Breaking the Spell with Credit-Easing*

Self-Confirming Credit Crises in Competitive Search Economies

Gaetano Gaballo† and Ramon Marimon‡

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Abstract

We develop a theory of *self-confirming* crises in which lenders charge high interest rates because they wrongly believe that lower rates would further increase their losses. In a directed search model of the financial market, this misperception can persist as at the equilibrium there is no evidence that can confute it; lenders could experiment with lower interest rates, but there are no incentives to take risk individually. In this context, a policy maker with the same beliefs as lenders will find it optimal to implement a subsidy to induce low interest rates and, as a by-product, generate new information for the market that may disprove misperceptions. We provide new micro-evidence that the 2009 TALF intervention in the market of newly generated ABS was an example of the optimal policy in our model.

Keywords: unconventional policies, learning, credit crisis, social experimentation, self-confirming equilibrium, directed search.

JEL Classification: D53, D83, D84, D92, E44, E61, G01, G20, J64.

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†European Central Bank, Monetary Policy Research Division; gaetano.gaballo@ecb.europa.eu

‡European University Institute, UPF - Barcelona GSE, NBER and CEPR; ramon.marimon@eui.eu

The only way to argue that the subsidy is small is to claim that there is very little chance that assets purchased under the scheme will lose as much as 15 percent of their purchase price. *Given what's happened over the past 2 years, is that a reasonable assertion?* (Paul Krugman, The New York Times, on 23 March 2009; emphasis is ours.)

1 Introduction

The recent global crisis has been characterized by a rapid surge of perceived counterpart risk in credit markets, resulting in high lending rates and, in some cases, a complete shut down. Probably the most impressive example of a market freeze has been the abrupt contraction of the Asset-Backed Security (ABS) markets in the US.[1]

An Asset Backed Security is a bond backed by a pool of consumer, and small business, loans. The ABS market constitutes a source of shadow-banking financing for important sectors of the US economy such as home equity, automotive, student loans and credit cards, to quote the principal four. When the whole ABS market collapsed at the end of 2007, the Fed decided to step in by launching a hitherto untried policy: the Term Asset-Backed Securities Lending Facility (TALF). By this policy the Federal Reserve Bank provided buyers of newly generated ABS with a subsidy contingent on ex-post realized losses, with the backing of the US Treasury. At that time, the move exposed the Fed to tough criticism. It was not easy to explain why the Fed should take risks that the private sector did not want to. Even more difficult was defending the provision of a subsidy to the unpopular crowd of financial intermediaries. Krugman's quote is representative of the mood at that time.

Nevertheless, the introduction of TALF in the AAA-rated ABS market coincided with a rapid recovery of transactions. Even more surprisingly, the recovery occurred without any subsidy actually being dispensed[2]! A proof, in retrospect, that the counterpart risk *perceived* by investors in that market was indeed excessive. But what lessons should we draw from this experience? Should we conclude that the Fed was less risk averse, better informed, or just lucky? And why should policies like TALF not always be in play?

In this paper we develop a general theory of optimal credit-easing policies in situations of high economic uncertainty. Our theory encompasses policy experiences like the TALF, without being specific to them. Through the lens of our theory, the success of TALF pertained to the generation of public learning that confuted pre-

[1]New issuances of consumer ABS plunged from 50 billion per quarter of new originations in 2007 to only 4 in the last quarter of 2008. At the same time, interest rates required by AAA-rated ABS investors rose to exceptionally high levels.

[2]On 30 September 2010, the Fed announced that more than 60% of the TALF loans had been repaid in full, with interest, ahead of their legal maturity dates. The Fed finally announced that "as of May 2011, there has not been a single credit loss. Also, as of May 2011, TALF loans have earned billions in interest income for the US taxpayer". Source: http://www.newyorkfed.org/education/talf101.html

TALF market pessimism. In the last part of the paper we provide evidence that supports our learning interpretation.

We model the credit market as a competitive search economy where atomistic lenders offer fixed interest rate loans to borrowers, who apply for loans to finance their – possibly risky – projects. The basic mechanism is simple: a borrower can implement a riskless project at a fixed cost, or a risky project without cost. With – and only with – sufficiently low interest rates, borrowers would pay the fixed cost and implement safe projects, however their action is not observable. Lenders then may overestimate counterpart risk – believing that fixed costs are higher than they actually are – and only offer high interest rate loans. Given that only high interest rates are offered, only risky projects are implemented and default rates are high.

Thus, credit crises can emerge in the form of a high-interest-high-risk equilibrium in which observables do not reveal whether or not defaults are high because interest rates are *too* high. In such a case, lenders, as any external observer, may have correct beliefs about equilibrium outcomes, but be wrong about the never-observed counterfactual in which low interest rates induce borrowers to adopt safe projects. Lenders could individually experiment with lower interest rates however, given their (mis)beliefs, they do not have incentives to do that. In such a case, lenders self-confirm the crises in which tight credit conditions induce high risk, and high risk induces tight credit conditions.

In this context we study the problem of an authority with the same beliefs as lenders. The authority can implement zero-sum transfers and evaluate overall welfare in the market. By providing lenders with a subsidy that partially insures them against ex-post losses, the authority induces a compression of the risk premia as lenders compete to attract loans. More precisely, the subsidy acts as an implicit tax in the form of lower matching rates to lenders who still offer high interest rates. As a by-product, the policy produces counterfactuals that may correct potential misbeliefs and break the spell of a self-confirming crisis. In such a case no losses would be realized, and so no subsidy will actually be given.

Therefore, if the possibility of a low-interest-low-risk equilibrium exists, the policy could both reveal and implement it at no cost, creating the conditions for its persistence even once the policy expires. If, instead, such an equilibrium does not exist (i.e. borrowers do not have low risk projects to finance), then the policy will only bear a one-shot finite cost. Therefore, whereas individuals have no incentives to experiment with credit easing, the (ex-ante) social gain from learning can be very large. In these cases, it is rational that the authority takes charge of such risks even if it suffers from the same uncertainty as agents. In other words, the social value of experimentation can be positive when the private value of experimentation is not.

TALF resembles the optimal policy in our model once we interpret lenders as ABS investors and borrowers as ABS issuers. In line with our theory, the success of TALF could be explained by its ability to induce learning the effect of easier credit conditions, as in a public social experiment. In particular, the introduction of TALF mechanically lowered rates, creating the incentives to issue less - rather than more - risky ABS, unveiling unexpected market profitability at low rates.

To test our hypothesis, we have collected micro data relative to issuance and riskiness on the second largest ABS market - that of AAA-rated auto loan ABS - two years before (the time horizon in Krugman's quote) and two years after the one-year lending facility of TALF, i.e from 2007 to 2012. Auto loan has many advantages in terms of informativeness and availability of transaction data, which other ABS sectors lack.

The data on ABS generated from the beginning of 2007 until the day before the introduction of TALF show that on average risk premia factored-in interest rates (fixed at the moment of ABS issuance) caused smaller losses. Thus, according to market information in the absence of TALF, it was rational for investors to increase rates to minimize losses. This can explain the surge of rates in ABS markets before TALF, and the fears that the effects of an artificial reduction of interest rates through a subsidy policy could have resulted in enormous losses for the Fed.

However, the data on ABS generated after the introduction of the TALF exhibit an inverse relation: on average lower risk premia caused smaller losses. This finding contradicts what could have been predicted by simply extrapolating from the available pre-TALF information. It is consistent with TALF producing new public information regarding the state of the AAA-rated ABS market, and once investors got evidence of this effect, subsidies were not needed. The ultimate redundancy of the policy reveals the key to its success: its ability to break the self-confirming crisis preventing the most important shadow banking sector in US from shutting down.

Beyond providing a theoretical foundation for TALF and, more generally, for a new design of optimal policies in situations of high economic uncertainty, this paper also contributes to the existing literatures of *financial crises*, of *Self-Confirming Equilibria* (SCE) and of *competitive directed search*. We now briefly discuss related work on TALF and place our work within these literatures.

Literature review

On TALF. Few articles have tried to explain the rather unique design and impact of TALF; e.g. Agarwal et al. (2010), Ashcraft et al. (2012) and Rhee (2016). The only previous article that has attempted a theoretical foundation for TALF is Ashcraft et al. (2011). In their model, TALF operates through a haircut channel reducing otherwise margin requirements on ABS.[3] However, this explanation implies that prices of securities in secondary markets were very sensitive to unexpected changes of eligibility criteria, which, however, has been proved not to be the case by Campbell et al. (2011).[4]

[3] See also the discussion of Ashcraft et al. (2011) by M. Woodford in the *NBER macroeconomics Annual 2010*.

[4] The authors conclude that "the impact of the TALF may have been to calm investors, broadly speaking, about U.S. ABS markets, rather than to subsidize or certify the particular securities that

The absence of effect at the security level is instead consistent with our learning interpretation since - in our model and in ABS markets - learning is public[5] and therefore independent of the specific security traded.

Moreover, our paper is the first to provide direct evidence of the effect of TALF on the *primary* market, focusing on how TALF changed the original riskiness of ABS measured as realized losses. All other papers focus rather on the secondary market, missing the link between the introduction of TALF and the incentives that issuers had in packing ABS. Although we do not deny the importance of TALF in alleviating liquidity constraints through a haircut channel, we think that learning market profitability at low rates was of crucial importance in inducing investors to actually use those margins. In doing so, we give a new angle of interpretation to the consensual view that "without support by the public sector, it could have taken considerable time for a market-clearing price of leverage to reemerge"(Ashcraft et al., 2011).

On financial crises. This paper belongs to a broad research agenda on financial market crises and related policy interventions. Examples of causes of the disruption of financial intermediation in the literature are: i) tighter incentives, as in Gertler and Karadi (2011) and Correia et al. (2014); ii) pervasive 'adverse selection', as in Chari et al. (2014) and Tirole (2012), or 'moral hazard', as in Farhi and Tirole (2012); iii) coordination failures as in models of Self-Fulfilling credit (Bebchuk and Goldstein (2011)) or debt (Cole and Kehoe (2000)) crises, and iv) deterioration of collateral value, as in Gorton and Ordonez (2014). Our approach departs from the existing literature in at least two respects. First, our mechanism specifically relies on uncertainty about 'non-observables' (i.e. out-of-equilibrium states) and it applies to models that have a unique rational expectations equilibrium. Second, we place the policy makers on the same footing as the private agents, in the sense that they do not have better information, nor are they more rational or less liquidity constrained; the only differences between the public authority and the private agents are their objective function and the capacity of the policy maker to induce market outcomes.

