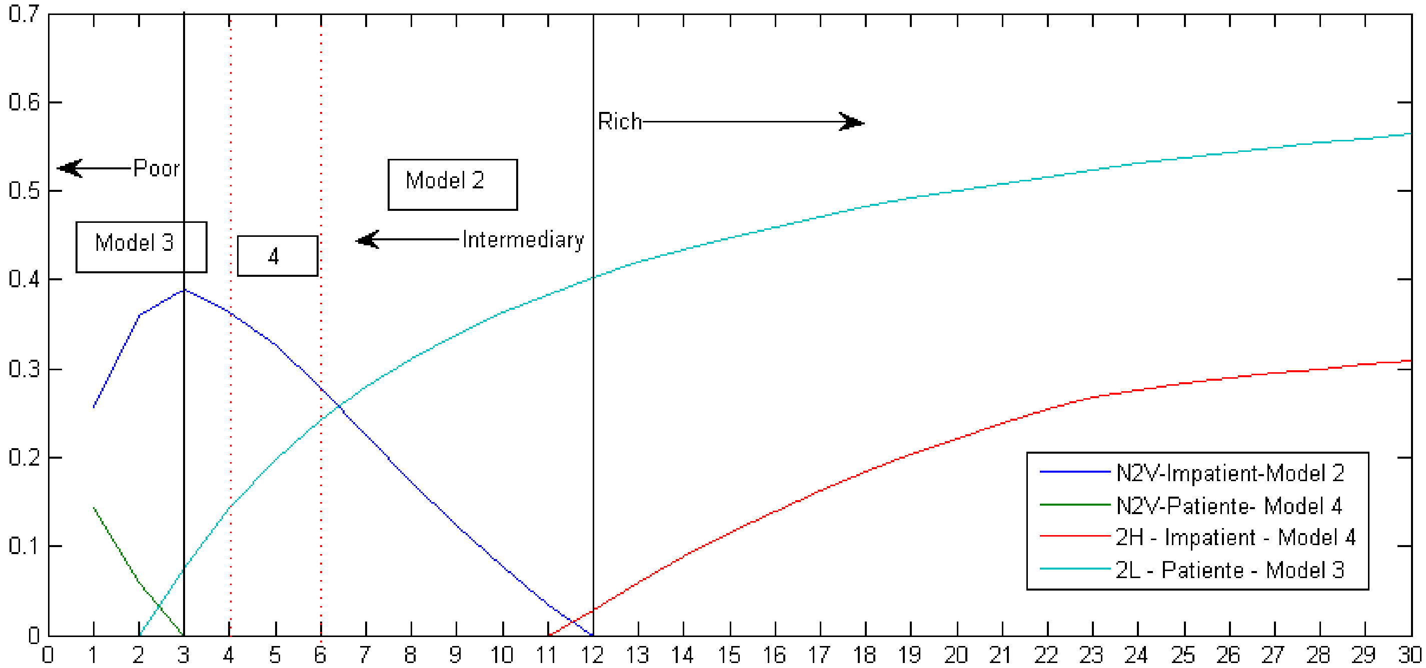
[a]The solid black line indicates the transition from poor to intermediary and rich wealth levels; the dashed red line indicates the end of an optimal role for a model, which is shown in the small boxes.The drawn functions are the values of the Kuhn-Tucker multipliers of the restrictions. In the figures we call the no binge restrictions N2V, the binge restriction of the impatient 2H and that of the patient 2L.

Figure 4: $(\theta^h = 2.5, \theta^l = 1.2, r = 1.5, s = 0.1, D = 0.02rw)$ [a]



[a] The solid black line indicates the transition from poor to intermediary and rich wealth levels; the dashed red line indicates the end of an optimal role for a model, which is shown in the small text boxes.The drawn functions are the values of the Kuhn-Tucker multipliers of the restrictions. In the figures we call the no binge restrictions N2V, the binge restriction of the impatient 2H and that of the patient 2L.

Figure 5: $(\theta^h = 3, \theta^l = 1.5, r = 2.25, s = 0.1, D = 0.02rw)$ [a]



[a]The solid black line indicates the transition from poor to intermediary and rich wealth levels; the dashed red line indicates the end of an optimal role for a model, which is shown in the small text boxes.The drawn functions are the values of the Kuhn-Tucker multipliers of the restrictions. In the figures we call the no binge restrictions N2V, the binge restriction of the impatient 2H and that of the patient 2L.

1.7 Discussion and Conclusion

As already stated, an optimal role for all types of economies is motivated in this kind of model by equally divided in highly impatient and highly patient agents , and the actual values of the parameters make more sense in longer horizons of time. It is a simple environment where round-about production without bank runs, but with imperfect monitoring of early withdrawals, allows an interplay between fraud and the flexibility and costs of means of payment.

An example that is far removed from the present historical and institutional setting may illuminate the issue. The first usage of metallic money in Ancient Rome was made feasible by the weighting of metal ingots by merchants.[2] It was at the time a cumbersome and costly method, comparable, for example, with the usage of drafts in the USA of the nineteenth century, but it prevented fraud. The discovery and practice of coinage was an advance in this respect, and worked by establishing an abstract system of valuation linked to the real weight of coins. With it commerce could be exercised in a speedier and more economical way. But coinage was also costly for almost all individuals, and the only agents able to cover these costs and establish a coinage in a significant geographical zone were the sovereign powers of the time. For them, coinage was relatively costless, even more if we add the possibility of fraud and manipulation that it opened. Sovereigns could obtain *seigniorage* by slowly depreciating the weight of coins, establishing a temporary discrepancy between the real quantity of coins and the nominal value they carried. For merchants coinage introduced much more flexibility , but submitted them to “binging” behavior by the sovereign power and its clients. Isolated individuals could be generally prevented from dilapidating coins by harsh punishment and the costs of forgery, but the sovereign could never commit to punish itself. This lack of punishment for bingers can be directly related to the process of inflation and decay that plagued the late Roman Empire. We could say that this was a context of a “check” economy, where future returns (in this case taxation of a richer economy) could only prevent binging coupled with a limited, but harsh enough punishment. The separating allocations could be related to the period before the usage of metallic money, where economies were very poor, trade restricted, and local means of payments that resembled fiat tokens could possibly have been used. The advantage of any mean of payment that improved on pure barter was such that the limited costs of fraud were not a problem.

Another example of this can be seen in colonial America, where paper money(and other “tokens”), highly prone to fraud, preceded the establishment of a stabler metallic money system, later of a fractional reserve system of bank notes and deposits on top of this metallic reserve, and finally of a pure fiat money system. Of course this shows that this historical development can begin anew with a new set of institutions, means

[2]See Groseclose(1976) [25] p.11 to 21 for a narrative of the birth of metallic money and coinage in Greece and the consequences there and p.28 to 45 for the parallel development in Rome

of payment technology and levels of wealth, and display non-linearity and many layers. The important point is the changing relation between costs of monitoring, liquidity preferences, future real returns and the possibility of discovering binging and enforcing punishment for it. If in a certain political-economical arrangement (which was previously in a "check" economy), for example, a considerable number of agents gain the ability to binge without punishment and even discovery, then the reintroduction of a costly but immune to fraud payment instrument may prove again feasible, or it may even happen that the decay and impoverishment produced by this behavior may lead society to a form of binge-economy or barter, as was the case in the Middle Ages just after the fall of the Roman Empire.

The model suggests that it is optimal to tolerate(in the sense of not needing to arrange enough future consumption to the impatient agent to prevent binging) payment fraud in poor societies or classes, if there is enough future punishment for the behavior . But in rich economies and classes, with a developed law system, punishment and the promise of future consumption should be enough to deter binging. This contrasts with the stylized facts of the financial crisis of 2008. If we consider that the rising levels of debt/GDP, with decreasing effects on real growth, and the multiplication of money substitutes indicate binging behavior in rich economies, this would suggest a lack of punishment and not the optimality of a binge-economy, which applies to poorer societies. In this case the "bingers" would be both the financial institutions that created and profited from excessive liquidity and the individuals that used this sources of purchasing power in a way that was truly incompatible with their present real resources and future wealth. The existence of multiple checks in the model would be akin to the mountains of re-hypothecation and all types of refinancing on top of a relatively stable pool of real collateral, and the problem of punishment would call into question the legality and optimality of many of these operations. Nonetheless, and as already stated, the model suggests that *ex-post facto* recognition of binging coupled with severe punishment should be enough to deter the behavior in rich economies if this outcome is clearly enforceable.

Another point is that in the model the real return of the economy is a determined and known data. In it, if the rate of return is raised closer to θ^h the welfare optimizing range of the check economy increases significantly. In reality, it is not absurd to imagine that agents can develop excessively optimistic beliefs about future returns, and these would have for some time an effect similar to an increase in the real rate. Agents will then believe that the increase in both present consumption and investment plans is sustained by a more productive economy, while in fact it is only the effect of binging behavior not limited by a sufficient threat of punishment. Aside from this possible historical context for the model, the welfare simulation clearly establishes a role for fraud in payment systems, especially in poor economies as defined in PW. This contrasts with the result that a draft economy would be optimal for poor wealth levels and a check economy for

richer levels.

We believe the conjunction of the model with the historical examples displays the strength of studying the relation between means of payment, production and consumption as an interplay between flexibility and costs from one side and fraud on the other. Impatient agents have an strong incentive to use the possibility of fraud open by flexible and costless instruments of payment if they have the ability to do so. As the example of Ancient Rome affirms, one of the main problem lies in the conjunction of more flexible means of payment with agents that can elude or block any enforcement of punishment for fraud. The richer the society, the more welfare-reducing is binge behavior, even with harsh punishment in the future. The main focus resides in identifying what is a binge behavior (harder with the new complexity of financial instruments), who are the possible bingers in the economy and if there is a feasible enforcement of punishment for this group of society. If the possible bingers are located amongst the most powerful elements of society, than a situation where punishment becomes less feasible may be the norm, and increased monitoring of payment instruments may turn optimal for rich economies.

2 Chapter 2 - Quantitative properties of an early-warning system for financial crises

2.1 Introduction

We propose a set of variables that we consider to be the most parsimonious statement of a boom and bust view of banking crises[3], in agreement with Borio and Dhremann(2009): growth in equity and housing prices, the difference between the short-term and the long term interest rate and the growth in total assets of the banking system. The focus is on their ability to signal a banking crisis with one year of anticipation in a complementary log-logit specification with annual data. This kind of model is a discrete-time counterpart to the continuous time proportional hazards model. In this context the hazard rate is the probability of entering a crisis during the next year conditional on survival until the present. Our panel includes 18 industrial economies from 1984 to 2007. We deal with the cumulative impact of the variables and heterogeneity between countries by transforming all variables to three-year moving averages and by standardizing with the country specific mean and standard deviation. We find evidence that a relatively flat yield curve and rapid growth in banking system assets and real asset prices are associated to the onset of a banking crisis. Accounting for an increasing risk associated

[3]This boom and bust view of banking crises has been historically advocated by the Austrian School of Economics. In appendix 1 we delineate the main elements of this view and a historical episode where an increasingly elastic banking system led to ever greater banking crises, even in a context of real economic growth and low inflation/deflation. Elastic in here means two things: continuous injection of reserves in the banking system (in a context of pure fiat money) and a process of economy of reserves, trough financial innovations that increase the credit expansion possible on top of a certain amount of reserves

with times of tranquility also proves to be informative. Out-of-sample prediction using a model estimated only with data from 1984 to 1997 shows that it could have pointed out a great increase in crisis probability starting in 2006 for almost all of the countries that later entered into a crisis. The results in terms of correctly indicating crises and avoiding false positive signals is significantly better than other papers in the literature.

After the Great Depression and the Second World War the world lived in an environment of financial repression[4] and trade protectionism. The liquidity creation capability of the banking system was turned to direct absorption of government debt and the financing of government enterprises. Typical of this era were the huge direct loans to national governments. A whole new framework of national and international institutions arose to regulate and protect the flow of these funds. It appeared that the boom and bust phenomenon that had plagued the development of almost all modern banking systems had been stopped, or at least reduced. As Bordo et al(2001) [2] shows, this period saw a virtual extinction of country-wide and international banking crises.

When the Keynesian prescriptions of an active fiscal and monetary policy reached their limits in the rise of inflation and severe recession of the 1970's, a consensus slowly developed that state intervention in the economy had gone too far, and that the time was ripe for privatizations and deregulation. This consensus reached national banking systems in developed economies when the default of sovereign loans in emerging economies during the 1980's generated great fragility in almost all of them. The alternative chosen to increase the profitability of banks was to deregulate deposit and loan markets, opening up new possibilities of liquidity creation. This new liquidity would go on to support the development of capital markets and the rise of private debt. A whole culture of small debt loads that had been developed since the Great Depression was gradually replaced by the view, for example, that debt and equity were equivalent in the financing of a firm. As soon as this process of financial liberalization took hold, systemic banking crises returned in both developed and emerging economies. A parallel development was the increasing establishment of explicit deposit insurance, implicit guarantees of rescue measures in the event of a crisis and inflation-targeting policies.

The first attempts at early warning systems for these systemic crises focused on three main concepts: the interaction between the adjustment to a liberalized system and moral hazard; the sudden stop of capital flows; and the quality of institutions, especially in poorer economies. The idea was that the first steps towards financial liberalization explained the crises in developed economies during the 1980's, while the continuing advent of theses crises in emerging economies during the 1990's was also due to the low quality of law and order institutions and sudden stops of capital coming from developed economies. They studied all kinds of countries together and the lack of data availability

[4]Reinhart and Sbrancia(2011) [40] define financial repression by the following measures: regulation of interest on deposits and government debt; strong government ownership in the banking sector coupled with high barriers to entry; high reserve requirements; a synthetic market for government debt, achieved trough capital requirements; and capital controls

for asset prices in developing and poor economies led to the negligence of this kind of information. Representative of this view are Demigurc-Kunt and Detragiache(1998, 2005) [15] [16], Kaminsky and Reinhart(1999) [38] and Davis and Karim(2008a,b) [13] [14]. Davis and Karim(2008b) showed that these models failed to signal the sub-prime crisis in the United States and the United Kingdom.

But a different view started to gain ground after the burst of the dot-com bubble in the 2000's, especially in a series of papers from the staff of the Bank for International Settlements, led by William White and Claudio Borio[5]. In an environment of liberalization, extensive protection to the financial system and positive supply side-shocks(like the opening and integration of communist countries in the world economy), inflation-targeting produced excess elasticity in credit creation. This allowed boom and bust cycles to develop without significant oversight from monetary authorities, for they only reacted to short-term inflation pressures. Banking crises were the result of this build-up of financial imbalances, and not only of a period of adjustments to liberalization. This is also essentially the view developed by the Currency School [6] after observing bank panics during the nineteenth century and elaborated by the Austrian School of Economics in conjunction with the banking crises that swept the world in the 1930´s.[7] The focus is always on the boom-phase, where financial imbalances are created, and not the bust where the crisis is materialized.

2.2 Literature Review

Caprio and Klingebiel(1996) [10] were the first to develop a consistent database of banking crises around the world since the late 1970's. Crises were defined mainly by an appeal for the judgment of finance professionals an researchers. Demirgurc and Detragiache(1998) [15] builds a data-set that runs from 1980 to 1994, where they try to establish a more clear-cut distinction between systemic and lesser crises, by judging the severity of a crisis by the extension of the emergency measures used after it and the ratio of of non-performing assets in the banking system. They them estimate the probability of a banking crisis using a multivariate logit model with a crisis dummy based on this dataset. The chosen explanatory variables try to capture macroeconomic shocks that affect non-performing loans, the progress of financial liberalization, external terms of trade and the exposure to foreign exchange risk, the financing needs of of central government, the liquidity of the banking system, deposit insurance arrangements and the quality of the legal system. The specification with the best performance in signaling crises has the following explanatory variables as the most significant: $\frac{M_2}{Reserves}$, Credit Growth(lagged by two periods), real GDP growth, the real short-term interest rate, in-

[5]See Borio and White(2004) [4], Borio and Lowe(2002a,b) [6] [5], White(2006) [52], White(2012) [53]

[6]See Vera Smith(1937) [45], pp. 71 to 91 and 132 to 145

[7]See Machlup(1940) [34], Robbins(1971) [41] and Philips, Mcmanus and Nelson(1937) [36]

flation, and explicit deposit insurance(increasing the risk of a crisis). Kaminsky and Reinhart(1999) [38] studies the link between currency crises and banking crises. They track the deviations from the average in times of tranquility of a series of macroeconomic and financial variables in a window of time just before crisis occurrence. The following causal sequence is shown as the most probable for the relationship above: the country starts a process of financial liberalization that leads to a banking crisis; later comes a currency crisis that deepens the previous banking problems. One important difference between currency and banking crises is that the real sector plays a much larger role in the last ones. Output and stock prices send early signals in more than 80 percent of theses crises. In both types of crisis the variables indicate that a financial shock, like financial liberalization or increased access to international capital markets, starts a boom and bust cycle due to easy financing. Bordo et al(2001) [2] questions the sufficiency of the financial liberalization for explaining banking crises by showing that a historical period of liberalization as the one from 1880 to 1913 had a small incidence of them. After a disappearance from 1945 to 1971 in developed economies, banking crises have returned with an increasing frequency and severity.

Borio and Lowe(2002a) [6] focus their attention in the relationship between credit aggregates, equity prices, property prices and banking crises from 1960 to 2002, using the deviations from trend of the explanatory variables to test their signaling ability. The central idea is that in a economy that passes trough positive supply side shocks and strong real economic growth the limitations put on credit growth by inflation stabilization measures is very small. Inflation can remain very low, while credit expands very fast, producing asset bubbles and excessive risk-taking. They discern a longer financial cycle in the credit and asset variables and the composite indicator of credit and asset prices was able to signal an important number of banking crises. Davis and Karim(2008a) [13] studies the performance of previous early warning systems in predicting the sub-prime crisis. The banking crisis dummy is taken from Demigurc and Detragiache(2005) [16], an updated estimation of the model in Demigurc and Detragiache(1998) [15]. The data is divided in a 1979-1999 sample for all countries and a 2000-2007 sample for the USA and the UK, both used for out-of-sample prediction. The estimated logit model has a poor performance out-of-sample: for the USA crisis probability increases in previous years, specially close to the end of the dot-com bubble, but reaches its lowest level in 2007; for the UK crisis probability is also at its lowest level in 2007.

Reinhart and Rogoff(2009) [39] extends the database of banking crises in Bordo et al(2001) from 1800 to the present. They stress the relationship between international capital account liberalization and the return of banking crises in the 1970's, and also between this type of crisis and a high incidence of sovereign defaults of external debt. Moreover, banking crises are as frequent in advanced economies as in emerging markets. Finally, the two studies closer to ours are Borio and Drehmann(2009) [7] and

Barrell, Karim and Liadze(2009) [1]. The first one mainly because their sample of 18 industrial countries is the same as ours(for the same motive of data availability) and the explanatory variables are very similar. In itself it is a review of the out-of-sample performance of the indicators in Borio and Lowe(2002a,b) for the period between 2004 to 2008. The indicators that include property prices display the best performance in signaling crises, while producing a low number of false signals. Barrell, Karim and Liadze(2009) return to the multivariate logit technique. It uses a smaller data-set of 14 industrial economics. They test the most significant explanatory variables in Demirgurc and Detragiache(1998,2005) against three new ones: liquidity ratio (ratio of the sum of cash balances with central banks and securities for all banks over end of year total assets of banks), unweighted capital adequacy ratio and real property price growth. The data-set was divided from 1980-2006 for in-sample estimation and 2007 for out-of-sample prediction. The traditional variables all proved too be insignificant, and the final specification with the new variables has a good performance in-sample and is able to signal most of the crises in 2007.

2.3 Crisis Database

The data set includes 25 systemic and non-systemic banking crises in 18 developed economies from 1984 to 2008. These countries were chosen because of the relative homogeneity in terms of institutions and the availability and reliability of information concerning asset prices and interest rates. Crises dates and durations were based on Laeven and Valencia(2012) [50], Caprio and Kinglebiel(2003), Reinhart and Rogoff(2009) and Borio and Dhremann(2009). The first divides systemic and non systemic crises by the following criteria:

1. Extensive liquidity support (5 percent of deposits and liabilities to non residents)
2. Bank restructuring gross costs (at least 3 percent of GDP)
3. Significant bank nationalizations
4. Significant guarantees put in place
5. Significant asset purchases (at least 5 percent of GDP)
6. Deposit freezes and/or bank holidays

A crisis is considered systemic if three of these interventions happened and borderline cases if only two. This database has the merit of giving a more quantitative definition of a crisis, but the problem of defining crises by intervention measures. Caprio and Kinglebiel(2003) define a systemic crisis as an episode where much or all of capital of the banking system was exhausted. They also use judgment and expert opinion where there is a lack of data on the size of losses. It also includes data on borderline and lesser

crises. Reinhart and Rogoff(2009) uses a series of sources with qualitative and quantitative definitions to build their historical database, while Borio and Dhremann(2009) chose the following two distinct definitions:

1. Countries where the government had to inject capital in more than one large bank and/or more than one large bank failed.

2. Countries that undertook at least two of the following operations: issue wholesale guarantees; buy assets; inject capital into at least one large bank or announce a large scale recapitalization program.

We use the criteria of studying the maximum number of episodes where quantitative and qualitative definitions pointed to significant distress in the banking system. Our dataset includes all the crises encountered in these sources for this period and these countries. Judgment was used to arbitrate between a few cases where crisis inception and duration differed between sources. We also document these sources and choices with detail in appendix 2. The build up of risk usually reaches its apex before the start of any emergency measure or visible crisis state. We call this apex a crisis onset phase and identify it with the year before the dating of the crises in the datasets above. The value 1 in our banking crisis dummy is located in this year, and estimation results should be interpreted as signaling a crisis in the next year.

2.4 Variable Selection

We chose our main variables in order to capture a boom and bust view of banking crises. This view states that these crises are the final outcome of severe business cycles caused by credit expansion. It was mainly developed by the the Austrian School of Economics, and in appendix 1 we provide a more detailed description of this conception and also a historical narrative of the development of banking in the United States as a sequence of evermore elastic banking arrangements followed by more severe crises until the Great Depression. Here we display a succinct collection of stylized facts connected to this view:

1. The beginning of the boom: The central bank sets an interest rate below the one which would make real savings proportional to the structure of projects of production and present consumption. This rate is sustained mainly by reserve injections trough open market operations. This initial phase displays the following features:

   (a) A steep yield curve. The short-run the demand for loanable funds is more inelastic than than long run, mainly because there are few real investments that will yield a return in a short time. Besides this, the increasing supply of credit for long run-investment is balanced by a rise in inflation expectations. Short-run interest rates fall much more with a injection of reserves, and the

long run rates may even remain stable. This steep yield curve gives an incentive for the financing of long-term investment with short-term funds, that is, maturity mismatching.

(b) An unsustainable structure of production. Lower interest rates trough credit expansion makes longer-term investment projects relatively more profitable in comparison with other maturities, while also reducing the incentive for real savings. If we, somewhat artificially, divide the productive structure in a sector closer to final consumption and another one of capital goods, raw resources and construction, it is reasonable to assume that in the second sector there will occur more instances of these long-run projects. The demand for the new loanable funds will come mainly from this sector, and the initial credit expansion will manifest itself as a huge increase of fixed capital formation in the second sector and also and a boom in raw material prices and wages in it.

(c) A rise in asset prices. Lower interest rates and credit expansion also leads to a rise in asset prices, which increases the nominal value of the collateral available in an economy.

2. In the expansion of the boom the central bank keeps on injecting reserves, while banks and the financial system search for innovations that increase the real bank money multiplier, allowing a continually increasing credit expansion. This phase has the following features:

    (a) Increasing competition for maturity mismatched short-term funds in production. As the initial credit expansion reaches the hands of the original factors of production (land and labor), this new purchasing power increases the demand for consumption goods. The profitability and the income of the sector closer to final consumption rises, allowing it to compete for factors of production and loans. And the entrepreneurs in highly irreversible long-term projects are willing to pay higher rates for maturity mismatched loans as long as the present value of the projects is positive. This competition for short-term funds to invest in the long run will contribute to a gradual flattening of the yield curve, even as the credit expansion accelerates.

    (b) A speculative moment in asset markets. The continued rise in asset prices attracts those who wish to speculate in short/medium run capital gains. The rise in the value of a portfolio is by itself collateral to sustain an increased demand for loanable funds. These speculators also have an incentive to accept higher interest rates for funds as long as they expect rising capital gains. There is also an wealth effect for households: unrealized capital gains serve as collateral for financing an increase in present consumption.

(c) Increasing competition for deposits in financial markets and the search for yield. This can be seen in the rise of the shadow banking system in the last decades. More and more financial institutions start to act like banks: they promise immediate liquidity in exchange for funds that act as reserves for maturity mismatched investment. These institutions compete with the traditional banking system by offering higher returns on deposits, contributing for the tendency of a flat or inverted yield curve.

3. In apex of the boom the credit expansion is close to its maximum limits, with a significant rise in consumer price inflation and the first signs of fragility in the banking and financial sector. In this point of time record rates of growth of asset prices and bank's balance sheets coincide with a flat or even inverted yield curve.

4. The collapse of the boom is either ignited by a contraction of the central bank to fight inflation or by problems in the real economy (or by both). Even without an intervention of the central bank there is a manifest tendency for much higher interest rates. This phase has the following features:

   (a) Collapse of investment projects. Rising interest rates finally reveal the degree of distortion in the productive structure. There is a marked increase of non-performing loans in the banking system as consequence.

   (b) Fire sales in asset markets. The scarcity of loanable funds lowers the demand for assets available in the market and this leads speculators to attempt selling their assets to reap at least some capital gain, collapsing even further asset prices. As this happens, the previous collateral base for credit expansion evaporates. Firms and households will attempt to reduce their debt loads, making it difficult for the banks to renew expiring loans.

   (c) A generalized risk aversion and distrust over the safety of future real returns in the asset side of the balance sheets of banks. If the previous credit expansion crossed a certain threshold it will be very hard for the banking and financial system to avoid a systemic crisis. All the above factors contribute to a sudden collapse in the bank money multiplier, with one bank and financial institution after another recalling their enforceable assets (mainly margin calls in highly leveraged financial markets) in other institutions. The public may also start a bank run, out of fear for the availability of bank money. Usually central banks and governments rescue banks and the financial sector, but the reality of the crisis can be measured by the magnitude of the emergency measures and the impact on real economic activity.[8]

[8] The accelerating and self-reinforcing nature of the collapse has been well described and studied in the literature on credit and leverage cycles. See Kyotaky and Moore(1997) [32] and Geanokoplos(2010) [22].

In agreement with this view we chose four variables to capture the behavior of asset prices, credit and the yield curve:

1. Real growth in equity and housing prices
2. The yield spread between the 10-year government bond and the 3-month interbank rate
3. The growth in total banking system assets.

Two traditional variables are also included: GDP growth and consumer price inflation. Variables and their source are described in table 1. The ideal is to capture the last step of a credit boom. A simple three-year moving average has information on the cumulative change in variables, but is also sensitive to one-year jumps in the variables. As both the cumulative impact and the impact of outliers variations should be important, each data point $x_{i,t}$ for country i and time t is recast as:

$$y_{i,t} = \frac{x_{i,t}+x_{i,t-1}+x_{i,t-2}}{3}$$

This transformation was used by Bordo and Jeanne(2002) [3] to identify boom and bust cycles in OECD countries. They restrict their attention to stocks and real state, but as shown above we also measure the spread and the growth in banking system assets with the same transformation. The choice of the 10 year - 3 month time horizon as a proxy for the yield curve is based on the results of Estrella and Mishkin (1996) [19] and Estrella and Hardouvelis(1991) [20]. They show that the spread between the interest rates on the ten-year Treasury note and the three-month Treasury bill is a reliable forecasting tool for U.S recessions. As recessions are connected to banking crises trough business cycles, we assume that this variable may prove to be also informative for forecasting these crises. Cwik(2004) [12] contains a good overview of the literature investigating the link between yield curve inversion and real economic activity. Calomiris and Gorton(1991) [24] and Gorton(1988) [23] both provide the evidence for a link between business cycles and banking crises in the American economy of the nineteenth century. The OECD database, our main source for these interest rates, usually collects the interbank rate for the 3-month time horizon, and we accept this rate as a good proxy for 3-month government bills in all the countries studied. For the 10 year time horizon they collect they collect the yield on government bonds with this maturity.