On Self-Confirming Equilibria (SCE). Originally introduced in Game Theory by Fudenberg and Levine (1993), SCE have two distinct properties.[6] First, subjective and objective probability distributions coincide in equilibrium, but may not coincide outside equilibrium; that is, agents may have misspecified beliefs about never-realized states of the economy. Second, agents' actions determine what is observable in equilibrium; that is, individual actions can potentially produce the observables that correct these misperceptions[7]. In Macroeconomics, Sargent (2001), Sargent et al. (2006)

were funded by the program" (Campbell et al., 2011). This seems to be the case also, indirectly, in other markets – such as new vehicles – highly sensitive to the credit conditions Johnson et al. (2014).

[5]As we emphasized, ABS markets strongly rely on the publicly available historical records. See our discussion in section 2.1.

[6]Weaker forms of Self-Confirming Equilibria were discussed in Hahn (1977) and labeled as Conjectuaral Equilibria. Also, Battigalli (1987) provides a specific case of Self-Confirming Equilibrium.

[7]It should be noted that in the macro literature the term SCE is sometimes (mis)used by accounting only for the first feature but not accounting for this second key feature, as for example in Sargent et al.

and Primiceri (2006) have used the concept of SCE by modeling the learning problem of a major actor who has the power to affect aggregate observables and hence to trap itself in an SCE.[8] In this paper, by contrast, we characterize an SCE in a directed search and matching competitive environment, where individual (atomistic) agents cannot affect equilibrium outcomes, but can affect what is individually observable within a match.

Our SCE concept is more resilient than the original concept (in game theory – and macro) on two grounds. First, since lenders choose the interest rate (a continuous variable), we require that subjective and objective probability distributions coincide in a neighborhood of the equilibrium, i.e. up to small variations of interest rates (we call it *Strong* SCE). This feature makes our results robust to extensions with stochastic payoffs or heterogeneous agents. Second, even if lenders were infinitely patient, the subjective *private expected value* of experimenting is negative. In fact, due to the public nature of the market, competition erodes any eventual private benefit of "discovering" that low interest rates induce lower default rates; in other words, in a competitive equilibrium lenders will run at zero profits anyway.[9]

On competitive directed search. As we explain below, the AAA-rated ABS market has frictions and limited capacity features that are also at the root of the directed search and matching models, as pioneered by Peters (1984) and further developed by Moen (1997) and Eeckhout and Kircher (2010), among others. We are the first to demonstrate the possibility of SCE in competitive directed search models and to show the power, in reestablishing efficiency, of a targeted subsidy policy in the context of a *Self-Confirming Crisis*[10].

2 Self-Confirming Crises in Competitive Markets

This section introduces Self-Confirming equilibria in a simple competitive search model of the credit market. Although our setting is general, we will provide an interpretation in terms of the market for *newly generated* ABS, which encompasses our later application.

(2009).

[8]In their case, the Fed was taking actions based on a theory of the economy, which was supported by the outcomes determined by the Fed policy, but that would have been confuted if the Fed had taken different actions based on an alternative theory. In these papers, Self-Confirming Equilibria can be thought of as an application of the Lucas critique (Lucas, 1976), as discussed in Fudenberg and Levine (2009).

[9]By contrast, in repeated games, learning rents do not generally disappear, and patient experimentation eventually pays off; a nice discussion on the topic is given by Fudenberg and Levine (2006). It should be noticed that our work also relates to the literature that studies 'price discovery', as in Kim et al. (2012), in the context of REE models.

[10]As an instrument that achieves an efficient distribution of the surplus – i.e. the *Hosios condition* – and therefore can be used to implement a constrained efficient equilibrium, it could also be used in economies with multiple *Self-Fulfilling* rational expectations equilibria, although in such a model it would be difficult to argue that the policy maker is uncertain and needs to experiment.

2.1 A simple search model of the credit market

Borrowers, lenders and credit contracts

The market consists of atomistic borrowers and lenders. A borrower needs one unit of liquidity to implement a project that matures in one period. Projects can be of two types, safe (s) and risky (r). A risky project yields $1 + y$ where $y > 0$ with probability α and only 1 otherwise. A safe project yields $1 + y$ for sure but requires an implementation cost k. A lender has liquidity but cannot implement projects. A credit contract is one in which the lender lends one unit of liquidity to the borrower in exchange for $1 + R$ to be paid when the project matures.

The borrower's liability is limited to project returns, i.e. if the project fails – which occurs when the project is risky and the realized return is 1 – the borrower cannot repay the interest rate R. Moreover, on the one hand, the type of project adopted is not observable by the lender, who therefore cannot monitor project adoption; on the other hand, the borrower observes R when she chooses the type of project to implement. As a result, lenders offer uncontingent take-or-leave-it contracts at a given interest rate and borrowers adopt projects on the basis of that.

Formally, a project adoption is an action denoted by ρ that belongs to $\{s, r\}$. The optimal adoption policy is given by

$$\rho^* (R, \omega) \equiv \arg\max_{\{\rho \in \{s,r\}\}} \{\pi^b (\rho; R, \omega)\}, \tag{1}$$

with

$$\pi^b (r; R, \omega) \equiv (y - R) \alpha, \tag{2}$$
$$\pi^b (s; R, \omega) \equiv y - R - k, \tag{3}$$

where $\pi^b(\rho; R, \omega)$ is the expected net return associated with the implementation of a project type ρ, given an interest rate R and a set of available projects characterized by $\omega \equiv \{\alpha, k\}$. The expected net return for a lender of a contract at an interest rate R, $\pi^l (R; \rho, \delta)$, is

$$\pi^l (R; r, \delta) \equiv \alpha R - \delta, \tag{4}$$
$$\pi^l (R; s, \delta) \equiv R - \delta. \tag{5}$$

depending on the type of project implemented by the borrower, where δ is the per-unit opportunity cost of liquidity. Hence, also the lender bears the cost of risk.

Note that the surplus generated by a contract, $\mathcal{S}(R, \rho) \equiv \pi^l (R; \rho, \delta) + \pi^b (\rho; R, \omega)$, is independent of R. In particular, $\mathcal{S}(R, r) = \alpha y - \delta$ and $\mathcal{S}(R, s) = y - k - \delta$. Thus, whenever $\bar{R} \equiv y - k/(1 - \alpha) > 0$, safe projects yield higher social benefit than risky ones, i.e. $\mathcal{S}(R, s) > \mathcal{S}(R, r)$. However, R determines the splitting of the surplus between the two agents, and therefore the incentives of the borrower to adopt a particular project. Specifically, the borrower will choose to implement a safe project if and only if the offered interest rate is sufficiently low, specifically, $R \leqslant \bar{R}$. Finally it is worth remarking that there are no externalities in contractual pay-offs, either across lenders or across borrowers; this can be a reasonable assumption in a number of markets, but is not necessary to our argument.

Modeling counterpart risk

Given the structure of the market, lenders need to anticipate borrowers' reactions to their offers. This requires knowing $\bar{R}$, and in particular the values that shape borrowers' incentives: y, k, and α. Whereas it is natural that an agent should know her own payoffs, it is less obvious that she can directly observe the underlying incentives of other players. This is the key idea motivating the formulation of a Self-Confirming equilibrium. In our case these insights are captured by the following assumption:

Information: *Lenders do not know the payoff structure of borrowers and can observe project adoptions only ex-post.*

As a consequence, the lender is a-priori uncertain about the actual behavior of the borrower. Such uncertainty generates counterpart risk in the lending contract as the borrower's choice ρ affects the returns of the lender.

Formally, we can think of the set of the available project as a random variable $\tilde{\omega}$ which is distributed on $\Omega \equiv \{(0,1), \mathbb{R}^{+}\}$ according to an *objective* density function $\phi(\tilde{\omega})$.[11] We can then denote by $\beta(\tilde{\omega})$ the *subjective* density function of a lender, describing her beliefs about the probability that a borrower has access to a set of choices characterized by $\omega \in \Omega$. In particular, for a given R and δ, $E^{\beta}\left[\pi^{l}(R; \rho^{*}(R, \tilde{\omega}), \delta)\right]$ denotes the expected lender's profit evaluated with the probability distribution induced by β, where

$$E^{\beta}\left[(\cdot)\right] \equiv \int_{\Omega} (\cdot)\beta(\tilde{\omega})\, d\tilde{\omega}, \tag{6}$$

is a subjective expectation operator. Note that we allow for subjective density function $\beta(\tilde{\omega})$ to possibly - but not necessarily - differ from the objective density function, $\phi(\tilde{\omega})$. Finally, without loss of generality, and to keep notation compact, we assume $E^{\beta}[E^{\phi}[(\cdot)]] = E^{\beta}[(\cdot)]$, that is, the subjective expectation of the objective mean is the subjective unconditional mean.[12]

[11] We use a tilde to denote a random variable, $\tilde{x}$, in contrast to one of its particular realizations, x. Our simple specification implies $\phi(\tilde{\omega})$ is degenerate with mass one on a particular value ω.

[12] This means that lenders do not doubt that their mean estimates are unbiased. A relaxation of this assumption is innocuous to the following analysis, although would force us to keep track of the double expectation making our formalism more cumbersome.

Matching in the credit market

Lenders and borrowers match to form a credit relationship in the context of a competitive direct search framework, as intoduced by Moen (1997) along the simplified variant described by Shi (2006). We normalize the mass of borrowers to one, whereas we allow free entry on the side of lenders.

Each lender can send an application for funds replying to an offer of credit posted by a borrower. The search is *directed*, meaning that at a certain interest rate R there is a subset of applications $a(R)$ and offers $o(R)$ looking for a match at that specific R. The per-period flow of new lender-borrower matches in a (sub)market R is determined by a standard Cobb-Douglas matching function

$$x(a(R), o(R)) = Aa(R)^{\gamma} o(R)^{1-\gamma} \tag{7}$$

with $\gamma \in (0,1)$.[13] The probability that an application for a loan at interest rate R is accepted is $p(R) \equiv x(a(R), o(R)) / a(R)$ and the probability that a loan offered at R is finally contracted is $q(R) \equiv x(a(R), o(R)) / o(R)$.

Borrowers send applications once lenders have posted their offers. A borrower sends an application to one posted contract R among the set of posted contracts H to maximize

$$J(R) \equiv p(R) E^{\phi}[\pi^b(\rho^*(R, \tilde{\omega}))], \tag{8}$$

with $E^{\phi}[(\cdot)]$ being analogous to (6). In (8) we assume that borrowers apply for credit without knowing the realization of their individual state ω; this is a simplifying assumption which ensures $p(R)$ being independent of $\tilde{\omega}$. The competitive behavior of borrowers implies that the mass of applicants to a submarket $R' \in H$, namely $a(R')$ increases (resp. decreases), whenever $J(R') > J(R'')$ for each $R'' \in H$ (resp. $J(R') < J(R'')$ for at least a $R'' \in H$). Competition among borrowers implies that $J(R)$ is equalized across the posted contracts, i.e. more profitable contracts are associated with lower probabilities of matching.