Heterogeneity in the variables between countries is dealt by standardization using the country-specific mean and standard deviation for each estimation. The exception is the real housing price. This variable displays much less variability inside each country

Table 1: Variable Description

Variable	Description	Type*	Lag*	Transformation*	Source
Spread	10 year - 3 month	New	no-lag	3-year MA,Std	OECD,IMF,FRED
House Index	Real house price growth(%)	Literature	1 year	3-year MA,Std,Threshold	Dallas Fed,Case-Shiller
Equity	Real equity price growth(%)	New	1 year	3-year MA,Std	OECD,IMF,FRED
Bank Assets	Growth in totalassets(%)	New	1 year	3-year MA,Std	OECD, FRED
GDP	Real GDP growth(%)	Literature	1 year	3-year MA,Std	OECD
C.P.I	Inflation	Literature	1 year	3-year MA,Std	OECD

Note*: The type refers to the variable being already used in the early warning system literature. Lag is from the crisis dummy that is already lagged by one period from actual crisis date. MA in Transformation refers to moving average; Std to standardization and Threshold to the establishment of a binary dummy based on a threshold crossing. The only extrapolation is that of equity price growth and interest rate data from 1980 to 1984 for a few European countries. For all of them there was data available for very similar countries, and we took the most recent data and hypothesized that in the years before the trajectory of the data was the same as that of similar countries (for example: Nordic countries).

than equity prices, and in Germany and Switzerland it displayed negative growth almost during the whole period in the study. For this reason we standardize based on the sample mean and standard deviation. As it also trends upward during longer periods, we built a dummy variable that takes the value 1 when the standardized variable crosses the threshold of 0.84 standard deviation. If the standardized variable keeps on increasing the signal is kept, and if it decreases the signal is kept for the next two years, vanishing afterward. This captures an accelerating but longer growth process, also including the next two years after the peak as a signal. The list of housing price booms achieved by this method is very similar to Bordo and Jeanne(2002). A expanded data set from 1980 to 2007 is used to insure that the moving average variable can be calculated for 1984, the first year in the estimation.

To reduce the problem of information availability, especially for housing prices, all variables, except the yield spread, are lagged by one period. This means, for example, that at the end of 2006 or beginning of 2007 the information needed for making a prediction about crisis probability in 2008 should have been available.

2.5 Descriptive statistics of main variables

Descriptive statistics for the boom and bust variables are displayed in tables 2 and 3. We also display the behavior of the average for all countries of each variable in figure 6. T All variables are measured in standard deviations. In the graph we highlight three points in time: 1989, 1999 and 2006. They are exactly two years before the two points of time with the greatest concentration of nearby crises(1991 and and 2008) and the burst of the dot-com bubble. We do this because our variables, except the spread, are actually lagged two periods from crisis occurrence. As they are all 3 year moving averages, behavior from the previous two years is also incorporated. For 1989 the graph reveals that it coincides with a peak in the housing market for this group of countries. Equity had peaked before, close to 1987 and the crises in Norway, Denmark and the United States. But 1989 is also the point of peak growth for the balance sheets of the banking system, and the tendency for an extreme inversion of the yield spread is already established.

All variables reach their low point around 1994, and from there they start a rapid recovery. A very steep yield spread becomes the norm around 1996 and is accompanied by a rapid rise in equity prices. Growth in balance sheets and house prices also trend upward, but in a much slower pace. The flattening of the spread reaches its maximum in 2000, and equity price growth declines abruptly after this, while the rate of expansion of balance sheets is also decreased. Curiously, the housing market kept its upward trend in face of this. The recovery of the yield spread reaches a maximum steepness in 2003, and from there on the rate of growth of equity prices and balance sheets starts to increase very fast reaching a peak in 2006 and 2007 respectively. The growth of housing prices reaches a peak in 2004, but it is maintained until 2007, and the yield spread flattens again close to 2007.

Table 2: Descriptive Statistics 1984-1997

	Share Prices		Bank Assets		Spread		House Prices
Country	Mean	S.D	Mean	S.D	Mean	S.D	Treshold
Australia	3.19	9.22	12.87	4.99	0.02	1.66	5.85
Belgium	2.90	6.19	7.77	2.37	0.63	1.06	5.85
Canada	2.62	6.75	7.86	2.71	0.58	1.33	5.85
Denmark	4.84	6.59	8.44	8.78	-0.22	1.31	5.85
Finland	10.63	19.20	11.10	10.49	0.52	1.39	5.85
France	7.19	9.06	5.00	2.57	0.71	1.10	5.85
Germany	6.57	9.20	8.50	1.70	0.85	1.22	5.85
Italy	2.70	14.87	7.16	5.00	0.07	0.97	5.85
Japan	5.23	15.40	7.43	6.36	1.86	0.39	5.85
Korea	8.16	21.69	14.35	4.22	-1.44	0.31	5.85
Netherlands	10.38	7.64	9.79	4.66	1.05	1.16	5.85
New Zealand	0.98	15.38	17.88	11.73	-1.66	1.69	5.85
Norway	7.89	9.82	9.90	8.05	-0.25	1.00	5.85
Spain	4.89	14.77	11.86	3.12	-0.32	0.99	5.85
Sweden	11.82	12.65	9.22	6.41	0.33	0.97	5.85
Switzerland	6.94	8.29	6.98	2.46	-0.38	1.15	5.85
United Kingdom	7.45	5.29	13.21	13.03	-0.10	1.45	5.85
United States	7.16	4.74	4.88	3.46	1.33	1.00	5.85

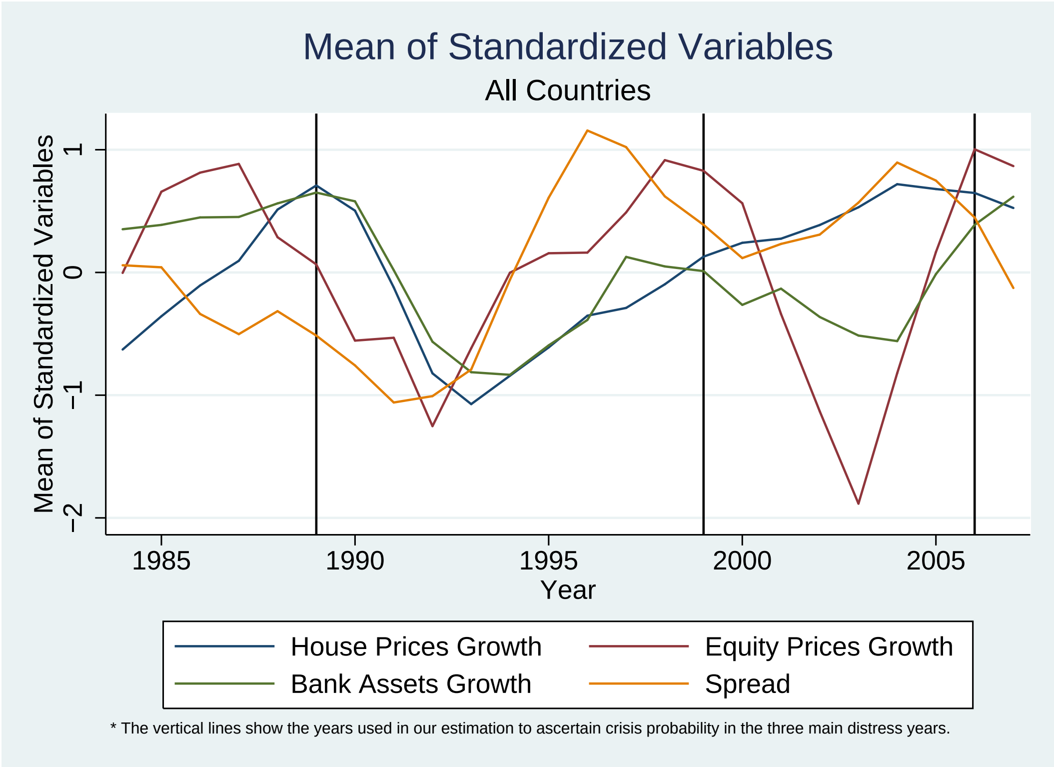
Note: All values are growth percentages , except the spread which is the level of the actual spread

Table 3: Descriptive Statistics 1984-2007

	Share Prices		Bank Assets		Spread		House Prices
Country	Mean	S.D	Mean	S.D	Mean	S.D	Threshold
Australia	4.13	8.03	11.90	4.06	0.16	1.32	7.38
Belgium	4.29	10.15	6.81	3.12	0.91	0.94	7.38
Canada	3.97	7.48	8.56	4.06	0.83	1.15	7.38
Denmark	6.48	8.48	9.72	6.94	0.35	1.29	7.38
Finland	10.87	21.12	9.92	8.42	0.87	1.20	7.38
France	6.88	11.88	5.83	3.86	0.93	0.94	7.38
Germany	5.52	12.39	7.08	3.27	0.99	1.01	7.38
Italy	4.07	15.18	7.18	3.87	0.49	0.98	7.38
Japan	3.09	13.55	4.38	6.05	1.61	0.44	7.38
Korea	5.67	18.94	13.87	3.93	-0.19	1.26	7.38
Netherlands	7.25	12.97	10.85	5.12	1.15	0.94	7.38
New Zealand	0.67	12.02	13.94	10.05	-1.10	1.58	7.38
Norway	8.88	11.98	10.84	6.57	-0.01	1.00	7.38
Spain	6.49	14.79	11.80	3.37	0.28	1.09	7.38
Sweden	10.00	14.28	9.91	5.38	0.80	0.96	7.38
Switzerland	6.65	10.81	6.94	3.74	0.35	1.29	7.38
United Kingdom	5.17	8.37	12.58	9.94	-0.12	1.15	7.38
United States	6.15	6.97	5.95	2.95	1.18	1.02	7.38

Note: All values are growth percentages , except the spread which is the level of the actual spread

Figure 6



The graph by itself suggests that the mild nature of the financial crisis in 2000-2001 was related to lower rates of credit expansion compared to the years before 1991 and 2008. The rapid growth of housing prices in the mid of a bust probably indicates a great relocation of money from stock exchanges and other investments to it, and strong policy and legislative incentives to do this. But in the end low short-term interest rates seem to have created a conjunction of very high growth in housing and equity prices, driven by expanding balance sheets and extreme maturity mismatch. And our measure of bank assets can capture only indirectly what was going on the shadow banking system. The rates of expansion of total credit in the global economy were probably much higher than what is displayed in this graph.

2.6 The Model

For the estimation we use a discrete time specification[9] for a continuous time proportional hazards model. This specification uses a complementary log-logit link function. This link function is more adjusted to the nature of our crisis database and also displayed better results since the first estimations. The adjustment is due to the yearly dating of cri-

[9] See Jenkins(1995,2005) [28] [29]

sis. This is adequate because its very hard to discern the actual date of crisis inception, even more knowing that the database is defined by emergency measures that presuppose a full-fledged crisis. Our dataset has the nature of grouped survival data, and according to Jenkins(2005), the discrete time analog of a continuous time proportional hazards model is the most fit for this kind of data when the proportion between the length of the grouping interval and the typical spell length is relatively high . The hypothesis of an increasing base line hazard agrees with the idea of highly elastic banking systems subject to moral hazard accumulating risk over time. We can introduce this restriction in the model with a log function specification for survival time, which is equivalent to a Weibull model in continuous time. The hazard is a conditional probability restricted to the interval [0,1], and denotes the probability of moving to a crisis on t+1 conditional on being in a tranquil state until period t. The complementary log-logit hazard function for a single observation in period t can be written as:

$$\text{h(t)} = 1 - \exp[-\exp(x(t)'\beta_1 - \phi(t)\beta_2]$$

Where x_t is a vector of time-dependent variables, β_1 a vector of corresponding coefficients, $\phi(t)$ the function that represents duration dependence and β_2 its coefficient. The contribution to the log likelihood by the i^{th} observation, which fails or is censored in time j is:

$$\text{L}_i(\theta) = d_i \ln(h_i(j)) + \sum_1^{j-1} \ln(1 - h_i(t))$$

θ is the set of parameters to be estimated and $d_i = 1$ if there is a transition to a banking crisis state and 0 if there is no transition. To account for duration dependence the data is divided in spells of tranquility that end with a single failure or censoring. We consider that the process of financial liberalization which started in the beginning of the 1980's, coupled with the consolidation of a series of explicit and implicit arrangements of deposit insurance and "too big to fail", greatly increased the possibilities of liquidity creation and risk taking by the banking system. Because of this we postulate the first year in our estimation, 1984, as the beginning of risk onset for all countries. If a country enters a crisis, the data for the duration of the crisis is expelled from the estimation, and after its end a new spell of tranquility begins with a duration count of 0. This means that the base-line hazard function does not depends upon previous entries into crisis and also on the number of these entries.

We have a full data-set from 1984 to 2007 and another divided from 1984 to 1997 and from 1998 to 2007. The full dataset is used for an estimation that could be used from now on for monitoring crisis probability. The divided dataset is used for estimation and out-of-sample prediction. This allows a study of the behavior of the explanatory variables if they had been used to signal a crisis before 2008. The exact point of division was chosen because it is close to what Borio and Drehmann(2009) identify as the end of a financial cycle that started close to the mid-80's and the last banking crisis(South Korea-1997) before the sub-prime crisis.

2.7 Results

First we report the results for the estimation and out-of-sample prediction for the data set divided into two periods: 1984-1997 and 1998-2007. The quality of the specifications is tested using the model χ^2 , the Akaike information criteria, and the in-sample and out-of-sample classification accuracy. This classification accuracy is judged by a loss function approach where the weights measure the tolerance for type I (failure to call a crisis) and type II (false crisis signals) error :

$$L= \theta\frac{C}{A+C} + (1-\theta)\frac{B}{B+D}$$

Where A is the total of correct crisis call; B of false crisis calls; C of no signals when there was a crisis; D of no signals when there was no crisis; and θ is the weight on the type of error. We choose two values of θ to define an optimum threshold for the hazard rate: one where the emphasis is on avoiding type I error and $\theta = 0.5$; and another where the emphasis is on avoiding type II error and $\theta = 0.3$. For the in-sample estimation we also impose a minimum of 75 percent of crises called. As crisis events are relatively rare, giving a weight of 0.5 to type I error makes every mistake in crisis calling costly.A policy maker using this model from 1998 to 2007 would have used the estimation from 1984 to 1997 to choose the threshold of the discrete hazard rate that provided the best in-sample results for predicting crises out-of-sample. Nowadays a policy maker would use the new estimation that includes the sub-prime crises to select the best thresholds for calling a crisis in the future.

At first we had the four boom and bust variables and the two traditional variables: inflation and GDP growth. To this we added two specifications of duration dependence: log T and a third-order polynomial of T, where T is the duration of a spell of tranquility before a crisis. The first specification for duration is analogous to the Weibull specification in continuous time and with it the base line hazard is monotonic. Our hypothesis it that the longer the spell of tranquility the greater the base line hazard. During a crisis malinvestments and non-performing loans are liquidated , and banks passes trough a

process of recapitalization. Without one, risks tend to keep accumulating over time.The third-order polynomial is estimated to test if it confirms this monotonic shape. Finally, the benchmark model is the one without duration dependence, analogous to an exponential model in continuous time.

Our first specification for the in-sample estimation from 1984 to 1997 is the one with all the explanatory variables and no duration dependence. Using a general-to-specific approach, both GDP growth and inflation were eliminated at the ten percent level. Our final model with no duration dependence is the one with the four boom and bust variables, all of them highly significant. The estimation of the duration specifications showed a similar pattern of an increasing baseline hazard function, and we report here the results of the log T specification. Both GDP growth and inflation proved to be insignificant at the ten percent level. In the general-to-specific approach the yield spread is also marginally insignificant at the ten percent level. So we have a second specification with the housing price index, the growth in equity prices, the growth of total assets in the banking system balance sheet and duration dependence. As the yield spread proved to be significant at the five percent level in the specification with no duration dependence, we also kept a third specification with it and log T. The result is that both are marginally insignificant at the ten percent level, but this confounding effect could be due to the small range of the data (13 years). Because of this we keep this specification and judge its results in out-of-sample prediction and in the in-sample estimation from 1984 to 2007.

The reported exponentiated coefficient is a hazard ratio, which can be interpreted for all variables, except the housing price index, as the increase in the hazard rate when there is a one standard deviation increase/decrease in the value of the variable, with all other variables fixed at their mean values standardized to zero. In the case of the log function of duration, it is the year one after risk onset. For the housing price index it is the increase in the hazard rate when the growth in real housing prices crosses the threshold of 0.84 standard deviation from the sample mean. These coefficients inform the sign of the effects (positive if the coefficient is higher than 1 and negative if it is smaller) and roughly indicate their magnitude. To better acknowledge these magnitudes we display in the next section the results of changing the values of the variables in the year of crisis episodes. Table 4 presents the results for the three specifications, where (1) is the model with no duration dependence, (2) the model with duration but without the yield spread, and (3) is with both. In it we show the classification accuracy of all the models with a single threshold of 0.07 for the hazard rate. The result for the coefficient of the yield spread, which is smaller than 1, should be interpreted as saying that a one standard deviation decrease in its value increases its hazard rate contribution by the inverse of the displayed coefficient.

Table 4: Estimation(1984-1997)

	1	2	3
Equity	1.95**	1.97**	2.22***
	(0.61)	(0.64)	(0.66)
House Index	6.60***	8.32***	6.67***
	(4.43)	(5.67)	(2.28)
Spread	0.50**	-	0.6
	(0.17)		(0.22)
Bank Assets	3.43***	3.60***	3.28***
	(1.4)	(1.39)	(1.39)
Log T	-	2.87**	2.61
		(1.44)	(1.66)
Constant	0.0087 ***	0.0017***	0.0019***
	(0.0065)	(0.0017)	(0.0020)
Crises	12	12	12
Observations	200	207	200
% Total correct	84	85	85
Number of correct crisis call	10	11	10
% Correct no crisis	84	85	84
Model χ^2	24.09***	45.99***	41.44***
AIC	69.01	68.53	69.01

Note: *** 1% significance level; ** 5% significance level; * 10% significance level; robust standard errors in ()

An analysis based on the loss function reveals that with $\theta = 0.3$ the best models are (1) with a threshold of 0.17, and (3) with a threshold of 0.15. When θ adjusts for the rarity of crises, and type II error is less tolerated, it is better to use higher thresholds in (1) and (3). In (2) the ability to call crises decreases significantly in higher thresholds. For $\theta = 0.5$, (2) has the best in sample results in terms of the loss function. Table 5 presents these results. The models are very similar in terms of the AIC criterion.

Table 5: Best thresholds- Estimation(1984-1997)

$\theta - Model$	Threshold	Crises Correct*	Type II error	Loss Function
0.3 - Model 1	**0.17**	**9**	**6%**	**0.1176**
0.3 - Model 2	0.07	11	15%	0.1280
0.3 - Model 3	**0.15**	**9**	**6%**	**0.1176**
0.5 - Model 1	0.09	10	13%	0.1493
0.5 - Model 2	**0.07**	**11**	**15%**	**0.1152**
0.5 - Model 3	0.05	11	19%	0.1355

*As the number of crises is small we prefer to display the number of crises correctly predicted instead of Type I error

In this first look only the signals one year before the actual crisis are considered a correct call. But earlier signals can be also a sign of the fit of the model. And can other false signals also be related to financial distress? To judge this we study the pattern of false calls for the best thresholds of each specification. Signals that occur at a maximum anticipation of 2 years before crisis onset are considered a correct early call. For model (1) with a threshold of 0.17 and model (3) with threshold of 0.15 it is revealed that they actually signal the French crisis of 1994 in the years of 1992 and 1991, but not in 1993. The remaining false positive calls for (1) with 0.17 are: Canada(1990-91), Finland(1985-86), Japan(1988) and Spain(1989). The signals in Japan and Finland happen before an actual crisis, and in Canada and Spain very close to the final developments of the Saving and Loans Crisis(1988-1991) and of the European Exchange Rate Mechanism(1992) crisis respectively. The same is seen in the other specifications: there are more false calls, but they are all clustered closely before or at these same episodes of financial distress, with the exception of Germany(1994-96) in the models (2) and (3) with lower thresholds. The results are displayed in table 6.

Table 6: Analysis of False Calls - Estimation(1984-1997)

Threshold	Total False	Early Calls	Timing of Actual False	Crises not called
Model 1(0.09)	27	9	CAN(89-92), FIN(84-87),FRA(90), NET(91-92),SPA(88-90), JPN(87-88)	KOR(96),ITA(89)
Model 1(0.17)	15	6	CAN(90-91),FIN(85-86), JPN(88),SPA(89)	KOR(96),ITA(89), FRA(93)*
Model 2(0.07)	30	9	BEL(91),CAN(89,92), FIN(85-87),FRA(89-90), JPN(87-88),KOR(92), NET(91-92),GER(94-96), SPA(88-89)	ITA(89)
Model 3(0.05)	42	11	BEL(90,91),CAN(89,92), FIN(85-87),FRA(89-90), JPN(87-89),KOR(92), NET(91-92),SPA(88-92), GER(94-96),SWI(91-92)	ITA(89)*
Model 3(0.15)	16	6	CAN(90-92),FIN(85), FRA(90),JPN(88), SPA(89)	ITA(89),KOR(96), FRA(93)*

Note: AUS-Australia, BEL-Belgium, CAN-Canada, DEN-Denmark, FIN-Finland, FRA-France, GER-Germany, ITA-Italy, JPN-Japan, KOR-South Korea, NET-Netherlands, NZL-New Zealand, NOR-Norway, SPA-Spain, SWE-Sweden, SWI-Switzerland, UKG-United Kingdom, USA-United States. The * means that the crisis was not called one year before its ocurrence, but was 2 and/or 3 years before.

We chose models 1 and 3 as producing the best results in-sample, for they actually

fail to signal only one crisis less than 2, while having the best performance in reducing type II error in the chosen thresholds. But how did the specifications behave out-of-sample in all the selected thresholds? The out-of-sample has 172 observations, and 13 crises, all of then happening in 2008. Models 2 and 3 are able to predict 12 out of 13 crises out-of-sample, but the rate of type II error is high in both when the chosen lower thresholds are used. Model 1 is able to predict only 6 out of 13 crises at the chosen threshold of 0.17 when $\theta = 0.3$. Nonetheless, it displays a very low rate of false calls and an interesting pattern in them. 6 out of the 9 false calls happens in 3 of the 7 countries where crisis is not predicted in 2007. They are: Netherlands(1999-2001), Switzerland(1999-2000) and United Kingdom(2000). Both models that account for an increasing base-line hazard are able to predict these crises. Switzerland and Netherlands are also among the the six countries that survived the whole period from 1984 to 2007 without a previous banking crisis. The other four are Belgium, Canada, Germany and Spain. A possible explanation is that our model with only the boom variables fails to predict them because these countries had already passed trough their most intense boom and bust cycle. Monetary policy after 2001 could have been able to postpone a crisis and a necessary adjustment, but not to recreate a full scale boom. The fact that with duration dependence these crises are predicted would militate in favor of this conception.

It could be argued that this is only the effect of a increasing base-line hazard for very long periods, as Netherlands and Switzerland survived the whole sampling period. But Germany also survived and its crisis was not predicted, while the United Kingdom passed trough a crisis in 1991. Moreover, the occurrence of credit and asset booms, and in the end of a new crisis, in countries that had earlier crises and went through reforms, could indicate that these reforms only created room for a new expansion of risky lending and a new boom and bust cycle. Those countries that passed through crisis in the past and some reforms experienced a clear boom in the onset of the sub-prime crisis and almost all these crises were called in our model (only with boom variables); the survivors seem to have passed through a more severe boom in the past, the fragility persisting until the global crisis acted as trigger, and this persistence and possible increase in fragility is captured by duration dependence: this is a reasonable inference from the data and the model. A complementary hypothesis is that banks in these countries expanded their foreign assets after an internal boom burst, increasing risk over time without inducing a clear boom in their own countries. Results for the out-of-sample prediction are displayed in table 7.

Table 7: Best Thresholds- Out-of-Sample (1998-2007)

$\theta - Model$	Threshold	Crises Correct*	Type II error	Loss Function
0.3 - Model 1	0.17	6	6%	0.2055
0.3 - Model 2	0.07	12	35%	0.2696
0.3 - Model 3	**0.15**	**12**	**19%**	**0.1551**
0.5 - Model 1	0.09	9	12%	0.2135
0.5 - Model 2	0.07	12	35%	0.2145
0.5 - Model 3	**0.05**	**12**	**33%**	**0.2051**

*As the number of crises is small we prefer to display the number of crises correctly predicted instead of Type I error

The best out-of-sample results are obtained by model 3. We believe $\theta = 0.3$ in the loss function reflects a real need to adjust for the small number of crisis episodes. The choice of model 2 when $\theta = 0.5$ in the in-sample is a result of treating equally the percentages of type I and type II error, and over-magnifying the effect of only one more crisis signaled. That said, model 3 with a threshold of 0.15 has the best overall signaling ability when the in-sample and the out-of-sample are taken into account. And of its 23 actual false calls, 17 are clustered just before and around the burst of the dot-com bubble in 2000-2001 and 2 in 2007.They are: Denmark(1999-2001), Finland(2001, 2007), Germany(1999-2001), Netherlands(1998-2001), Switzerland(1998-2000), United Kingdom(2000), United States(1999-2000) and Norway(2007). All results are in table 8.

Finally, we proceed to the estimation for the whole data set from 1984 to 2007. We can then compare its results to the first estimation. The new estimation without any duration dependence eliminates GDP growth, but inflation is significant at the five percent level. We believe this to be a side effect of regime change in inflation behavior and the greater number of crises in 2008. The estimated coefficient show that the periods of smaller inflation contribute to a higher probability of crisis. There exists theoretical and historical support for the contention that financial and banking crises can happen and do happen in periods of low consumer price inflation. But high inflation is also associated with crisis in previous early warning systems; and the previous result of inflation being insignificant in the estimation for the period from 1984 to 1997 made us decide to drop this specification. We tested again the third order polynomial specification for the duration dependence, and it again resulted in a positive and monotonic duration dependence similar to the log specification of time. In the end we have two models: one with no duration dependence(4) and one with a log T specification for duration(5). Results are presented in tables 9 and 10.

Table 8: Analysis of False Calls - Out-of-Sample(1998-2007)

Threshold	Total False	Early Calls	Timing of Actual False	Crises not called
Model 1(0.09)	19	3	CAN(03-04),DEN(99), NET(99-01),NOR(99,07),SWI(98-00), UKG(00),USA(98-00)	GER(07),ITA(07), NET(07),UKG(07)
Model 1(0.17)	10	1	CAN(03),NET(99-01), NOR(07),SWI(99-00), UKG(00),USA(99)	AUS(2007),GER(07), ITA(07),NET(07), SWE(07),SWI, UKG(07),
Model 2(0.07)	56	15	BEL(98-99),CAN(02-04), DEN(98-01),FIN(00-02,06-07), GER(98-01),NET(98-02), NZE(05-07),NOR(99,06-07), SWE(00-02),SWI(98-00), UKG(00-01),USA(98-00)	GER(07)
Model 3(0.05)	53	13	BEL(98-99),CAN(02-04), DEN(98-01),FIN(00-02,06), FRA(00),GER(98-01), NET(98-02),NZE(06-07), NOR(99,07),SWE(00-01) ,SWI(99-00),UKG(99-01), USA(98-01)	GER(07)
Model 3(0.15)	29	7	CAN(02-04),DEN(99-01), FIN(01,07),GER(99-01), NET(98-01),NOR(07), SWI(98-00),UKG(00), USA(99-00)	GER(07)

Note: AUS-Australia, BEL-Belgium, CAN-Canada, DEN-Denmark, FIN-Finland, FRA-France, GER-Germany, ITA-Italy, JPN-Japan, KOR-South Korea, NET-Netherlands, NZL-New Zealand, NOR-Norway, SPA-Spain, SWE-Sweden, SWI-Switzerland, UKG-United Kingdom, USA-United States. The * means that the crisis was not called one year before its occurrence, but was 2 and/or 3 years before.