Lenders are first movers in the search: they choose whether or not to pay an entry cost c and, once in the market, at which interest rate R they post a contract. A posted R is a solution to **the lender's problem**:

$$\max_R E^{\beta}[q(R) E^{\beta}[\pi^l(R; \rho^*(R, \omega))] - c], \tag{9}$$

subject to

$$p(R) E^{\phi}[\pi^b(\rho^*(R, \omega))] = \bar{J}, \tag{10}$$

[13] This assumption, which is standard in the literature, ensures a constant elasticity of matches to the fraction of vacancies and applicants, for each submarket R. In particular, the ratio $\theta(R) = a(R)/o(R)$ denotes the tightness of the submarket R. The tightness is a ratio representing the number of borrowers looking for a credit line *per-unit of vacancies.* Notice that the tightness is independent of the absolute number of vacancies open in a certain market.

and

$$q(R) = A^{\frac{1}{1-\gamma}} p(R)^{-\frac{\gamma}{1-\gamma}}, \tag{11}$$

where $\bar{J}$ is an arbitrary constant and $\pi^l(R;\rho^*(R))$ replaces $\pi^l(R;\rho^*(R),\delta)$. Note that (11) is a direct implication of (7). Lenders cannot individually affect the distribution of offers and applications, and in particular $\bar{J}$, the expected utility granted to borrowers. The constraints (10) and (11) make sure that the individual lender takes the probability of matching in a submarket as given. Such probabilities are evaluated according to the subjective probability distribution $\beta(\tilde{\omega})$. Thus, the competitive behavior of borrowers implies that (10) holds, which together with (11), defines $q(R)$.

On the side of the lenders, free entry guarantees competition, so that the mass of lenders posting a contract in the submarket R, namely $o(R)$, increases (resp. decreases) whenever $E^{\beta}[V(R)] > 0$ (resp. $E^{\beta}[V(R)] < 0$), where

$$V(R) \equiv q(R)\, E^{\beta}[\pi^l(R;\rho^*(R))] - c, \tag{12}$$

is the value of posting a vacancy. Competition among lenders implies $max_R E^{\beta}[V(R)] = 0$, i.e. at the equilibrium lenders run at zero profits.

Notice that, in order to solve (9), a lender needs to anticipate the reaction of the borrower $\rho^*(R,\tilde{\omega})$ to an offer R, to determine both the probability $q(R)$ that an offer R is accepted and the default risk associated with it. Hence a lender bears the risk that a posted contract is not filled and that she wrongly evaluates a borrower reaction to a credit offer.

An interpretation: the market for *newly-generated* ABS

We discuss here the mapping between our model and the market for *newly-generated* ABS. We can think of a borrower as a financial company that collects a pool of illiquid loans that matures in one period.[14] Loans can be of two types: safe and risky. One unit of safe loans always yields one unit of capital plus receivables for a total of $1+y$; risky loans instead yield $1+y$ with a probability α, and only 1 otherwise. Collecting safe loans, in contrast to risky loans, requires a per-unit cost of k, which accounts for screening or opportunity costs needed to secure receivables y.

To liquidate its pool of loans, the borrower issues an ABS, i.e. an obligation which is backed by one unit of the pool of loans. This obligation is sold at 1 and will yield $1+R$ in one period, with R depending on investor demand. However, the liability of ABS issuers (which formally issues the asset via an ad-hoc created special purpose vehicle) is limited to the value of the underlying pool of credits, so she will be able to repay R only in the case that receivables y mature.

A buyer of the ABS, i.e. the lender, does not observe the actual quality of the underlying credit, as well as the particular pooling and tranching strategy adopted by

[14] Whether payments occur in one or several periods does not make any difference as long as the schedule of payments is fixed at the beginning of the contract.

the ABS issuer. This generates counter-part risk in the market. In particular, in these markets, investors' valuation relies almost exclusively on the historical performances, which are published quite regularly and classified according to precise rating rules. In this sense, market conditions - and hence the offered R for a given class of ABS - are predetermined at the moment of the ABS generation and there is no credible way of signalling the quality of the underlying asset. Importantly, this institutional arrangement forces issuers to closely maintain the same ABS structure in time, as investors are typically reluctant to buy ABS for which there are no sound historical records.

However, an ABS issuer observes the market conditions at which it can sell its ABS. Therefore, pricing in the primary market may affect the way issuers pack ABS, which ultimately determines their riskiness. This is a specific feature of primary markets; by contrast in secondary markets the riskiness of an asset is independent of agents' trade. The key mechanism of our theory therefore does only concern the primary ABS market.[15]

Finally, our competitive search setting captures the fact that competition in ABS markets is mainly driven by prices, but there is no agent on the market that can trade infinite amounts.[16] On the one hand, borrowers cannot generate whatever quantity of ABS is demanded since available credit (especially of AAA quality) is limited; on the other hand, buying ABS requires costly intermediation in specialized financial institutions and exposures are normally bounded by the availability of funds and other micro-prudential concerns.

2.2 Equilibria

Definition of an SSCE and an REE

Let us introduce now the definition of Strong Self-Confirming Equilibrium (SSCE) putting that in relation to the notion of Self-Confirming Equilibrium (SCE) and the one of Rational Expectation Equilibrium (REE).

Definition 1 (SSCE)**.** *Given an objective density function $\phi(\omega)$, a Strong Self-Confirming equilibrium (SSCE) is a set of posted contracts H^* and beliefs $\beta(\omega)$ such that:*

sc1) for each $R^* \in H^*$, the maximizing value for the borrower $J(R^*) = \bar{J}$;

sc2) each $R^* \in H^*$ solves the lender's problem (9)-(11);

sc3) for each $R^* \in H^*$, there is an open neighborhood $\mathfrak{I}(R^*)$, such that <u>for any $R \in \mathfrak{I}(R^*)$</u> it is

$$E^{\beta}[V(R)] = E^{\phi}[V(R)], \tag{13}$$

[15] We do not exclude that the policy may have spillovers into secondary markets through portfolio arbitrages.

[16] The interpretation of competitive search models as models of price competition with quantity constraints was originally introduced by Peters (1984). We thank Philipp Kircher for this reference.

that is, borrowers correctly anticipate lenders' reactions only locally around the realized equilibrium contracts.

The third condition (sc3) restricts lenders' beliefs $\beta(\tilde{\omega})$, regarding borrowers' actions, to being correct in a neighborhood of an equilibrium R^*. This is a stronger restriction on beliefs than the one usually assumed within the notion of Self-Confirming Equilibrium (SCE), which does not contemplate any belief restriction out of equilibrium. In fact, in an SCE, condition (sc3) holds punctually for any R^* rather than for any $R \in \mathfrak{I}(R^*)$.

Crucially, the definition of SSCE does not require lenders to have correct beliefs about non-realized out-of-equilibrium behavior. This leaves open the possibility that, in an SSCE, better contracts outside of the neighborhood of the equilibrium could be wrongly believed by lenders to be strictly dominated by existing ones. However, in the neighborhood of the equilibrium contracts, agents behave optimally; this feature makes our notion of equilibrium robust, at least locally, to the introduction of stochastic perturbation and heterogeneity. Thus, lenders may misperceive the actions the borrowers would take – and the resulting risks – when offered interest rates that are *sufficiently* low. Since such contracts will not be posted, then in equilibrium there do not exist counterfactual realizations that can confute wrong beliefs. Thus, SSCE may be highly persistent outcomes.[17]

An REE is a stronger notion than an SSCE, requiring that no agent holds wrong out-of-equilibrium beliefs. In the present model this is equivalent to imposing that lenders' beliefs about borrowers' payoffs are correct. In such a case the equilibrium contract is the one which objectively yields the highest reward with respect to every possible feasible contract.

Definition 2 (REE)**.** *A rational expectation equilibrium (REE) is a Self-Confirming equilibrium such that, at any $R \in \mathfrak{R}$, (13) holds – that is, lenders correctly anticipate borrowers' reactions for any possible contract.*

An REE obtains from a tightening of condition (sc3) in the definition of a SSCE. This implies that each $R^* \in H^*$ is such that lenders can make an exact forecast of the out-of-equilibrium value of posting a credit line, as they can correctly anticipate borrowers' responses. Therefore, posting contracts R^* is a globally dominant strategy both from an objective and a subjective point of view. It is worth noting that every REE is also an SSCE, but not viceversa. However, for the sake of simplicity of exposition, in the following we will refer to SSCE whenever the equilibrium is SSCE but not REE.

At a deeper level, one important difference between the SCE and the REE logic is that, whereas in the latter it is possible to correct coordination failures by optimal

[17] In particular, SCE can be rest point of adaptive learning dynamics as defined by Cho and Sargent (2008). See also Evans and Honkapohja (2001) for an extensive introduction to adaptive learning dynamics in Macroeconomics.

mechanism design (hence without any policy intervention), in the former there it is not. In fact, whenever agents have rational expectations, they could correct out-of-equilibrium incentives in the mutual interest by the adoption of optimal contracts. However, in an SCE, agents may well have wrong beliefs about the out-of-equilibrium reactions of their opponents so that there is no guarantee that they can agree on an optimal contract, which would correct their misbeliefs.

Equilibrium Characterization

We now provide a simple characterization of an equilibrium. Plugging constraints into the objective[18] we can derive the condition for an equilibrium contract as:

$$R^* = \arg\max \left(A^{\frac{1}{1-\gamma}} \bar{J}^{-\frac{\gamma}{1-\gamma}} E^{\beta}[\pi^b\left(\rho^*(R,\omega)\right)]^{\frac{\gamma}{1-\gamma}} E^{\beta}[\pi^l\left(R;\rho^*(R,\omega)\right)] - c] \right),$$

so that, after defining

$$\mu(R) \equiv E^{\beta}[\pi^b\left(\rho^*(R,\omega)\right)]^{\frac{\gamma}{1-\gamma}} E^{\beta}[\pi^l\left(R;\rho^*(R)\right)], \tag{14}$$

we have the following lemma as a direct consequence:

Lemma 1. *Consider two contracts posted respectively at R_1 and R_2. From the point of view of a single atomistic lender*

$$E^{\beta}\left[V\left(R_1\right)\right] \geqslant E^{\beta}\left[V\left(R_2\right)\right] \Leftrightarrow \mu\left(R_1\right) \geqslant \mu\left(R_2\right), \tag{15}$$

for any profile of contracts offered by other lenders.

Note that the evaluation of R does not depend on $\bar{J}$, i.e. it does not depend on the level of utility granted to the other side of the market, which a single lender cannot affect. However, lenders partly internalize the welfare of borrowers, since contracts that provide better conditions for borrowers are more likely to be signed[19].

Let us introduce here a definition of local maxima of μ evaluated by the system of beliefs β and ϕ, respectively.

Definition 3. *A contract R' is a β-local maximum for the lender if there exists a neighborhood of R', namely $\mathcal{I}(R')$, such that*

$$\mu(R') = \sup_{R \in \mathcal{I}(R')} \mu(R), \tag{16}$$

[18] Remember, to simplify the notation, we are looking at the case $E^{\beta}[E^{\phi}[\cdot]] = E^{\beta}[\cdot]$, which avoids the necessity of keeping track of the double expectation.

[19] In particular, with $\gamma = 0$, when all the surplus is extracted by lenders, (15) becomes $E^{\beta}\left[\pi^l(R_1;\rho^*(R_1))\right] \geqslant E^{\beta}\left[\pi^l(R_2;\rho^*(R_2))\right]$ that is, at the equilibrium only the interim payoff of lenders is maximized, as borrowers will always earn zero. With $\gamma = 1$ on the other hand, when the whole surplus is extracted by borrowers, (15) becomes $E^{\beta}\left[\pi^b(\rho^*(R_1))\right] \geqslant E^{\beta}\left[\pi^b(\rho^*(R_2))\right]$ that is, only the interim payoff of borrowers is maximized as lenders will always earn nothing.

with $\mathcal{M}^{\beta}$ denoting the set of β-local maxima. An interior β-local maximum is a contract R such that

$$\mu(R)\left(\frac{\gamma}{1-\gamma}\frac{1}{E^{\beta}[\pi^{b}(\rho^{*}(R,\omega))]}-\frac{1}{E^{\beta}[\pi^{l}(R;\rho^{*}(R,\omega))]}\right)=0, \tag{17}$$

with $\hat{\mathcal{M}}^{\beta}\subseteq\mathcal{M}^{\beta}$ denoting the set of interior β-local maxima. The corresponding sets of local ϕ-maxima, namely $\hat{\mathcal{M}}^{\phi}$ and $\mathcal{M}^{\phi}$, obtain for $\beta=\phi$.

The definition above allows a simple characterization of the equilibria as follows:

Lemma 2. *For a given $\phi(\tilde{\omega})$ and $\beta(\tilde{\omega})$, a set of contracts H^{*} is a SSCE but not a REE if any $R^{*}\in H^{*}$ is such that: i) $R^{*}=\sup\mathcal{M}^{\beta}$, ii) $R^{*}\in\mathcal{M}^{\phi}$ but $R^{*}\neq\sup\mathcal{M}^{\phi}$; whereas it is a REE if any $R^{*}\in H^{*}$ is such that: $R^{*}=\sup\mathcal{M}^{\beta}=\sup\mathcal{M}^{\phi}$.*

The requirement $R^{*}\in\mathcal{M}^{\phi}$ is a direct consequence of having $\beta=\phi$ locally around the equilibrium. Of course, (17) is satisfied locally by any interior SSCE (or REE), i.e. an equilibrium where neither incentive compatibility nor participation constraints are binding. In such a case we can obtain a marginal condition on the elasticity of the $\mu(R)$ function which identifies the local maximum. The criterion (17) is nothing else than the famous Hosios (1990) condition – that is, R^{*} is such that $\gamma E^{\beta}[\pi^{l}(R^{*};\rho^{*}(R^{*},\omega))]=(1-\gamma)E^{\beta}[\pi^{b}(\rho^{*}(R^{*},\omega))]$.

2.3 Self-Confirming crises

We are ready now to use our simple model to describe how an economy can slide from an efficient REE into an SSCE. We will first compute equilibria in closed form and then discuss a simple example.

Equilibria

We use (17) to compute the interior local maximum relative to safe and risky project adoption respectively, and we then check whether such contracts are within the bounds imposed by incentive compatibility and participation constraints.

Proposition 1. *For a given ω, the set of ϕ-local maxima is $\mathcal{M}^{\phi}=\{R_{s}^{*},R_{r}^{*}\}$ where $R_{s}^{*}=\min(\bar{R},\hat{R}_{s})$ with*

$$\hat{R}_{s}=(1-\gamma)(y-k)+\gamma\delta, \tag{18}$$

provided that $R_{s}^{*}>\delta$, and $R_{r}^{*}=\min(y,\hat{R}_{r})$ with

$$\hat{R}_{r}=(1-\gamma)y+\frac{\gamma}{\alpha}\delta \tag{19}$$

and it exists if $R_{r}^{*}>\bar{R}$.

Proof. See Appendix A.1 ∎

$\hat{R}_s$ and $\hat{R}_r$ represent interior local maxima, namely the contracts which, for a given project adoption, maximize lenders' profits when no constraints are binding; R_s^* and R_r^* account for the possibility that constraints do bind. In particular, $R_r^* > R_s^*$, that is, ceteris paribus, risky projects imply higher interest rates. Nevertheless, the expected profit of both a borrower and a lender can be higher when a risky project is implemented depending on parameters (for example, when $\alpha = 1$).

Let us now characterize the set of REE, i.e. $\sup \mathcal{M}^{\phi}$.

Proposition 2 (REE)**.** *For a given ω, there exists a threshold value $\hat{\alpha}(k)$ which is decreasing in k and belongs to $(\underline{\alpha}(k), \overline{\alpha}(k))$, where*

$$\underline{\alpha}(k) = \frac{y - \hat{R}_s - k}{y - \hat{R}_s} \quad \textit{and} \quad \overline{\alpha}(k) = \frac{y - \delta - k}{y - \delta},$$

such that:

(i) if $\alpha < \hat{\alpha}(k)$ then $\sup \mathcal{M}^{\phi} = \{R_s^*\}$,

(ii) if $\alpha > \hat{\alpha}(k)$ then $\sup \mathcal{M}^{\phi} = \{R_r^*\}$,

(iii) only for $\alpha = \hat{\alpha}(k)$ then $\sup \mathcal{M}^{\phi} = \{R_r^*, R_s^*\}$.

Proof. See Appendix A.2 ∎

The proposition establishes that for a sufficiently high level of riskiness ($\alpha < \hat{\alpha}$) the safe equilibrium is the unique REE, otherwise the risky equilibrium is the unique REE. The threshold $\hat{\alpha}$ is the only value of α where two REE exist in this model. This threshold lies in $(\underline{\alpha}, \overline{\alpha})$ – hat is, the interval for which $R^s \geqslant \bar{R} \geqslant \delta$.

We state now the existence of a unique equilibrium contract, which is SSCE.

Proposition 3. *For a given ω, only R_r^* can be SSCE. In particular, for $R_r^* \in \mathcal{M}^{\phi}$ it is $\sup \mathcal{M}^{\beta} = \{R_r^*\}$ without being $\sup \mathcal{M}^{\phi} = \{R_r^*\}$ provided that : $\alpha < \hat{\alpha}$ and $E^{\beta}[k]$ is sufficiently high so that $E^{\beta}[\hat{\alpha}(k)] < E^{\beta}[\alpha] = \alpha$.*

Proof. See Appendix A.3 ∎

The conditions for the existence of a risky SSCE are intuitive. Evaluated with the objective distribution, the safe equilibrium must be a strictly dominant contract globally. In contrast, lenders with subjective beliefs must think that the adoption costs k are sufficiently high that it is unlikely that borrowers adopt the safe project if they lower the interest rate; in other words, lenders must believe themselves to be in a risky REE.

There are two points that are worth taking into account. There is a unique determinate SSCE, which is characterized by having excessive credit tightening and risk taking. Hence, in this model, misbeliefs can only sustain credit crises. Moreover, beliefs that sustain a Self-Confirming crisis satisfy a threshold condition, which is compatible with belief heterogeneity[20].

Transition into a Self-Confirming Crisis

Let us now summarize our findings by discussing a set of figures. In particular, we want to clarify how a deterioration of fundamentals can shift the economy from an initial REE into an SSCE.

Figure 1 illustrates the set of equilibria in the (α, R) space. Our baseline configuration is $y = 0.03, \delta = 0.008, k = 0.005, \gamma = 0.4, c = 0.001, A = 0.1$. The dotted thin curve denotes $\bar{R}$; for any offered $R < \bar{R}$ (resp. $R > \bar{R}$) borrowers adopt safe (resp. risky) projects.

The solid thick line represents R_r, i.e. the equilibrium interest rate conditional on the adoption of a risky project. When α is sufficiently high – and so the risk low – the risky project is the only REE equilibrium (in red), that is, the globally optimal equilibrium in this economy. However, for sufficiently low values of α – when risk is high – R_r can be optimal only locally (in blue), since there exists a strictly dominant REE equilibrium with safe projects adoption, namely R_s, which is denoted by a red dotted line; in this last case R_r is an SSCE (not REE) interest rate.

We can think about a Self-Confirming crisis as determined by an exogenous increase in risk from $a = 0.9$ to $b = 0.55$. When the risk is low then the unique REE is the risky equilibrium where borrowers only adopt risky projects. In this equilibrium, lenders also observe low default rates $(1 - a)$.

When risk increases up to a sufficiently high level, the REE requires that lenders switch to a low interest rate regime R_s. However, in the logic of Self-Confirming equilibria, lenders do not observe any information about k and so they could well be pessimistic about the level of $\bar{R}$, believing that there is no profitable $R < \bar{R}$ that they can offer. As a consequence, lenders can only offer a high interest rate R_r. By doing that, no information about the reaction of borrowers to low interest rate is produced at this equilibrium and so misbeliefs cannot be confuted. Thus, instead of cutting interest rates to induce safe behavior, lenders can increase their interest rates self-confirming high default rates, which in turn justify high interest rates.

Figure 2 illustrates the lender's maximization problem that is behind the situation plotted in the previous figure. On the x-axis we measure R, i.e. the individual choice of a lender. On the y-axis we measure the expected pay-off of the individual lender $\mathbb{E}^{\beta}[\mu(R)]$ *when all the other lenders post at the equilibrium* R. Thus, the figure illustrates the individual (dis)incentive to deviate at a given equilibrium.

When risk is at a low level a the maximization problem of the lender is represented by the convex solid red curve. The maximal value for a level of risk a obtains at R_a^{ree}, which yields zero as implied by the zero profit condition.

[20] It should be noted that considering risk aversion or ambiguity would expand the set of beliefs that sustain a Self-Confirming crisis; see, Battigalli et al. (2015).