Table 9: Estimation - 1984-2007

	4	5
Equity	2.36***	2.62***
	(0.52)	(0.65)
House Index	6.41***	5.31***
	(3.04)	(2.28)
Spread	0.48***	0.28***
	(0.09)	(0.08)
Bank Assets	2.61***	2.74***
	(0.66)	(0.76)
Log T	-	4.54***
		(2.48)
Constant	0.0098***	0.0003***
	(0.0044)	(0.0004)
Crises	25	25
Observations	372	372
% Total correct	82	84
Number of crises correct	20	22
% No-crises correct	83	84
Model χ^2	72.62	57.92
AIC	126.91	113.61

Note: *** 1% significance level; ** 5% significance level; * 10% significance level; robust standard errors in ()

Table 10: Best Thresholds - In-sample(1984-2008)

$\theta - Model$	Threshold	Crises Correct*	Type II error	Loss Function
0.3 - Model 4	0.11	20	11%	0.1386
0.3 - Model 5	**0.15**	**21**	**8%**	**0.1031**
0.5 - Model 4	0.11	20	11%	0.1561
0.5 - Model 5	**0.15**	**21**	**8%**	**0.1193**

*As the number of crises is small we prefer to display the number of crises correctly predicted instead of Type I error

Models 4 and 5 are equivalent to 1 and 3 in the previous sample estimation. The hazard ratio for the House Index and the yield spread changes very little in model 4 compared to 1, but in this estimation the risk associated with expansions in equity prices is increased , while the impact of expansions in the banking system balance sheet is reduced. In 5 the change is more pronounced in the hazard of the spread. The impact of a reduction in the yield spread is much higher in the full sample estimation. For both weights in the loss function, 5 has the best results, and the best threshold of the hazard rate is 0.15 for both types. Analysis of early and false calls reveals a pattern very

similar to the one in the previous estimation and prediction. There is still a cluster of false calls around 1998-2001, and the only significant difference is a new cluster of false signals (with duration dependence) for European countries between 1991-1993. They are: Belgium(1991), Germany(1992-1993), Netherlands(1991-92), Switzerland(1991-1992). All of these countries, except Belgium, also produce false signals around 1998-2001. As already mentioned, they are also 4 of the 6 countries that survived a banking crisis until 2008. There is a clear pattern of "survivors" generating false signals around moments of financial distress. With a constant base line hazard this new cluster of false signals is absent, but it still displays a higher level of false signals. This shows that an increasing base-line hazard is able to capture real information coupled with the other explanatory variables, for there are almost no false calls from 2002-2007, a period trough which many countries had a spell of tranquility longer than the one between 1984 and 1992. This real information is basically the same already affirmed in the previous out-of-sample: crisis that are not signaled only with the boom variables tend to happen in countries which passed trough their most intense boom-and-bust cycles in the past, without significant interventions and restructuring of the banking system, be it by done by the government or by market forces. In the full data-set this is again true for Netherlands(2008) and Switzerland(2008). This reinforces the idea that boom and bust cycles should come together with necessary adjustments under current institutions, and that they move the economy closer to a sustainable path. The plight of Japan, which reacted to a banking crisis by continuous rounds of quantitative easing and protection of the banking system, can be an example of the costs of postponing liquidation and reform. The results are displayed in table 11. We also present the hazard rates in all estimations of the best specification in appendices 3, 4 and 5. Finally we also display in table 12 a comparison between our best results in terms of crisis and no-crisis correctly signaled and the best results of other papers in the literature.

Table 11: Analysis of False Calls - In-Sample(1984-2007)

Threshold	Total False	Early Calls	Timing of Actual False	Crises not called
Model 4(0.11)	39	15	AUS(86),BEL(91), CAN(90-91),DEN(99), FIN(84-87,01),JPN(87-89), NET(99-01),NOR(07), SPA(88-90),SWI(99), UKG(00-01),USA(99)	GER(07),ITA(89)*, KOR(96),NET(07), SWI(07)
Model 5(0.15)	27	12	BEL(91),CAN(90-91), FIN(07),GER(92-93,00-01), JPN(88),KOR(92), NET(91-92),NOR(07), SPA(88-89),SWI(91-92, 99-00), UKG(00),USA(99)	GER(07),ITA(89)*, NOR(86),USA(87)

Note: AUS-Australia, BEL-Belgium, CAN-Canada, DEN-Denmark, FIN-Finland, FRA-France, GER-Germany, ITA-Italy, JPN-Japan, KOR-South Korea, NET-Netherlands, NZL-New Zealand, NOR-Norway, SPA-Spain, SWE-Sweden, SWI-Switzerland, UKG-United Kingdom, USA-United States. The * means that the crisis was not called one year before its occurrence, but was 2 and/or 3 years before.

Table 12: Comparison of signaling results

Variables	Present paper	BKL(2010)	DD(1998)	DD(2005)
Crises Correct - In Sample	75%	66%	70%	60%
No-Crisis Correct - In Sample	94%	71%	84%	70%
Crises Correct - Out of Sample	92%	66%		
No-Crisis Correct - Out of Sample	79%			

Note: We only compare with papers that use a multivariate logit model. BKL is Barrell, Karim and Liadze; DD is Demigurc and Detragiache.

2.8 Discussion of the magnitude of effects in crisis years

We chose to display changes of 0.5 standard deviation in each variable, while the others are kept at their levels in each crisis date. For the growth of housing prices index the change is from crossing the threshold of 0.84 standard deviation to not crossing it. The objective is to see how a hypothetical smaller rate of growth in asset prices and bank's balance sheets and a higher yield spread would impact crisis probability in isolation. These results are displayed for the estimations with data from 1984 to 1997 and from 1984 to 2007 in tables 13 and 14 .

As can be already seem in the reported coefficients the most significant change from the first to the second estimation is the greater impact of the yield spread in crisis probability. This reflects the fact that the overall level of this yield spread was much lower before 1991 than before 2008. When the crises of 2008 are included in the estimation, there is still a inversion of the yield spread, but at higher levels. By far the greatest impact in reducing crisis probability is given by a reduced growth in housing prices in the 3 years preceding the crisis onset. In both estimations crisis probability is reduced between 70-80% by the hypothesis that the 3-year moving average of housing price growth had not exceeded the chosen threshold. In both estimations the effect of reduced growth in stock prices and balance sheets is very similar.This is akin to the fact that the two variables seem to move almost in concert in the years before a crisis, to the point that we could say that variations in the stock price index are almost a function of bank credit. It makes sense: without a constant series of external and unpredictable positive shocks to the economy, the overall level of real stock prices should not grow with such a consistency in such a number of countries. Rarer and bigger shocks should be almost instantaneously incorporated in prices in discrete points of time, as long as they are known. There should be changes in the relative prices between stocks and even between different stock exchanges, but not this constant real appreciation above the rise in consumer price levels in all countries. In the context of our study this would be consistent with credit expansion acting as a sort of external shock to these economies. Even if the path of expansionist monetary policy is highly predictable, its effect over relative prices is not. This would explain why the shock of this new path , instead of being incorporated instantaneously to prices in the present, are actually smoothed over longer periods of time. That is, even if the levels of credit expansion in the future are known, growth in stock price levels will follow its gradual and unpredictable effects in relative prices and not this previous knowledge of general expansion.

The effect of varying the yield spread, stock prices and balance sheet growth together is almost identical to that of the threshold for house prices growth. One viable hypothesis is that allowing real estate to be a channel for credit is much more dangerous to financial stability. For the majority of people a house is their most important asset, and usually the only relevant one. A much smaller fraction of the population is highly invested in stocks (excepting the case of countries where pension funds put almost all of

Table 13: Effect of variables in crisis probability(Estimation from 1984 to 1997 and Out-of-Sample from 1998 to 2007)

Crisis Episode	Crisis Prob.	Δ Shares	Δ Bank	Δ Spread	Δ Houses	Δ Except House
1987-DEN	0.55	-0.25	-0.35	-0.16	-0.80	-0.63
1987-NZE	0.17	-0.31	-0.43	-0.21	-0.84	-0.70
1987-NOR	0.28	-0.30	-0.41	-0.20	-0.83	-0.68
1988-USA	0.23	-0.30	-0.42	-0.21	-0.84	-0.69
1989-AUS	0.26	-0.30	-0.41	-0.20	0.00	-0.68
1990-ITA	0.02	-0.33	-0.45	-0.23	0.00	-0.71
1991-FIN	0.53	-0.25	-0.36	-0.17	-0.80	-0.63
1991-SWE	0.36	-0.28	-0.39	-0.19	-0.82	-0.67
1991-UKG	0.65	-0.22	-0.32	-0.14	-0.78	-0.60
1992-JPN	0.25	-0.30	-0.41	-0.20	-0.83	-0.68
1994-FRA	0.12	-0.32	-0.43	-0.22	-0.84	-0.70
1997-KOR	0.07	-0.32	-0.44	-0.22	0.00	-0.71
2008-AUS	0.56	-0.24	-0.35	-0.16	-0.80	-0.63
2008-BEL	0.99	-0.03	-0.06	-0.01	-0.47	-0.23
2008-CAN	0.72	-0.20	-0.30	-0.13	-0.76	-0.58
2008-DEN	0.65	-0.22	-0.33	-0.15	-0.78	-0.60
2008-FRA	0.80	-0.17	-0.26	-0.11	-0.73	-0.54
2008-GER	0.03	-0.33	-0.44	-0.23	0.00	-0.71
2008-ITA	0.38	-0.28	-0.39	-0.19	-0.82	-0.66
2008-NET	0.21	-0.30	-0.42	-0.21	0.00	-0.69
2008-SPA	0.93	-0.11	-0.18	-0.06	-0.65	-0.43
2008-SWE	0.51	-0.25	-0.36	-0.17	-0.80	-0.64
2008-SWI	0.29	-0.29	-0.41	-0.20	0.00	-0.68
2008-UKG	0.28	-0.29	-0.41	-0.20	-0.83	-0.68
2008-USA	0.89	-0.13	-0.21	-0.08	-0.69	-0.48

Note: AUS-Australia, BEL-Belgium, CAN-Canada, DEN-Denmark, FIN-Finland, FRA-France, GER-Germany, ITA-Italy, JPN-Japan, KOR-South Korea, NET-Netherlands, NZL-New Zealand, NOR-Norway, SPA-Spain, SWE-Sweden, SWI-Switzerland, UKG-United Kingdom, USA-United States. Δ means the effect of a 0.5 S.D reduction in share and housing prices growth and also in the growth of the banking system balance sheet in crisis probability. For the yield spread it is a 0.5 S.D increase and for housing prices growth the effect of not crossing the 0.84 S.D threshold. All values are in percentage points from 0 to 1.

Table 14: Effect of variables in crisis probability(Estimation from 1984 to 2007)

Crisis Episode	Crisis Prob.	Δ Shares	Δ Bank	Δ Spread	Δ Houses	Δ Except House
1987-DEN	0.33	-0.34	-0.35	-0.42	-0.78	-0.77
1987-NZE	0.32	-0.34	-0.35	-0.42	-0.78	-0.77
1987-NOR	0.08	-0.37	-0.39	-0.46	-0.81	-0.79
1988-USA	0.03	-0.38	-0.39	-0.46	-0.81	-0.80
1989-AUS	0.51	-0.30	-0.31	-0.38	0.00	-0.74
1990-ITA	0.02	-0.38	-0.39	-0.46	0.00	-0.80
1991-FIN	0.56	-0.29	-0.30	-0.37	-0.74	-0.73
1991-SWE	0.27	-0.35	-0.36	-0.43	-0.79	-0.78
1991-UKG	0.98	-0.08	-0.08	-0.12	-0.48	-0.46
1992-JPN	0.17	-0.36	-0.37	-0.44	-0.80	-0.79
1994-FRA	0.32	-0.34	-0.35	-0.42	-0.78	-0.77
1997-KOR	0.17	-0.36	-0.37	-0.44	0.00	-0.79
2008-AUS	0.55	-0.29	-0.30	-0.37	-0.75	-0.73
2008-BEL	0.99	-0.04	-0.05	-0.07	-0.40	-0.38
2008-CAN	0.79	-0.22	-0.23	-0.28	-0.68	-0.66
2008-DEN	0.46	-0.31	-0.32	-0.39	-0.76	-0.75
2008-FRA	0.57	-0.29	-0.30	-0.36	-0.74	-0.73
2008-GER	0.05	-0.38	-0.39	-0.46	0.00	-0.80
2008-ITA	0.18	-0.36	-0.37	-0.44	-0.80	-0.78
2008-NET	0.25	-0.35	-0.36	-0.43	0.00	-0.78
2008-SPA	0.69	-0.25	-0.27	-0.33	-0.71	-0.70
2008-SWE	0.23	-0.35	-0.36	-0.43	-0.79	-0.78
2008-SWI	0.19	-0.36	-0.37	-0.44	0.00	-0.78
2008-UKG	0.23	-0.35	-0.37	-0.44	-0.79	-0.78
2008-USA	0.94	-0.12	-0.13	-0.17	-0.56	-0.54

Note: AUS-Australia, BEL-Belgium, CAN-Canada, DEN-Denmark, FIN-Finland, FRA-France, GER-Germany, ITA-Italy, JPN-Japan, KOR-South Korea, NET-Netherlands, NZL-New Zealand, NOR-Norway, SPA-Spain, SWE-Sweden, SWI-Switzerland, UKG-United Kingdom, USA-United States. Δ means the effect of a 0.5 S.D reduction in share and housing prices growth and also in the growth of the banking system balance sheet in crisis probability. For the yield spread it is a 0.5 S.D increase and for housing prices growth the effect of not crossing the 0.84 S.D threshold. All values are in percentage points from 0 to 1.

their resources in stocks). When credit is highly geared towards real estate it has a immediate wealth effect which, if considered permanent, may lead households to finance increased present consumption with the higher levels of collateral allowed by price expansion. The effects of falling prices and fixed debt levels in the bust can be disastrous, as the sub-prime crisis indicates.

2.9 Conclusion

Our paper can be directly compared to the literature on early warning systems for banking crises that estimates crisis probability with a multivariate logit model. In contrast with them, we restrict our variables to a set of coherent indicators of peak expansion in a boom and bust cycle in developed countries: real growth in equity and housing prices, the yield spread between the 10-year government bond and the 3-month interbank rate, and the growth in total banking system assets. Barrel, Karim and Liadze(2009) also focuses on property prices and advanced countries. But it has a smaller set of countries , and the final specification is one of property prices and the liquidity and capital adequacy ratios of the banking system. This is insufficient to capture the dynamics of credit and leverage cycles, as equity prices, interest rates and the growth in banking assets (loans and securities) are also central. Our division of the dataset from 1984 to 1997 and from 1998 to 2007 allows a more extensive test of the out-of-sample classification accuracy of the model, in contrast with using only the year of 2007 for out-of-sample prediction. The results in terms of in-sample and out of sample classification accuracy are superior to this closely related paper, and also to the previous early warning systems (but comparison in this last case is tainted by their much larger database and heterogeneity between countries). Our best specification is able to retain its predictive ability out-of-sample, while the results of an estimation from 1984 to 2007 confirm the significance of the variables in the dataset that includes the run-up to the sub-prime crisis.

The confirmed link between boom peaks and the onset of a crisis reinforces the need of counter-cyclical measures to contain sustained exceptional growth in asset prices and in maturity mismatch (denoted by the move from steep to flat/inverted yield spread). An analysis of the false calls in our out of sample prediction shows a significant increase of crisis probability around 1998-2001 in a series of countries that later suffered a banking crisis. This leaves the following question: could regulation of asset prices and a more restrictive monetary policy have helped the prevention of the much more severe sub-prime crisis? The decision to enact an expansive monetary policy and to deregulate even further financial markets (increasing the room for liquidity creation in the interactions between the traditional and the shadow banking system) may have postponed a mild banking crisis at the cost of a much bigger one.

We believe that further research could initially improve these results mainly in two fronts: first, adding emerging countries to the model by researching other data sources, but for the same time range used here. And, second, by extending the time range for

this same set of industrial countries. This would imply building a database for crises and boom-and-bust variables from the middle of the nineteenth century until the Great Depression. The lack of crises in the period of financial repression from 1945 to 1980 strongly suggests that it should be excluded. This historical extension of the model is probably not feasible in emerging and poor economies, due to complete lack of data, but it is possible for some advanced economies. During the time range studied here, some emerging economies had already developed better institutions and also data keeping and recording . Further research in local sources may enrich the crisis database used here and allow testing if emerging economies also conform to this boom and bust framework.

A Appendix

A.1 Main stylized facts of an Austrian Business Cycle Theory and its connection to banking crises

The building block is the notion of round-about production. We can display its main characteristic with a simple story: suppose a certain population lives only by directly catching fruits from the trees in its neighborhood. Then a discovery is made of a much more productive region, but which requires a long trip before starting and finishing the extraction. Traveling requires time and also the saving of a portion of fruits to allow for survival during the trip. If before the middle of the journey the travelers discover that the food saved is enough to return without dying, but not enough to complete the trip, then they will clearly prefer to return without any fruit. The saved fruits can be considered "free capital" spent without producing any return, as the planned subsistence fund was not enough to allow the maturing of the long-run production process. If they financed the expedition with their own sacrifice in past consumption, this sacrifice proves to be unprofitable. The essential nature of the process is the availability of this subsistence fund for those who do not work in the production of immediate consumption. The subsistence fund here has no relation to a minimum standard of living; it is simply the fact that, for example, a miner demands consumption goods (in the form of an equivalent money wage) for his work, which will only mature into a consumption good much later. When this subsistence fund is used to produce durable instruments that will increase productivity we have what is usually called "durable capital goods". In the end we have the following structure: a more productive process which demands more time for its completion, and consumption goods available for those who work on it , incurring with this the risk that along the journey to maturity future returns are discovered as not worth of further sacrifices.

This process can by itself be conceived in a non-monetary economy. But any higher degree of round-about production can only be imagined in a complex exchange economy. And a deep ambiguity in money revealed in connection with round-about production. In a complex economy, round-about production is based on the revelation and coordination of a myriad of different preferences between present sacrifice and future consumption, and this is expressed in monetary values. But these choices are based on individual wealth levels also measured in money. In the context of a commodity money economy, for example, a sudden discovery of huge amounts of the money-commodity can alter all wealth levels and all plans of production. If the first recipients (the discoverers) choose to buy mainly present consumption goods with this new flow of money, they will compete for scarce goods in a previously set structure of consumption and production and contribute to stop or reduce several investment projects. No one could predict this kind of discovery and the point inside the economy that this money would be injected, and this implies that any significant increase in the supply of money will have

real effects. Bank money is not different in this respect: it is created as new loans, but the bank (or any institution capable of creating money) always gains an increasing purchasing power in the form of interest payments for the usage of this new money source, and the first recipients of credit at reduced rates also have a first comer advantage. It is true that the bankers incur a cost in the payment of interest over deposits generated by new loans, but the whole condition of bank profitability is that there is a positive spread between these rates. An excessively steep yield curve, driven by continuous reserve injections, is akin to this sudden and relatively not costly discovery of commodity-money and not with a costly process of searching and mining. The substantial difference resides in the injection effects of bank money: the bank owner does not simply creates money to use for his own consumption and investment projects, but loans the majority of it to finance new investments in business plans. Sudden and relatively costless increases in the money supply are like a series of continuous redistributive shocks to the structure of production and wealth, and the effects of these shocks in relative prices are largely unpredictable.

Any injection of money in a loan market that was previously close to equilibrium, must reduce the nominal interest rate or facilitate loan conditions in other to find a demand.The reduction in the interest rate and/or other loan conditions generated by bank money creation can be balanced by a voluntary increase in real savings that gives sustainability to the new structure of production. But this outcome is purely contingent and relies on a change in the preferences for consumption and saving. Without it, and with a first injection trough a business lending channel, the following effects apply: the greater inelasticity of the demand for investment in the short run leads to a greater decrease in short term interest rates, creating a steep yield curve and incentive for maturity mismatching; lower interest rates produces a greater incentive for investment in more round-about methods of production and durable capital, without a proportionate subsistence fund being liberated to work as a complementary good for this increased round-aboutdness. The overall effect of credit expansion is to increase investment in the projects farther from immediate consumption, this investment being financed with maturity mismatched funds. Nominal liquidity leads to real iliquidity. But in time the impact of the new money will be felt in the market for present consumption goods trough the increased income for original factors of production. In the firms closer to consumption this will be manifested more as an increase in demand than as a increase in costs (wage demands). This increased profitability will allow these firms to compete with those farther from consumption for factors of production and new loans. This explains why a boom can only be sustained by increased credit expansion : its initial conditions were given by the lead in credit access (in terms of incentives) that the sector farther from consumption had. A boom cycle initiated by credit injections, not mattering its size, contains the seed of its own reversal. The movement towards the bust is a movement back to equilibrium and not a move away from it. Every new round of increased credit

renews the effect of being the first recipient of newly created money, which is needed to maintain investment projects in the face of increased costs produced by the previous credit injection. When the expansion ceases to accelerate this bidding war for factors of production will stop in favor of those firms and projects closer to final consumption, revealing a series of unprofitable long-term projects, with a definitive loss of irreversible real resources in the form of intermediary goods.

Investment in durable capital and durable consumer goods (especially new homes) is highly irreversible. There is a limited possibility of redirecting these resources to other investment projects when needed. If we add to this the incentive for maturity mismatching created by a steep yield curve, there arises an important heterogeneity between agents: those who invested in maturity mismatched irreversible projects are disposed to pay increasing rates for maturity mismatched funds, as long as the present value of the investment is still positive. The initial credit expansion generates rising rates of investment with maturity mismatched funds and also a search for yield due to the lower interest rates. The financial sector can create instruments that promise higher rates of return and immediate availability for liquid funds that can be used as a basis for more credit creation. When the credit expansion stops accelerating, the competition for short-term funds both in the real and the financial sector will contribute to rising short-term rates, while the increased supply of these funds to long-term investments will maintain long-term rates relatively stable, or even reduce them. Close to the reversal of the boom this movement will generate a flat or inverted yield curve.

One element that could slow the process of credit expansion would be the exigence of collateral for loans and securities. But one of the first effects of credit expansion is to raise asset prices, increasing the availability of collateral, while new securities that are accepted as collateral can always be created as a function of an easy monetary policy. This rise of asset prices and new higher-yielding securities can create an speculative moment where the prospect of huge capital gains justifies the payment of higher interest rates for new money sources. This speculative motive will also fasten the flattening of the yield curve in the end of the cycle, and even a small decrease in asset prices when the acceleration of credit stops can be enough to start fire-sales in order to reap at least some capital gain or to repay debt loads; of course this will only decrease prices even more and collapse the collateral that sustained credit expansion.

The main forces of credit expansion in a modern economy are the injection of new reserves (high-powered money) by a central bank and the financial innovations that allow more total credit to be generated on top of these reserves. This usually starts by setting a excessively low short term interest rate sustained by open market operations. The rate that would induce a relatively stable structure of production and consumption can be called a "natural rate". If stability and fewer business cycles were the objective, the job of the central bank would consist in guessing exactly this rate and strictly regulating the activities which expand the bank money multiplier (conceding that this is

actually feasible).

The duration of the boom and the onset of the reversal process will be determined mainly by the size of the initial injection of reserves, the continued injections of reserves, the speed with which the banking and financial system transforms these reserves in new credit, and the availability of new methods to economize on reserves (increasing the real bank money multiplier). Continued expansion can be kept while the new credit is enough to allow entrepreneurs in higher levels to compete for factors of production with those closer to final consumption. Constant injection of reserves and financial innovation can lead to a very prolonged boom and a more severe bust. Anyways, when the credit expansion reaches its maximum feasible limits, the interest rate will rise to allow the allocation of scarce factors of production where they are more profitable. The discrepancy between the nominal supply of monetary capital and real saved capital during the whole process will insure that this rate is such that many of the started investment projects completely fail or are greatly reduced. This increases non-performing loans and spreads a generalized aversion to risk amongst the public and a demand for more liquid investments. Firms and families with great debt loads prefer to repay their loans, and the demand for cash as a precautionary measure also increases. All these forces work to increase bank fragility and to reduce the bank money multiplier and can produce a spiral which ends up in bank panics and systemic banking crises.

De Soto(2006) [46] sustains that this boom and bust economy is completely rational if we take into account a moral hazard institutional framework for the financial system and the existence of genuine uncertainty in the boom and bust cycle. Potential credit creation is a sort of "public good" in this environment. If a bank or financial firm chooses to be conservative and refrain from risky lending and investment, others can replace it, while there is no guarantee that a conservative firm has more chances of survival in the bust-phase. In fact, the doctrine of "too big to fail" almost guarantees that a bank or financial firm that expands more and becomes "too big" has a greater probability of survival. It is rational to join the boom phase and to actively lobby for generous emergency measures when credit expansion produces its necessary consequences. Calvo(2012) mentions the Austrian Trade Cycle Theory exactly in this context of a rational explanation for excessive credit expansion. In this context the connection between these cycles and systemic bank crises will only increase with time: the nature of the process will lead to ever bigger and predatory financial institutions, actualizing a self-fulfilling prophecy concerning the need for even more protection and unconditional measures to save these firms [10].This would explain the persistence of boom and bust cycles and banking crises in the last 30 years, even accounting for increasing knowledge of the process by economic agents.

The history of the development of the banking system in the United States from the Independence till the Great Depression is a sort of case study for a situation of increasing

[10]See Dowd and Hutchison(2010) [18]

credit expansion based on fractional-reserve banking. In the next section we narrate the great transitions in terms of banking system structure in this process, and the systemic banking crises that were, in a certain sense, almost its necessary counterpart[11]. This historical narrative supports the hypothesis that the return of systemic banking crises with the advent of financial liberalization in the 1980's is not the exception, but the rule in the history of this kind of financial arrangement. It is the period from the Great Depression to the 1970's that would constitute an exception. And only a relative one: the banking system was highly regulated and much of its credit creation forcefully directed to finance government enterprises and bonds, while the rise of international institutions that a provided a safety cushion for sovereign loans gave a huge incentive for banks in the United States and Europe to also direct their credit creation towards sovereign powers in developing and poor economies. This flow of credit to public institutions crowded out credit to the private sector and greatly reduced its business cycle effects and also the probability of systemic banking crises connected to these extreme variations in real economic activity. But it also ended in the crises of high inflation and low economic growth in the 1970's and the sovereign loan crisis of the 1980's. One of the main points of the following narrative is that an increasing supply of money and credit is not simply demand-based, but a consequence of the nature of fractional reserve banking, or , in other words, mainly a supply-side phenomenon. When a certain institutional arrangement of fractional reserve banking reaches its maximum feasible credit expansion, there are basically two options: a destructive monetary contraction which wipes out banks (and creates room for new banks and credit expansion in the future) , but also debt levels, or a new arrangement which sustains more debt absorption (which is in fact a progressive devaluation of previous debt). In the history of American banking these two paths combine themselves in erratic ways until there is a clear continuity in credit expansion in the transition from the National Banking System created in the Civil War to the Federal Reserve System in 1913. The mild nature of the first financial crisis of the Federal Reserve System in 1921 led many to believe that an equilibrium between abundant credit and financial stability had been achieved. But the crash of 1929 and the systemic banking crises of the 1930's in a certain sense proved that present stability was bought with more credit and at the price of a much greater crisis and instability in the future.

A.1.1 Notes on financial arrangements in the US from the Independence to the Great Depression

Colonial times in the United States were marked by weak local states, with a limited capability for taxation and finance. The main alternative for increasing its power and to finance wars and investments was the emission of paper money with a fixed exchange

[11] Our sources for this narrative are the following works based on the Austrian framework: Rothbard(2000) [43],2002 [42]), Machlup(1940) [34], Phillips, McManus and Nelson(1937) [36], Smith(1990) [45], Groseclose(1976) [25], Robbins(1971) [41] and Strigl(2000) [47]

rate against metallic money and its acceptance as legal tender. This produced the effects expected by Gresham's Law: the increasingly over-valued emissions of paper money expelled the under-valued metallic money from circulation. This proclivity to paper money as a form of state finance also affected inter-state trade: when manufacturing colonies decided to accept the notes of other colonies on par with species they created a great incentive for paper inflation in exchange of real goods. The few banks which appeared were usually connected with these attempts of local governments to finance themselves, in this case with fractional-reserve banking on top of species.

The Revolutionary War of Independence saw a huge influx of money creation for its financing. After it, the debate about banking and monetary standards was forever marked by the conflict between Thomas Jefferson and Alexander Hamilton. The first abhorred paper money and was responsible for the constitutional clause that prohibited the Congress from creating any kind of it. He saw central banking and paper money as instruments of centralization of political and economical power. The second believed that a fractional reserve banking system protected and regulated by a central bank was an opportunity to help creating a strong national government centered on mercantilism and government protected trusts. He advocated and obtained the creation of the First Bank of the United States, with a twenty year charter and notes with quasi legal tender status. The idea was to bypass the prohibition of note emission by Congress by directing government specie deposits to the bank, with subsidized loans as the counterpart. Jeffersonian resistance finally blocked the renewal of the bank charter after its expiration. But the Anglo-American War of 1812 saw a great expansion in banks, banks notes and deposits, almost all of the new credit created going to war finance. New England was the most conservative in this respect and was already an important producer of manufactured goods. As a consequence it received a great influx of paper money, and when conversion to species was demanded a general crisis was initiated. In the end state governments declared a general suspension of payments, and this decision would gain the status of a prerogative: from now on the banking system as whole expected that a crisis produced by a joint expansion would be met with all kinds of legal privilege. As consequence of this new protection the business of banking expanded mightily in the country, and most of it happened in the states who exploited the acceptance of notes on par by the manufacturing states. The growth in banking is displayed in table 15.