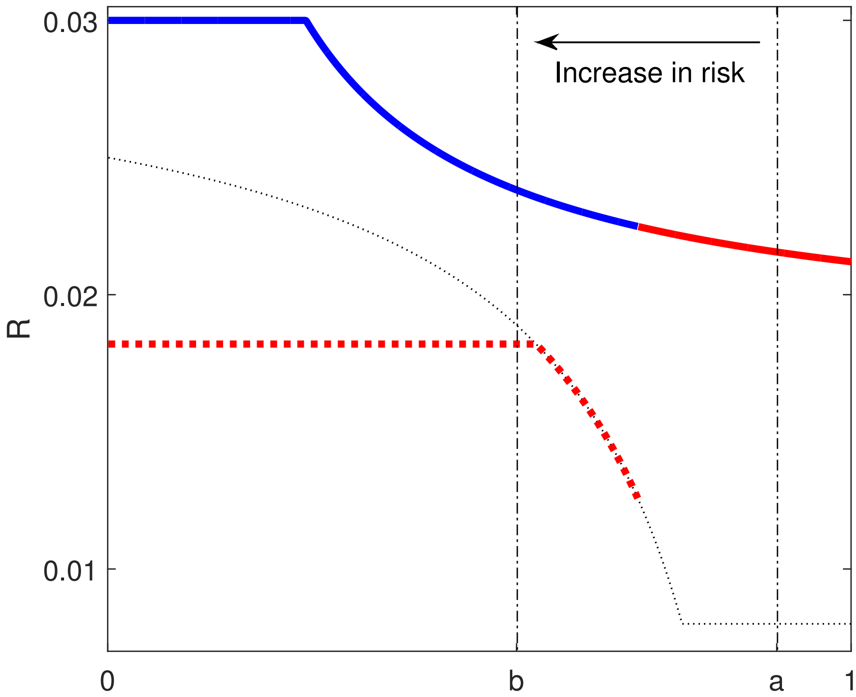

Figure 1: **Weaker fundamentals (α going from a to b) create room for a Self-Confirming crisis.** Equilibria are represented in the (α, R) space. The thick solid line denotes R^r whereas the thick dotted denotes R^s. Red curves indicate REEs and blue curves SSCEs. Other parameters are: $y = 0.03, \delta = 0.008, k = 0.005, \gamma = 0.4, c = 0.001, A = 0.1$.

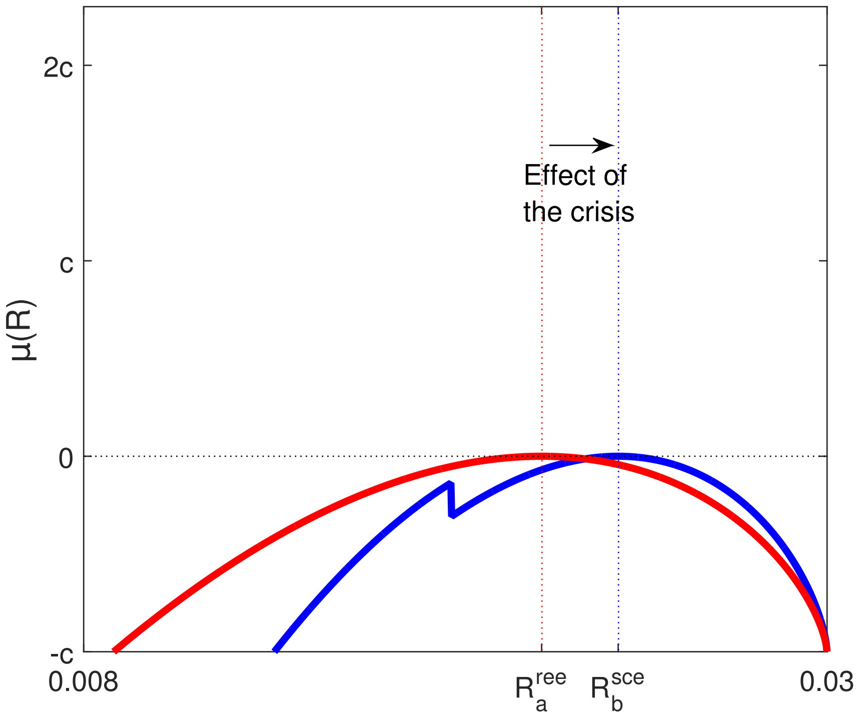

Figure 2: **In a Self-Confirming crises, an increase in risk implies higher interest rates.** The figure plots the borrower-expected payoffs in the $(\mu(R), R)$ space whenever everybody else posts equilibrium contracts, in two situations: with $\alpha = a$ (red curve)a and with $\alpha = b$ (blue curve). The optimal contract moves from R_a^{ree} to R_b^{sce}. Other parameters are: $y = 0.03, \gamma = 0.4, c = 0.001, A = 0.1$.

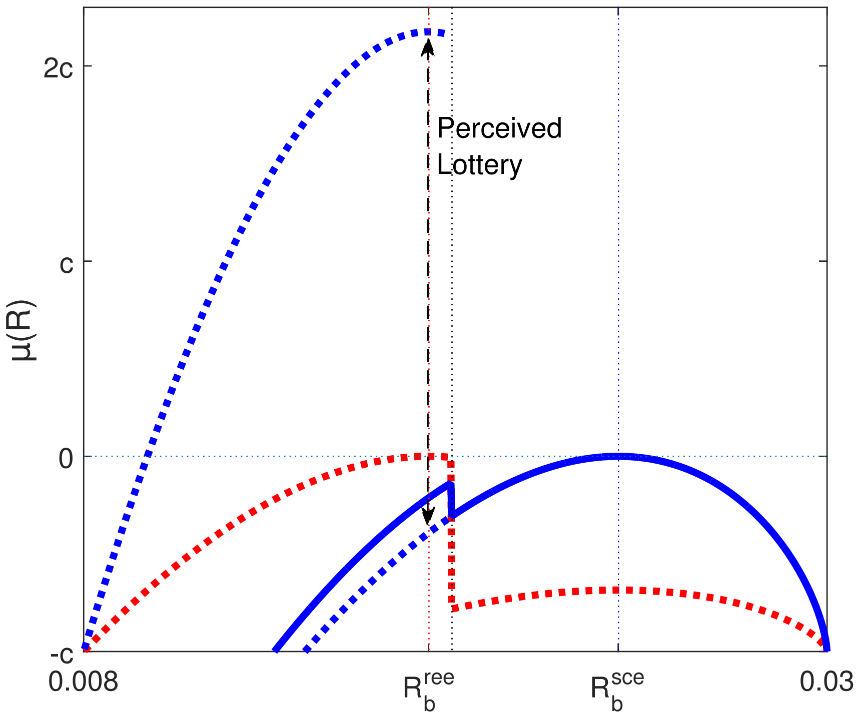

Figure 3: **At a Strong Self-Confirming Equilibrium, a lender perceives a out-of-equilibrium lottery with negative expected value.** The figure plots individual expected values of contracts in the $(\mu(R), R)$ space whenever everybody else posts equilibrium contracts in the case where $\alpha = b$. The dotted blue curves correspond to borrowers' individual payoffs with $k = 0.005$ (higher curve) and $k = 0.015$ (lower curve) which are believed with probability 0.07 and 0.93 respectively. The dotted red curve denotes borrowers' individual payoffs at the unique REE. Other parameters are: $y = 0.03, \gamma = 0.4, c = 0.001, A = 0.1$.

An exogenous increase in risk from a to b shapes the value function as the solid blue curve. The new curve peaks at $R_b^{sce} > R_a^{ree}$, accounting for a higher risk premia factored into interest rates.

A subjectively perceived lottery

In figure 2, along the blue curve, one can observe a non-smooth break. This results from the lender's *subjective* uncertainty about the borrower's reaction to lower interest rates. In this particular example, designed for the sake of clarity, we consider the case of a lender putting a low probability $p = 0.07$ on k being low, i.e. $k_L = 0.005$, and residual probability on k being high, i.e. $k_H = 0.015$.

The example is such that a profitable low interest rate R_s exists only for low k and lenders put too little probability on k being low. However, in an equilibrium where only a high interest rate R_r is offered, there is no evidence on the level of k and so misperception can persist.

Figure 3 illustrates the perceived lottery of the lender. The lower and higher dotted blue lines denote the lender's payoff in the case where k is high and low, respectively. Although a lender may understand that R_b^{ree} entails the strictly dominant action in case of a low k, this state is believed with too small a probability to induce an individual deviation. This is a necessary condition for R_b^{sce} to be an equilibrium.

Private vs. social cost of uncertainty

The interest rate R is an individual choice of a lender. One could wonder whether, in a dynamic extension of this model, a lender could have incentives to potentially experiment with large deviations. In fact, lenders do not have such incentives as long as they cannot prevent others from observing the outcome of their deviation. As in a model of R&D, the competitive nature of the market dries any individual learning rent. In our static environment this is equal to saying that lenders earn zero profits in *any* equilibrium, no matter whether it is an REE or an SCE. This is true also at the unique REE, as plotted in figure 3 with a dotted red curve. Therefore, at the SCE, the ex-ante value of individual experimentation is determined by the perceived cost of a one-shot deviation from equilibrium.

From a social point of view on the other hand, the evaluation of different equilibria changes dramatically. Figure 4 plots social welfare, measured in terms of cost-per-vacancy c, as a function of α. Colors are used to distinguish the REE from the other SCE, as in figure 1. Note that since lenders run at zero expected profits, the social welfare coincides with the expected profits of borrowers $J(R)$.

Social welfare is increasing in α (and so decreasing in R_r) when the economy is on a risky equilibrium, whereas it is insensitive to risk at an REE where borrowers adopt safe projects.[21] The effect of a Self-Confirming crisis triggered by an increase

[21] Social welfare is decreasing in α when $\alpha \in (\underline{\alpha}, \bar{\alpha})$ i.e. the safe equilibrium arises as a corner

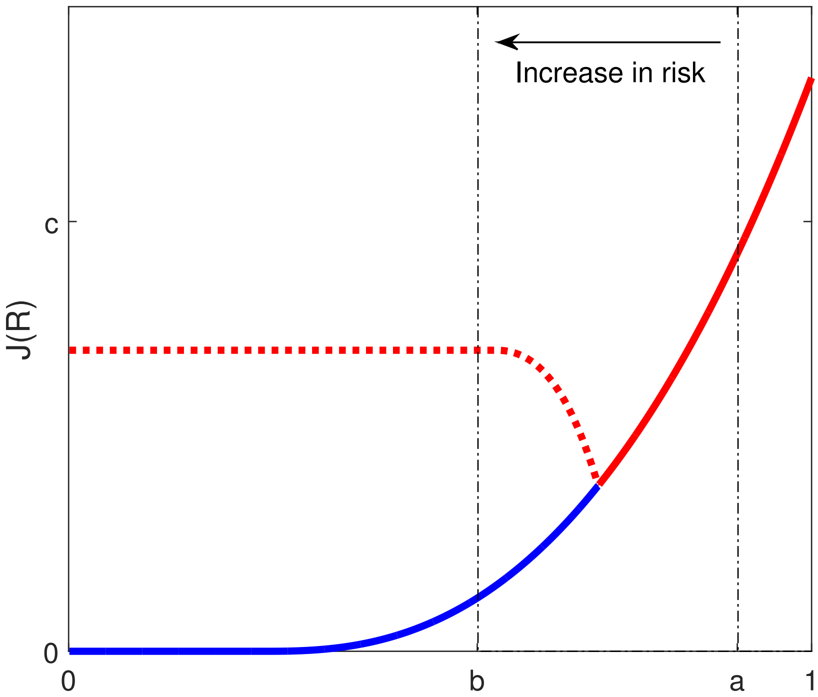

Figure 4: **Social welfare in a self-confirming crisis.** Social welfare, i.e. $J(R^*)$, is represented in the $(J(R), R)$ space. The thick solid line denotes $J(R^r)$ whereas the thick dotted line denotes $J(R^s)$. Red curves indicate REEs whereas the blue curve indicates SSCE (not REE). Other parameters are: $y = 0.03, \delta = 0.008, k = 0.005, \gamma = 0.4, c = 0.001, A = 0.1$.

in fundamental risk is a dramatic fall in social welfare. The drop would have been much lower at the unique REE.