The sure basis for all the other kinds of credit expansion, a never-ending demand for loanable funds at subsidized rates, came from the monetization of government debt. The attempt to block redemption and to make the system as "elastic" as it could be was incarnated in the tolerance with the famous wild-cat banks. These banks were established in far-away distances from the main centers of trade and transportation, in order to make it hard for money brokers to travel and demand note redemption. And in the middle of the war chaos in 1816 was created the Second Bank of the United States. The idea was for it to be a private corporation with one fifth of the shares owned by

Table 15: Expansion of banking in the war of 1812

Variables	**1811**	**1815**
Number of banks	117	212
Specie reserves(Reported)	2.570.000	5.400.000
Notes and Deposits (Reported)	10.950.000	31.600.000
Specie reserves(Estimated)	14.900.000	13.500.000
Notes and Deposits(Estimated)	42.000.000	79.000.000
Reserve ratio	27%	17%

Source: Rothbard, Murray. History of Money and Banking in the United States: The Colonial Era to World War II p.73. Note: The estimated numbers are generated by extending the proportions in the reported banks in each date to the unreported and then adding the values of the Bank of the United States.

government, destined to create a national paper currency, to absorb a good deal of the public debt and receive Treasury funds as deposits. Its primary intentions were clear from its inception in 1816: a deal was made to issue 6 million dollars in credit in New York, Philadelphia, Baltimore, and Virginia in exchange for the return of redemption in state banks. With this inflationary base for new expansion they were happy to oblige. They also agreed that the strong Second Bank would come to rescue weaker banks in times of emergency. At the heights of the first expansion, in July 1818, species amounted to 2.36 million dollars and aggregate notes and deposits to 21.8 million, a reserve ratio of 0.11.

Very lax in its exigencies of redemption from state banks, it practically made its notes new reserves for the expansion of state banks. This is shown by the spectacular rise of incorporated banks and the estimated total money supply from 1816 to 1818: 232 banks to 338 and 67.3 million to 94.7 respectively. A great boom was initiated, with prices and stock trading on the rise. It was to serve this increase in trade that the New York Exchange was founded in 1817. The period also watched the birth of investment banking. All this expansion put the Second Bank at a real risk of failing, and made it start to contract loans and demand species redemption from other banks in 1819. Second Bank notes and deposits fell to approximately half of the boom peak, and banks failed all over the country. The economy was very flexible and liquidation was swift, but its short-run consequences were fearful: in some states there was even a return to barter.

The consequences of the panic of 1819 led to the creation of the Democratic Party by the group that centered around the future president Andrew Jackson. The objective was to close the Second Bank and institute a 100% reserve gold standard. The Second Bank kept on expanding mightily during the period from 1823 to 1832 (under the administration of Nicolas Biddle), as can be seen in table 16, and the state banks were able to expand on top of its notes. In the end Jackson was able to win the fight and his reelection, closing the Second Bank. But a great influx of silver during the thirties

provided even more reserves for credit expansion, which ended in a great crash from 1839 to 1943 and several bank runs.

Table 16: Expansion of the Second Bank under Nicolas Biddle

Variables	**1823**	**1832**
Notes and Deposits(SB)	12	42.1
TMS	81	155
Reserve Ratio (SB)	0.26	0.17
Reserve Ratio (Total)	0.25	0.15

Source: Rothbard, Murray. History of Money and Banking in the United States: The Colonial Era to World War II p.94. Note: Money values are in million dollars. SB stands for Second Bank of the United States. TMS is Total Money Supply.

The next step towards a more elastic banking system happened during and after the Civil War, which established a perfect symbiosis between banks and the central government and ended with the governmental monopoly of note emission. Federal expenditures increased from 566 million dollars in 1861 to 1.30 billion dollars four years later. This was financed by note emissions, later known as greenbacks, and by a massive selling of state bonds, which were payed in species, leading to suspension of payment by the Treasury. Convertibility of greenbacks was eliminated in 1863, leading to even more depreciation of notes, which was blamed on gold "speculators".

The monetary legacy of the Civil War was the National Banking System. The objective was to destroy state rights and nationalize politics. The brain behind the system was Jay Cooke, an investment banker who received the monopoly on the underwriting of the public debt in 1862. He was a propaganda genius and persuaded the public to buy vast amounts of government bonds. His next move was the proposal of the national banking system, entirely designed to create a synthetic market for government debt and to economize and centralize metallic reserves. This was achieved by a new three-tiered system of central reserve city banks (only New York), reserve city banks (cities over 500.000 population) and country banks (all other national banks). States banks were excluded from the system, and the innovation was that deposits of the lower ties in the higher-tied banks were considered reserves "as good as gold". It was and inverted pyramid of expansion on top of the reserve of New York City Banks. The period of 1869-1879 was characterized by heavy lobbying for inflation on top of greenbacks coming from all kinds of industries, especially railroads, which were heavily in debt. State banks did not join the system, due to the prohibition on real estate loans and high capital exigencies. Table 17 displays this new round of growth in banking.

This period was also the basis for a great error of historical interpretation. Armed with the thesis that a fall in price levels is necessary linked with a recession, or at least low economic growth, economic historians discovered a "Great Depression" from 1873 to 1879 that was simply never there. Friedman and Schwartz noticed the implications

Table 17: Expansion under the National Banking System

Variables	1865	1873
National Banks	1294	1968
State Banks	349	1330
TMS	835	1.964

Source: Rothbard, Murray. History of Money and Banking in the United States: The Colonial Era to World War II p.153. Note: Money values are in million dollars. TMS is Total Money Supply

of this fact. [12]. It was a real and fantastic growth that produced price deflation. It has also been shown that the parallel "Great Depression" in England did not exist. The panic of 1873 liquidated expansionary banks and railroads with excessive debt, but the real growth continued in spite (or because) of this and also because the economy was allowed to rapidly adjust to the boom and bust cycle. The deflation in this period is similar to the low rates of inflation during the 1920's and in the 1990's and 2000's. In all these decades positive supply-side shocks went side by side with credit expansion, producing low levels of inflation and a sequence of boom and bust cycles. And this always confounded those who believed that a stable price level was a sufficient condition for economic stability and moderation of business cycles. The data on economic growth from 1869 to 1896 can be seen in table 18. Kehoe and Atkenson(2004) [30] also provide good evidence that deflation and low economic growth are not empirically linked.

Table 18: Economic growth from 1869 to 1896

Variables	1869-1879	1879-1896
Nominal GDP	3%	-
Real GDP	6.80%	3.70%
Real product per capita	4.50%	1.50%
TMS	2.70%	6%
Bank Money	2.60%	10%
Prices	-3.80%	-1%

Source: Rothbard, Murray. History of Money and Banking in the United States: The Colonial Era to World War II p.161-166. Note: TMS is Total Money Supply. Growth rates are the average per year.

The gold standard was fully reestablished in 1879, and it was again a period of great real growth from 1879 to 1896 . The money supply expanded more than during the greenback standard: by 6% per year, and that´s why prices only fell 1% annually during

[12] "The price level fell to half its initial level in the course of less than fifteen years and, at the same time, economic growth proceeded at a rapid rate. . . . Their coincidence casts serious doubts on the validity of the now widely held view that secular price deflation and rapid economic growth are incompatible." See Milton Friedman and Anna J. Schwartz, A Monetary History of the United States, p. 15

this period. Total bank money rose by 10.45% per year, showing that the system had great "elasticity". And it was this elasticity that produced cycles of boom and bust in the midst of prosperity.

But state banks entered heavily in the deposit business and started to compete for reserves with the great national banks. These banks and the economical groups behind them desired a more centralized system and joined hands with the growing progressist movement to advocate "benign oligopolies" that would rationalize the economy and allow better government oversight of it. The confluence of these forces ended up as the legislation for the creation of the Federal Reserve System in 1913. The system worked mainly by reducing the reserve rates previously operating in the National Banking System and by adding the Federal Reserve Banks as new layer, and deposits on it were considered as good as gold by the other banks that joined the system. This increased elasticity was first used to finance the costs of the First World War, but it expanded even more from 1918 to 1921, mainly by the conduit of loans to finance commodities buying and inventories. The growth of the banking system is displayed in table 19.

Table 19: Expansion rate of the balance sheet of the banking system

Year	Loans and Investments	Deposits	Wholesale Prices
1914-15	3.26%	3.04%	2.06%
1915-16	14.54%	18.96%	24.24%
1916-17	15.05%	15.79%	50.41%
1917-18	12.47%	9.16%	3.24%
1918-19	14.95%	16.82%	6.28%
1919-20	13.99%	12.25%	19.70%

Source: C.A Philips, T.F McManus, R.W Nelson. Banking and the Business Cycle - A Study of the Great Depression in the United States p.30.

Table 20: Expansion of the Money Supply during the 1920's

Date	Currency	Demand	Time	M1	S&L Capital	Life Insurance	TMS
1921-22	-8.97%	5.44%	5.19%	3.91%	12.43%	7.42%	4.70%
1922-23	11.64%	5.10%	13.07%	9.25%	16.35%	8.88%	9.51%
1923-24	-2.41%	2.37%	7.81%	4.48%	19.42%	9.82%	5.87%
1924-25	-2.19%	10.15%	9.08%	8.62%	20.42%	10.87%	9.54%
1925-26	0.84%	2.90%	6.68%	4.57%	17.53%	11.17%	6.22%
1926-27	-1.11%	-0.09%	6.95%	3.30%	14.91%	11.38%	5.19%
1927-28	1.69%	1.27%	7.82%	4.63%	14.68%	10.72%	6.25%
1928-29	0.55%	1.26%	0.28%	0.70%	11.32%	9.41%	2.87%

Source: Rothbard, Murray. America's Great Depression p.92 Note: SL refers to Saving and Loans firms.

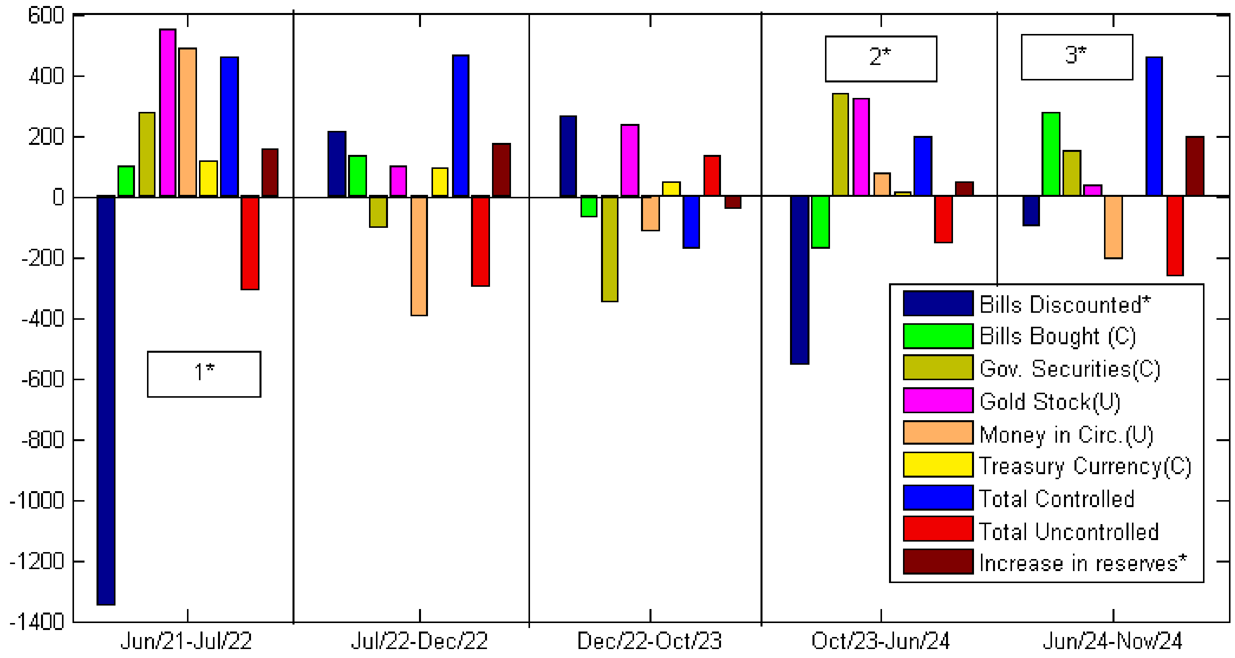
The twenties starts with the recession of 1921, a result of the new round of economy of reserves and increase in the elasticity of the banking system generated by the creation of the Federal Reserve System. The desire inside the government was to speed up the recovery with cheap credit for farmers, foreign governments and exporters. This appeal for a new round of credit expansion was well received by Benjamin Strong, president of the NY Fed, and the interests who wanted to help Great Britain quixotic attempt to keep inflating while at the same returning to the gold par that preceded the war. The growth of the money supply can be seen in table 20.

The main conduits of credit expansion were the conversion of demand to time deposits, open market operations buying government securities and acceptances, and the discount window. Banks in fact transformed time deposits in instantaneously demandable resources and convinced customers to open these accounts, due to their lower reserve requirements. Trough massive buying of government securities the NY Fed injected reserves in three crucial points of time: 1922, 1924 and 1927. They happened just as economic activity slowed, signaling a sort of deflationary adjustment to internal and external realities. The buying of acceptances virtually created this market in the United States, and, by increasing total credit to entrepreneurs, had clear business cycles implications. Finally, the discount rate was usually not a penalty rate that would inhibit arbitrage borrowing. Banks used it to counter inconsistent contractions in open market operations, and as rates were set a little above the lowest yields in the market, there was an incentive to lend to riskier borrowers. Figures 7 and 8 portray detailed information on the flow of new reserves to the banking system and the actions of the Federal Reserve. Despite some inconsistent moves, period after period the conjunction of the actions of the Federal Reserve with financial innovations produced a continuing credit expansion.

Debt in 1929 reached a value equal to two times total wealth 30 years before, and there was 1.2 billion dollars of it with maturity after the year 2000. In 1910, 10% of purchases were made with credit lines; in 1929 they were 50%. One of the channels of credit expansion was a clear housing boom. The Federal Reserve Board index of building contracts (taking 1923-25 as 100), rose from 63 in 1920 to 122 in 1925, and 135 in 1928. In 1927 the administration approved the MacFadden Act, which greatly increased the total amounts banks could lend to real estate. The result was that terrains in Florida were in the end of the boom advertised with prices that would demand the rent of a perpetually occupied office building of 200 floors for its amortization. The stock market boom is well known.