3 Credit Easing as an optimal policy

In this section, we demonstrate how a policy maker, who shares the same beliefs as lenders, should implement a subsidy to lenders, financed by borrowers, that induces the social optimum as a market outcome.

3.1 Welfare in *laissez-faire* economies

We first analyze the problem of a benevolent social planner in a *laissez-faire* economy, i.e. one in which a planner has no other instrument than R to affect the terms of trade. The authority maximizes social welfare by choosing R, subject to the directed search competitive restrictions, in particular taking lenders' zero profit condition, and the market tightness, as constraints. In such a case the social welfare is equal to the expected payoff of borrowers. We provide the planner with the same subjective beliefs of the lenders.

The problem of a planner in a *laissez-faire* economy is:

$$\max_{R} E^{\beta}[p(R)\,E^{\phi}[\pi^{b}(\rho^{*}(R))]], \tag{20}$$

subject to

$$c = q(R)\,E^{\beta}[\pi^{l}(R;\rho^{*}(R))]$$

and

$$p(R) = A^{\frac{1}{\gamma}} q(R)^{-\frac{1-\gamma}{\gamma}};$$

Note that in (20) the subjective beliefs are those of the planner. Having the same beliefs automatically implies that the planner knows the β beliefs of the lenders. Our results generalize to the case in which the planner has different subjective beliefs from private agents (even more pessimistic), provided she knows the subjective beliefs of the lenders, that is, that she can properly assess their zero profit condition.

As before, by plugging constraints into the objective[22] we can derive the constrained first-best contract as

$$R^{\star} = \arg\max\left(A^{\frac{1}{\gamma}} c^{-\frac{1-\gamma}{\gamma}} E^{\beta}[\pi^{l}(R;\rho^{*}(R,\omega))]^{\frac{1-\gamma}{\gamma}} E^{\beta}[\pi^{b}(\rho^{*}(R))]\right),$$

solution.

[22]Remember, to simplify the notation, we are looking at the case $E^{\beta}[E^{\phi}[\cdot]] = E^{\beta}[\cdot]$, which avoids the necessity of keeping track of the double expectation.

so that after defining

$$\bar{\mu}(R) \equiv E^{\beta}[\pi^{l}(R;\rho^{*}(R,\omega))]^{\frac{1-\gamma}{\gamma}} E^{\beta}[\pi^{b}(\rho^{*}(R))], \tag{21}$$

we have a criterion to rank the welfare generated by different contracts. From here onward, we will use an $\star$ to denote a policy outcome, as opposed to $*$ denoting a market outcome.

Lemma 3. *Consider two alternative laissez-faire economies trading at interest rates* R_1 *and* R_2*, respectively. From the point of view of a planner:*

$$E^{\beta}[J(R_1)] \geqslant E^{\beta}[J(R_2)] \Leftrightarrow \bar{\mu}(R_1) \geqslant \bar{\mu}(R_2), \tag{22}$$

for any profile of contracts offered by other lenders.

Comparing (22) and (15) we can easily see that the two criteria are maximized for the same equilibrium contract, i.e. $R^{*} = R^{\star}$. We therefore obtain the following corollary, which is a version of the well known result on the efficiency of the directed search competitive equilibrium:

Corollary 1. *In a laissez-faire economy where lenders and the planner have the same subjective beliefs, the competitive allocation is a solution to the planner's problem.*

In an economy in which the social planner has no other instrument than R to alter the terms of trade, the socially preferred allocation coincides with the one determined by the decentralized market. Corollary 1 replicates the standard result on the constrained efficiency of directed search equilibria, however this is a weaker result in our context. In fact, in our model, a market equilibrium is a *locally constrained efficient* but may fail to be a *globally constrained efficient* as consistency of beliefs (of policy maker and lenders) is not granted out of equilibrium.

3.2 Welfare with optimal fiscal transfers

We now introduce the possibility that the social planner can use transfers between borrowers and lenders. We consider a structure of transfers that have two desirable features:

i) the transfer that an agent - a lender or a borrower - *expects* in a match is independent of individual actions: posted interest rates and project adoptions;

ii) the transfer scheme is revenue neutral, i.e. subsidies must be entirely financed by taxes on market transactions.

The availability of a fiscal instrument introduces the possibility of insuring lenders against their perceived counterpart risk inducing lower interest rates in the market.

In turn, lower interest rates give incentive to borrowers to implement safe projects, maximizing social surplus.

The planners' problem can be decomposed into sub-problems. The design of the optimal policy (**P**) consists of two steps: first, we define the optimal policy reaction $d^{\star}(R)$ to a given market rate R, and second, we define the optimal target $R^{\star}$, given that the optimal policy is in play. The market implementation of the optimal policy (**R**) requires us to establish the mapping between a given transfer $\bar{d}$ to the induced market rate $R^{m}(\bar{d})$, and to finally check that indeed fixing $\bar{d} = d^{\star}(R^{\star})$ gives $R^{m}(d^{\star}(R^{\star})) = R^{\star}$, i.e. the optimal policy is implementable as a market outcome.

P: Optimal policy design.

P1: The optimal policy reaction: $d^{\star}(R)$**.** The optimal transfer at a given interest rate R solves the problem:

$$\max_{d} E^{\beta}[p\,(R)\,E^{\phi}[\pi^{b}(\rho^{*}(R,\omega)) - d]], \tag{23}$$

subject to

$$c = q(R)E^{\beta}[\pi^{l}(R;\rho^{*}(R,\omega)) + d],$$

and

$$p\,(R) = A^{\frac{1}{\gamma}} q\,(R)^{-\frac{1-\gamma}{\gamma}},$$

where d denotes a subsidy to lenders financed by taxing borrowers. Plugging constraints into the objective[23] we obtain the optimal subsidy for a given R:

$$d^{\star}(R) = \arg\max_{d} \left(A^{\frac{1}{\gamma}} c^{-\frac{1-\gamma}{\gamma}} \left(E^{\beta}[\pi^{l}\,(R;\rho^{*}(R,\omega))] + d \right)^{\frac{1-\gamma}{\gamma}} \left(E^{\beta}[\pi^{b}(\rho^{*}(R))] - d \right) \right).$$

Hence, after defining

$$\mu^{\star}(R) \equiv \left(E^{\beta}[\pi^{l}\,(R;\rho^{*}(R,\omega))] + d^{\star}(R) \right)^{\frac{1-\gamma}{\gamma}} \left(E^{\beta}[\pi^{b}(\rho^{*}(R,\omega))] - d^{\star}(R) \right), \tag{24}$$

we have a criterion to rank the welfare generated by different contracts provided the authority implements the optimal subsidy. The optimal subsidy $d^{\star}(R)$ for a given R must satisfy the first-order condition[24]:

$$\frac{1-\gamma}{\gamma} \frac{1}{E^{\beta}[\pi^{l}\,(R;\rho^{*}(R,\omega))] + d^{\star}(R)} + \frac{1}{E^{\beta}[\pi^{b}(\rho^{*}(R,\omega))] - d^{\star}(R)} = 0, \tag{25}$$

[23]Remember, to simplify the notation, we are looking at the case $E^{\beta}[E^{\phi}[\cdot]] = E^{\beta}[\cdot]$, which avoids the necessity of keeping track of the double expectation.

[24]Here we exploit the linearity of our pay-off structure, i.e. $\partial\pi^{l}/\partial R = -\partial\pi^{b}/\partial R$.

that is,

$$d^\star(R) = (1-\gamma)E^\beta[\pi^b(\rho^*(R,\omega))] - \gamma E^\beta[\pi^l(R;\rho^*(R,\omega))]. \tag{26}$$

Note that the optimal subsidy implies a split of the total expected interim surplus generated by a given offer R that is determined by the relative elasticities of the matching function to the mass of applications and offers:

$$\begin{aligned} E^\beta[\pi^b(\rho^*(R,\omega))] - d^\star(R) &= \gamma E^\beta[\mathcal{S}(R,\rho^*(R,\omega))], & (27)\\ E^\beta[\pi^l(R;\rho^*(R,\omega))] + d^\star(R) &= (1-\gamma)E^\beta[\mathcal{S}(R,\rho^*(R,\omega))]. & (28)\end{aligned}$$

In sum, the optimal policy reaction to a given market interest rate R results in an efficient sharing of the *interim* surplus generated by that contract within the match.

P2: The optimal interest rate target: $R^\star$**.** Equation (26) defines an optimal subsidy for every feasible interest rate R. Plugging (26) into (24) provides a simple characterization of the planner's preferences over interest rates given the optimal policy reaction:

$$\mu^\star(R) = \gamma(1-\gamma)^{\frac{1-\gamma}{\gamma}} E^\beta[\mathcal{S}(R,\rho^*(R,\omega))]^{\frac{1}{\gamma}}. \tag{29}$$

This reduces the social evaluation to a simple total expected surplus criterion, given by $\log(\mu^\star(R))$. As a consequence, we have the following:

Lemma 4. *Consider two alternative economies trading at interest rate* R_1 *with a transfer* $d^\star(R_1)$ *and* R_2 *with a transfer* $d^\star(R_2)$*, respectively. From a the point of view of a planner:*

$$E^\beta\left[J\left(R_1, d^\star(R_1)\right)\right] \geqslant E^\beta\left[J\left(R_2, d^\star(R_2)\right)\right] \Leftrightarrow E^\beta[\mathcal{S}(R_1,\rho^*(R_1))] \geqslant E^\beta \mathcal{S}(R_2,\rho^*(R_2))]. \tag{30}$$

In general the criteria (22) and (30) do not necessarily coincide. The reason is that, without the subsidy, the interest rate R determines at the same time two choices by affecting: i) the incentive of the borrower in choosing a project, and ii) the incentive of the lender in posting an interest rate, which depends on the split of the expected surplus. The subsidy enables the policy maker to disentangle these two dimensions. In particular, the optimal subsidy achieves an efficient share of the (subjectively expected interim) surplus for a given R, i.e. it makes the *Hossios condition* hold. The absence of share inefficiency redefines social preferences over contracts as stated by the following corollary:

Corollary. *An optimal interest rate target*, $R^\star$ *satisfies*:

$$R^\star \in \arg\max_R E^\beta \mathcal{S}(R,\rho^*(R)).$$

Therefore, given the optimal policy reaction to a market contract, the planner would prefer a contract that maximizes the social surplus; this constitutes an optimal target. But how can a social planner induce lenders to select such a contract? We now address this question showing how the optimal policy can also implement the optimal target as a *market equilibrium* outcome.