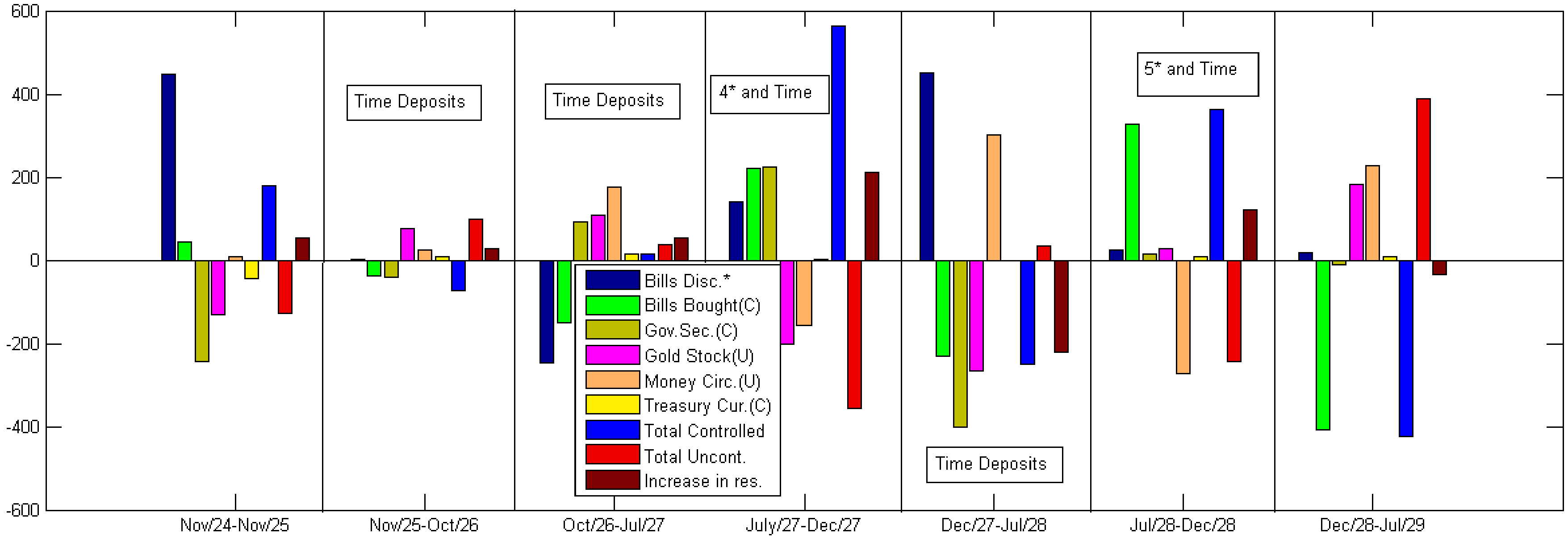
This rise in construction and in the purchasing power of firms produced incredible rates of capital fixation, as can be seen in table 21. Great surges in the production of pig iron and steel happened exactly after the three greatest injection of reserves by the FED. This fits well with the idea that the first effect of credit expansion is excessive imobilization. Credit from American banks also helped to fuel a great boom in foreign countries. Expectations about fabulous future returns in South America fueled lending.

Figure 7: (Increase in member (FED) bank reserves from 1921 to 1924) [a]



[a]Source: Rothbard, Murray. America's Great Depression p.103-116. The numbered boxes indicate the periods where the Fed injected more reserves trough the purchase of government securities and other bills. The variable signal is displayed according to its effects on the reserves of banks. For example, a positive sign for money in circulation indicates that the population chose to hold less cash. C indicates a reserve source controllable by the FED an U an uncontrollable one. Some minor sources are omitted .*Discounting is controllable by the FED, for it could always close the discount window or raise rates, but its repayment is not controllable.

Figure 8: (Increase in member (FED) bank reserves from 1924 to 1929) [a]



[a]Source: Rothbard, Murray. America´s Great Depression p.103-116. The numbered boxes indicate the periods where the Fed injected more reserves trough the purchase of government securities and other bills. The variable signal is displayed according to its effects on the reserves of banks. For example, a positive sign for money in circulation indicates that the population chose to hold less cash. C indicates a reserve source controllable by the FED an U an uncontrollable one. Some minor sources are omitted.Time deposits in the boxes indicate the periods where time deposits boomed and demand deposits stagnated, signaling a conversion from the latter to the former. *Discounting is controllable by the FED, for it could always close the discount window or raise rates, but its repayment is not controllable.

In 1931, about 2.383 million dollars lent in South America carried only 20% of this value in the market. In Germany, where the weight of the Versailles Treaty suffocated its government, private firms were crowded out by state bonds, and they sought to finance short-term inventory with credit from American banks.

Table 21: Average Annual Rate of Growth of Fixed Capital

Period	Growth
1858-1864	6.9%
1865-1873	7.5%
1876-1883	8.1%
1885-1890	8.1%
1893-1900	9.1%
1900-1907	12.3%
1908-1913	16.8%
1914-1917	13.6%
1921-1929	21%

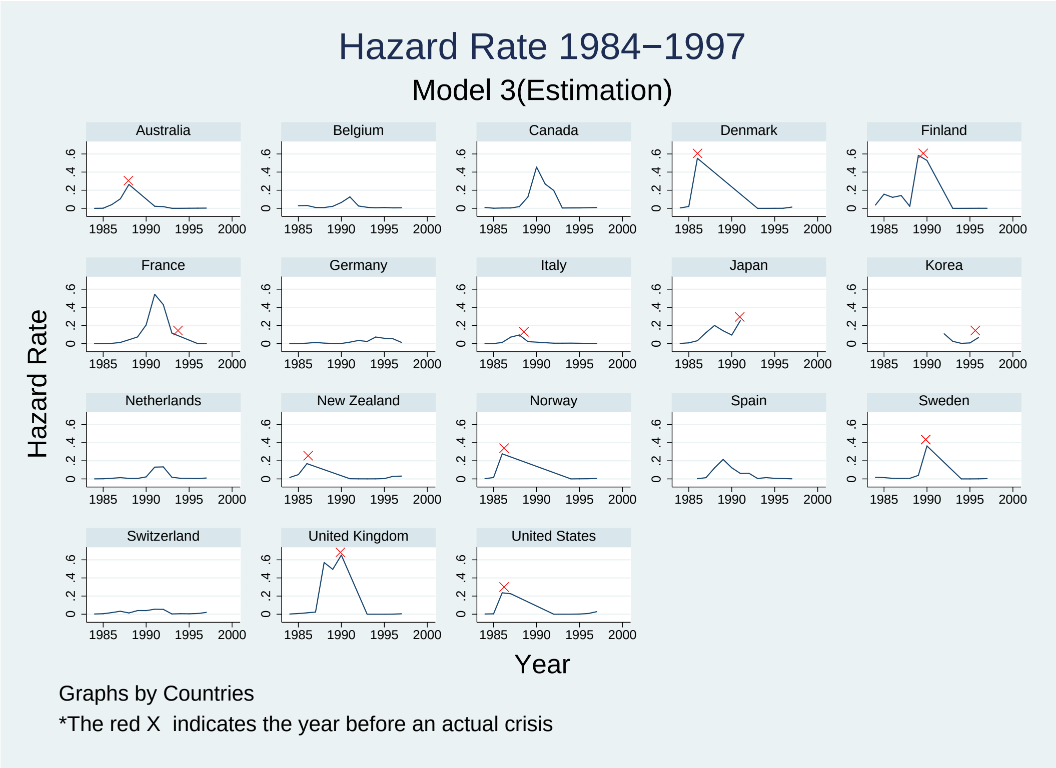
Source: C.A Philips, T.F McManus, R.W Nelson. Banking and the Business Cycle - A Study of the Great Depression in the United States p.124.

A.2 List of Banking Crises

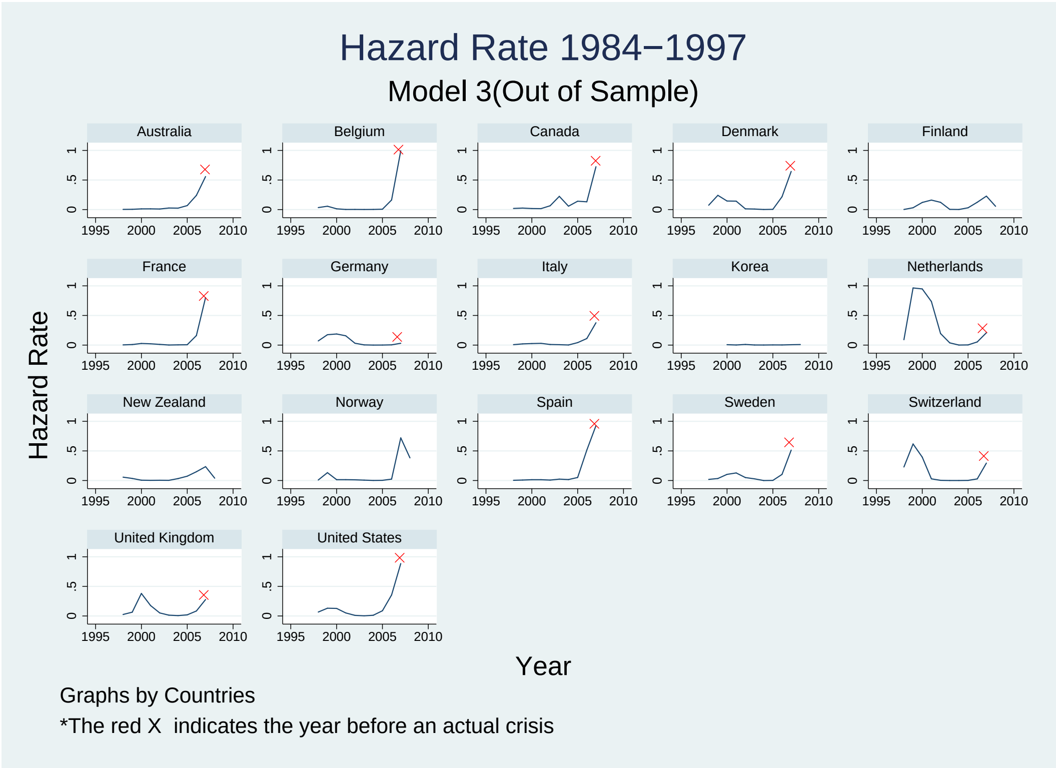
Country	Tranquility	Crisis year	Duration	Sources
Australia	1984-1988; 1993-2007	1989; 2008	1989-1992; 2008-?	Caprio and Klingebiel(2003), Borio and Dhremann(2009)
Belgium	1984-2007	2008	2008-?	Laeven and Valencia(2012)
Canada	1984-2007	2008	2008-?	Borio and Dhremann(2009)
Denmark	1984-1986; 1993-2007	1987; 2008	1987-1992; 2008 - ?	Caprio and Klingebiel(2003), Laeven and Valencia(2012)
Finland	1984-1990; 1993-?	1991	1990-1992	Caprio and Klingebiel(2003)
France	1984-1993; 1996-2007	1994; 2008	1994-1995; 2008 - ?	Caprio and Klingebiel(2003), Laeven and Valencia(2012)
Germany	1984-2007	2008	2008 - ?	Laeven and Valencia(2012)
Italy	1984-1989; 1995-2007	1990; 2008	1990-1995; 2008-?	Caprio and Klingebiel(2003)
Japan	1984-1991	1992	1992-?	Reinhart and Rogoff(2009)
South Korea	1984-1996; 1999-?	1997	1997-1998	Laeven and Valencia (2012)
Netherlands	1984-2007	2008	2008-?	Laeven and Valencia(2012)
New Zealand	1984-1986; 1991-?	1987	1987-1990	Caprio and Klingebiel(2003)
Norway	1984-1986; 1994-?	1987	1987-1993	Reinhart and Rogoff(2009)
Spain	1986-2007	2008	2008-?	Caprio and Klingebiel(2003); Laeven and Valencia(2012)
Sweden	1984-1990; 1995-2007	1991; 2008	1991-1994; 2008-?	Caprio and Klingebiel(2003), Laeven and Valencia(2012)
Switzerland	1984-2007	2008	2008-?	Laeven and Valencia(2012)
United Kingdom*	1984-1990; 1993-2006	1991; 2007	1991-1993; 2008-?	Caprio and Klingebiel(2003), Laeven and Valencia(2012)
United States*	1984-1987; 1992-2006	1988; 2007	1990-1995; 2008-?	Caprio and Klingebiel(2003), Laeven and Valencia(2012)

*Note: In our crisis dummy, crisis onset in the UKG(07) and USA(07) are dated in 2007, meaning that the actual crisis and emergency measures occurred in 2008.There were three minor banking crises in the United Kingdom from 1984 to 1995 and we chose the middle one of 1991(close to other crises) for our crisis dummy.A ? signal means that a period of tranquility exits the dataset with right censoring in the last period, and that a crisis is is still on-going nowadays.

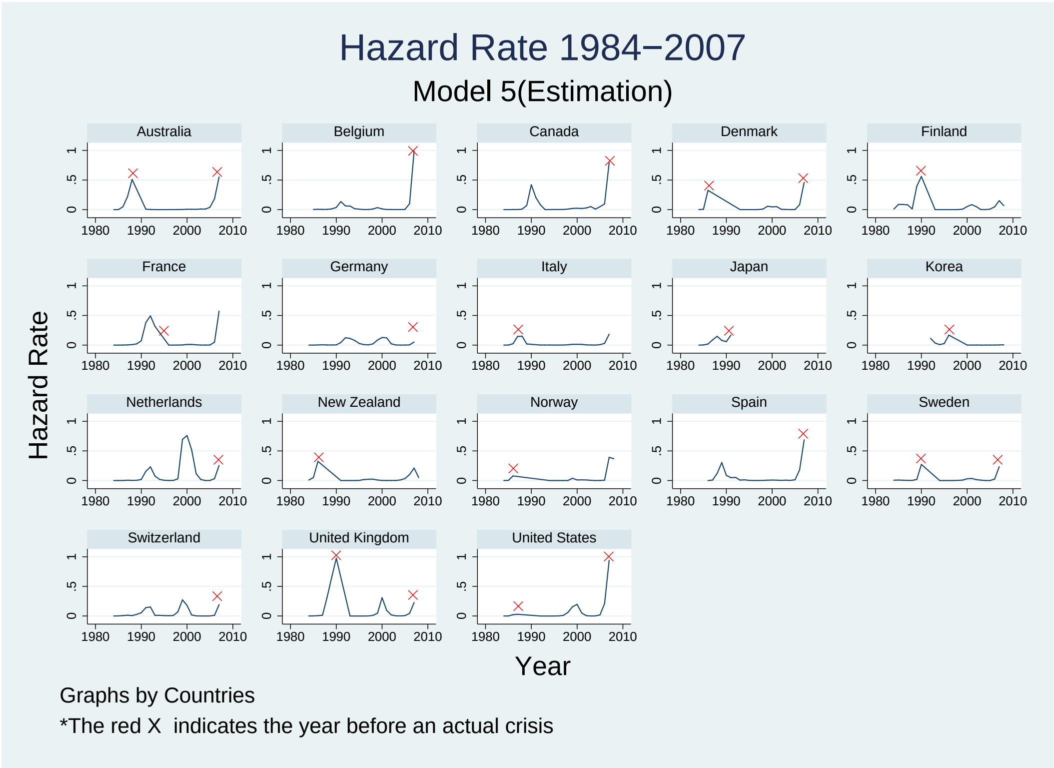
A.3 Hazard rate 1



A.4 Hazard rate 2



A.5 Hazard rate 3



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