R: Market (Ramsey) Implementation

R1: Market reaction to a transfer: $\tilde{R}(d)$**.** Suppose the authority implements an arbitrary transfer d. To recover the market reaction, we need to solve **the lender's problem** (9) where we subtract and add a fixed transfer d to $E^{\beta}[\pi^{l}(R;\rho^{*}(R,\omega))]$ and $E^{\beta}[\pi^{l}(R;\rho^{*}(R))]$, respectively. As a result, the private evaluation criterion in the case of a subsidy becomes:

$$\mu(R,d) \equiv \left(E^{\beta}[\pi^{b}(\rho^{*}(R,\omega))] - d\right)^{\frac{\gamma}{1-\gamma}} \left(E^{\beta}[\pi^{l}(R;\rho^{*}(R))] + d\right) \qquad (31)$$

where $\mu(R,0)$ is nothing else than (14). Therefore, we have $\tilde{R}(d) = \arg\max_{R} \mu(R,d)$.

R2: Implementation of the optimal target R^{*}**.** Notice that when $d = d^{\star}(R)$, by substituting the (Hosios) efficiency conditions (27) and (28) in (31), one can easily prove that, for a given R we have: $\mu(R, d^{\star}(R)) = \mu^{\star}(R)^{\gamma/(1-\gamma)}$, i.e. the private and social evaluations become the same. Formally, we have shown:

Proposition 4. *Suppose the authority targets a contract* R' *fixing a targeted subsidy* $d^{\star}(R')$*, then*

$$\tilde{R}(d^{\star}(R')) = R',$$

i.e. $d^{\star}(\cdot)$ *provides an implementable targeting policy.*

To complete the solution to the planner's problem we only need to clarify under what conditions the authority will decide to implement a subsidy.

Corollary. *Consider a decentralized SSCE equilibrium* $R^{*} \in \mathcal{M}^{\phi}$ *delivering an expected total surplus* $\mathcal{S}(R^{*},\rho^{*}(R^{*}))$*. The authority will implement a contingent subsidy* $d^{\star}(R^{\star})$ *targeting a contract* $R^{\star}$ *whenever* $E^{\beta}[\mathcal{S}(R^{\star},\rho^{*}(R^{\star}))] \geqslant E^{\beta}[\mathcal{S}(R^{*},\rho^{*}(R^{*}))]$.

Furthermore, by the definition of SSCE, $E^{\beta}[\mathcal{S}(R^{*},\rho^{*}(R^{*}))] = E^{\phi}[\mathcal{S}(R^{*},\rho^{*}(R^{*}))]$. In sum, the authority will implement the subsidy no matter how small the subjective probability that total surplus could improve, is. The implementation of the subsidy is, in general, *ex-ante* the right decision for the authority, irrespective of what agents can eventually learn after exploring new submarkets (notably, that the status quo was not an REE). However, lenders are totally indifferent to the implementation of the policy. The fact that all the distribution of posted contracts moves after the subsidy, leaves the lenders at zero expected profits anyway – that is, they do not get any advantage from the policy. On the contrary, from the lender's point of view the subsidy induces entry of other lenders into the market, which means tougher price competition.

The optimal subsidy as an implicit tax on high-interest rate offers.

To go a bit deeper into the understanding of the effects of the optimal policy, it is useful to look back to figure 3. In that example, the probability of a low k_L, namely p, is also the probability that

$$E^{\beta}[\mathcal{S}(R', s)] > E^{\beta}\left[\mathcal{S}(R_b^{sce}, r)\right], \tag{32}$$

for any $R' < y - k_L/(1-b)$. This implies that the authority would like to implement a contingent subsidy at any of such R'. Let us focus on the case where the authority targets a contract R_s^{ree}, which is the best contract conditional to the realization of the good state k^L (as shown in Figure 3). In particular, the optimal targeted subsidy is

$$d^{\star}(R_s^{ree}) \;\; = \;\; p d^{\star}(R_s^{ree}, s) + (1-p) d^{\star}(R_s^{ree}, r),$$

and given that $d^{\star}(R_s^{ree}, s) = 0$ then we finally have

$$d^{\star}(R_C) \;\; = \;\; (1-p)\left((1-\gamma)\alpha(y - R_s^{ree}) - \gamma(\alpha R_s^{ree} - \delta)\right).$$

As we have seen, through the subsidy lenders internalize the social evaluation of interest rates (31), therefore *all lenders* strictly prefer to post offers at R_s^{ree}. This situation is illustrated by the curved green line in figure 5, which represents the *expected* value function when the subsidy $d^{\star}(R_s^{ree})$ is implemented. The peak of the green line is exactly at R_s^{ree}, where the zero profit condition is satisfied. Note that in this case lenders reply to the *credit easing* policy by offering loans at the interest rate R_s^{ree}. At such low interest, borrowers will choose the safe technology if the implementation cost is low, finally unveiling the true state. As a result, the effect of implementing a subsidy to lenders at the cost of taxing borrowers results in no rent for lenders, but in an *implicit tax* if they do not offer the planner's desired equilibrium interest rate. In particular, as lenders stop pricing risk, too-high interest rates will generate too few matches yielding losses (indicated in figure 5 with a double arrow).

Credit Easing as a self-financed policy

Finally, we show here how a credit easing intervention can be self-financed in the context of our example. Condition ii) requires that the subsidy to lenders is financed by a tax to matched borrowers. Nevertheless, in the case of a risky project adoption, matched borrowers could fail and not have pledgeable income to finance the policy. To ensure that the policy is self-financing, we shall consider individual-specific taxes on borrowers $d(R, i)$ where $i \in \{c, f\}$ denotes the *ex-post* state of the project of the borrower being either a success (c) or a failure (f). The realization of the state i, it should be noted, is not under the control of a borrower, so that condition i) is still

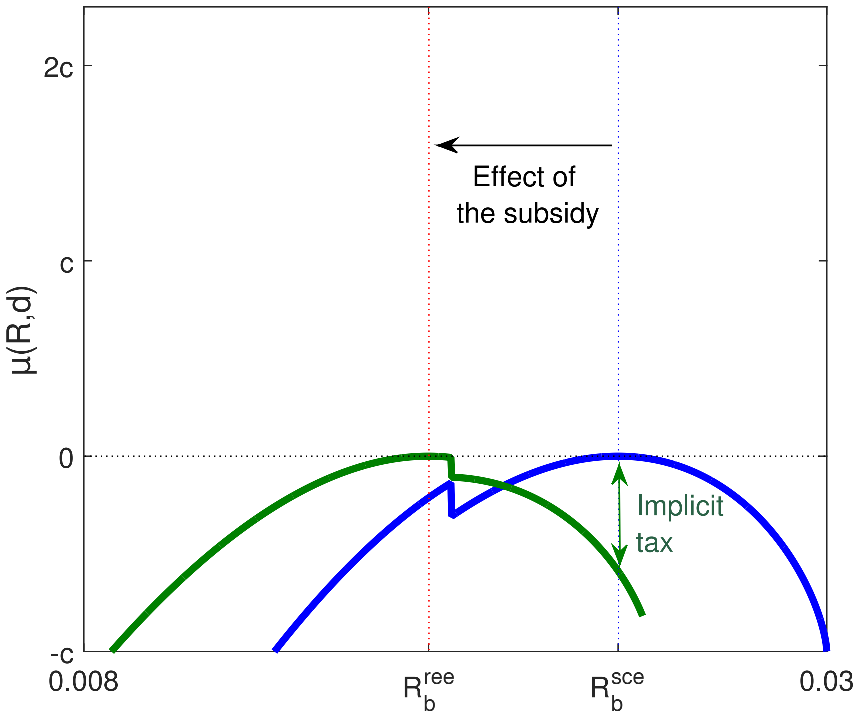

Figure 5: **The effect of the optimal subsidy.** The figure plots individual expected values of contracts in the $(\mu(R), R)$ space, whenever everybody else posts equilibrium contracts, in the case where $\alpha = b$ with (green curve) and without (blue curve) subsidy. In this example, the subsidy targets R_b^{ree}. Because of free entry, the presence of the subsidy translates into an implicit tax on lenders that post high interest rates via lower matching probabilities. Other parameters are: $y = 0.03, \gamma = 0.4, c = 0.001, A = 0.1$.

satisfied. Self-financing, in our example, implies:

$$d^{\star}(R_b^{ree}, c) = b^{-1} d(R_b^{ree}) \quad \text{and} \quad d^{\star}(R_b^{ree}, f) = 0,$$

so that $d^{\star}(R_b^{ree}) = b d^{\star}(R_b^{ree}, c) + (1 - b) d^{\star}(R_b^{ree}, f)$. This structure of contingent transfers ensures that the government can finance the subsidy to lenders, relying on the same pledgeable income on which private contracts also rely. In practice, in equilibrium each matched borrower finances *in expectation* a matched lender.[25] In particular, in the case that k_L do not realize, matched borrowers with successful projects still have pledgeable resources to pay the tax.

3.3 Mapping salient features of our model into TALF design

In this subsection we want to emphasize some key features of TALF on *newly-generated* ABS that map into our optimal policy.

TALF provided a contingent subsidy to ABS investors. TALF offered non-recourse loans against highly rated ABS with a 15% haircut. The non-recourse nature of the loan gave the option to the ABS investor to eventually default on the loan putting the ABS collateral back into the hands of the Fed. Thus, TALF constitutes a subsidy to ABS investors contingent on losses on the ABS value, where losses are defined as the ABS losing more than 15% of its market value.[26]

TALF relied on the purchases of ABS by private investors. The policy intervention did not undermine the ability of the private sector to price the new securities. In this sense, with the TALF the Fed did not substitute itself for the market, as with other more intrusive types of policies (e.g. direct purchases of traditional quantitative easing).

The subsidy was independent of specific terms of trade. In particular, the program did not require a particular amount or a particular level of coupon rates, so in this sense it was independent of the single trading actions of investors and issuers. Thus, as in our model, the evaluation of the pros and cons of TALF could be done by investors on a per-unit base.

TALF required explicit fiscal backing. With TALF, the Fed committed itself to being a buyer of last resort in the event of a further abrupt collapse of the market, taking tail risk that at that time the market did not want to take (but leaving first-order losses to private investors!). TALF required an explicit backing by the Treasury to allow the Fed to take up this risk.[27] In our model, we made the policy a self-

[25] Moreover, note that in our example $y - R_b^{ree} \geqslant d(R_b^{ree})$ always holds. This implies that borrowers still have incentives to participate in the market despite the tax.

[26] To be precise, one could consider the rate of the Fed loan as an uncontingent component of the TALF subsidy. However, such a rate was generally high relative to the historical coupon rate of ABS. This feature was intended to induce a smooth exit from the program (for further details, see Ashcraft et al. (2012)).

[27] In the words of Ben Bernanke on 13 January 2009: "Unlike our other lending programs, this facility

financed one, which is of course a tighter requirement for policy intervention.

4 TALF as social learning

In the previous sections we have shown how our basic model maps into the ABS market and how our optimal contingent subsidy replicates some salient features of TALF. Hence, through the lens of our theory, the success of TALF is due to its ability to drive the market towards low rates, unveiling unexpected profitability of easier credit conditions.

However, the theory of Self-Confirming Equilibrium relies on out-of-equilibrium beliefs as a free explanatory variable. To push TALF further as a frontrunner example of our theroy, we need to address some questions: what induced misperceptions in the first place? Why were such misperceptions similar across investors? What kind of evidence is consistent with correct beliefs?

In this section, we provide a natural answer to these questions[28] focusing on the public observable information available before and after TALF implementation in one of the key ASB sectors. We will show that before TALF similar misperceptions on counterpart risk were sustained by what could have been extrapolated from public market data. Then we will show that new evidence which emerged after the introduction of TALF actually confuted pre-TALF projections.

We do not intend to claim an ultimate explanation for what remains one of the most controversial interventions in the recent history of policy making. We want instead to emphasize that, as a matter of fact, TALF produced public learning, which could be one of the keys to interpreting its success.

Explaining skepticism about TALF and its success

The crisis of the ABS market could be interpreted using figure 1 as a shift induced by a fundamental increase in the risk, which shifted the economy from a risky REE to a risky SCE. In that equilibrium we should observe higher default rates and higher interest rates. At the same time as 2 suggests, along the transition, we should observe that higher risk premia were required by ABS buyers to hedge against losses. This leads to the formulation of our first hypothesis as follows:

(H1) Before TALF, higher risk premia were *causing* lower ABS losses.

[TALF] combines Federal Reserve liquidity with capital provided by the Treasury, which allows it to accept some credit risk" “The Crisis and the Policy Response”, the Stamp Lecture, London School of Economics.

[28]Similar questions regarding the nature of beliefs had been addressed on similar empirical grounds by other papers on Self-Confirming application as, for example, Primiceri (2006) and Sargent et al. (2006)

Acceptance of (H1) would rationalize the upward trend of interest rates during the crises and the contextual reluctance of ABS buyers to accept transactions at lower interest rates. Acceptance of (H1) would also explain the fear that a policy like TALF that aims at lowering spreads could merely have the effect of increasing ABS losses at the expenses of the taxpayer, as Paul Krugman wrote.

The effect of the TALF could be interpreted as the effect of our optimal policy illustrated in figure 5. Risk premia should decrease for the effect of the insurance on counterpart risk. Competition should drive interest rates down, finally revealing the loss rate associated with low interest rates. A condition for the market to maintain low interest rates even after the intervention relies crucially on our second hypothesis.

(H2) After TALF, lower risk premia were *causing* lower ABS losses.

The acceptance of (H2) would establish that the introduction of TALF unveiled a relation between risk premia and losses that could not have been predicted by extrapolating from pre-TALF evidence. In other words, TALF generated public learning that made it possible for the market to stabilize at low risk premia. As a consequence, the TALF subsidy was never implemented, although the recovery was permanent.

4.1 Evidence in the market for *newly-generated* ABS Auto Loans

Why look at ABS Auto Loans?

To test our hypothesis we have chosen to investigate the Auto loan segment of the market for newly-generated ABS. The automotive ABS is the second largest category of ABS, after credit cards, supported by the TALF program on *newly-generated* ABS.[29] We chose to look at this market because the peculiar characteristics of the underlying contracts make our analysis particularly informative. Specifically, this is a segment which is fairly transparent, data are updated quite frequently and are publicly available. Moreover, the structure of both the ABS security and the underlying auto loan contracts are simple and mainly based on fixed interest rates with fixed maturity and known collateral (the auto itself). On the contrary, credit card ABS are typically less transparent, being based on revolving unsecured credit with a peculiar structure of interest rates and fees. Finally, as in our model, auto loans do not exhibit externalities across consumers (which could operate in credit cards); that is, it is hard to argue that the credit conditions granted to a set of auto loans may affect the likelihood of losses on a different set of auto loans.

[29]The TALF program for commercial mortgage-backed securities (CMBS) attracted almost exclusively *legacy* CMBS; however, as we said, our mechanism concerns primary - and not secondary - markets, so mortgages are excluded form our analysis.

Our Dataset

We have collected all the available free, online information[30] on Auto AAA-rated ABS tranches issued from 2007 to 2012, for 9 different issuers in the automotive sector. These nine companies are listed in Table 1. For each company, we list the tranche issued in each year with its own identifying tag.[31] In bold we report the tranches that were eligible collateral under TALF, which amounts to the 46,5% of all ABS-Auto covered by TALF.

	BMW	**Carmax**	**Ford**	**Harley**	**Honda**	**Hyundai**	**Nissan Lease**	**Nissan Owner**	**World Omni**
2007	2007-1	2007-1 2007-2 2007-3	2007-A 2007-B	2007-1 2007-2 2007-3	2007-1 2007-2 2007-3	2007-A	2007-A	2007-A 2007-B	2007-A 2007-B
2008		2008-1 2008-A 2008-2	2008-B 2008-B 2008-C	2008-1	2008-1 2008-2	2008-A	2008-A	2008-A 2008-B 2008-C	2008-A 2008-B
2009	**2009-1**	**2009-1** **2009-A** 2009-2	**2009-A** **2009-B** **2009-C** **2009-D** 2009-E	**2009-1** **2009-2** 2009-3 2009-4	**2009-2** **2009-3**	**2009-A**	**2009-A** 2009-B	2009-1 **2009-A**	**2009-A**
2010	2010-1	2010-1 2010-2 2010-3	2010-A 2010-B	2010-1	2010-1 2010-2 2010-3	2010-A 2010-B	2010-A 2010-B	2010-A	2010-A
2011	2011-1	2011-1 2011-2 2011-3	2011-A 2011-B	2011-1 2011-2	2011-1 2011-2	2011-A 2011-B 2011-C	2011-A 2011-B	2011-A 2011-B	2011-A 2011-B
2012	2012-1	2012-1 2012-2 2012-3 2012-3	2012-A 2012-B 2012-C 2012-D	2012-1		2012-A 2012-B 2012-C	2012-A 2012-B	2012-A 2012-B	2012-A 2012-B

Table 1: List of tranches for every issuing company (in **bold** the tranches that were eligible collateral under TALF).

For each tranche issued by company i at time (month) T we collected the following information.[32]

- The principal amount in US dollars – i.e. the total face value of the underlying pool of credit which bakes the security – which we denote by $Val_{i,T}$. Each of these entries is relative to a tranche, which is identified as being issued by company i at time T.

- The weighted average fixed interest rate[33] paid monthly by the security. In

[30] The data have been collected one piece of information at a time from prospectuses publicly available online. The major source utilized is *https://www.bamsec.com/companies/6189/208* where the majority of observations are available. The other sources are the issuers' websites which sometimes contain Trust prospectuses. Official TALF transaction data are available at: http://www.federalreserve.gov/newsevents/reform_talf.htm#data

[31] For example, Ford issued two different tranches on two different dates in 2007, whose labels are "2007-A" and "2007-B".

[32] Further details on the composition of the dataset, the sources and the procedure through which the data were collected are presented in Appendix B.1.

[33] A very few tranches included a small fraction of credit subject to variable interest rates. See Appendix B.1 for an explanation on how we treat these cases.

particular, each tranche consists of notes of different seniority, with different interest rates. More senior notes pay lower interest rates as they have priority in repayments. Hence, we take an average across different types of notes weighted for their relative principal amount. We denote by $X_{i,T}$ the difference between such weighted average and the 1-month Libor at time T, which is a proxy for the implied risk premium factored into interest rates. Each of these entries is relative to a tranche, which is identified as being issued by company i at time T.

- The per month flow of actual losses on receivables, measured as a fraction of initial pool balance, generated along the life of a tranche (around 4 years). In particular, we denote by $Y_{i,t,T}$ the difference in cumulative losses between date t and $t-1$ with $t > T$. Those summarize delinquencies on ABS receivables on a tranche of company i issued at time T that mature at a *subsequent* date $t > T$. Therefore, *causality* (if any) can only go from fixed interest rates to monthly losses and not viceversa.

A first look at the rough data gives a sense of the specific impact of the TALF on the ABS Auto market in the context of the general macroeconomic outlook.

Figure 6 plots the sum of $Val_{i,T}$ across companies at each point in time T. Note the collapse of issuance at the end of 2008 and the following recovery in 2009 during the TALF window. Contrast this with the course of the dotted green line, which denotes the total value (y-axis on the left) of minimal risk loan issued by US banks in the same period. The contrast highlights that the recovery in the ABS auto market during the TALF intervention coincides with the lowest pick of the safest segment of the credit market in the US economy.

Figure 7 plots the average $X_{i,T}$ across companies weighted for their issuance at each point in time T. Note the sharp increase of interest rate differentials at the end of 2008 and the following decrease in 2009 during the TALF period. Contrast this with the evolution of the dotted green dashed line, which denotes the interest rate differential on minimal risk loan issued by US banks in the same period. From the comparison we note that the decrease in interest rates in the automotive market during the TALF intervention is in stark contrast with a permanent increase in interest rates in the safest credit market in the US economy, which occurred at the beginning of 2009.

Figure 8 shows, for three representative companies, the evolution of the average $Y_{i,t,T}$ across time t relative to different issuances dates T. Note that the TALF period coincides with a drastic drop in average losses for each company. After TALF, losses never again reached the pre-crisis level. The figure also plots, with a dashed green line, the evolution of credit losses reported by all US banks in the same period. One can observe that while losses diminished in the AAA-Auto market, US banks were experiencing a rapid increase in delinquencies.

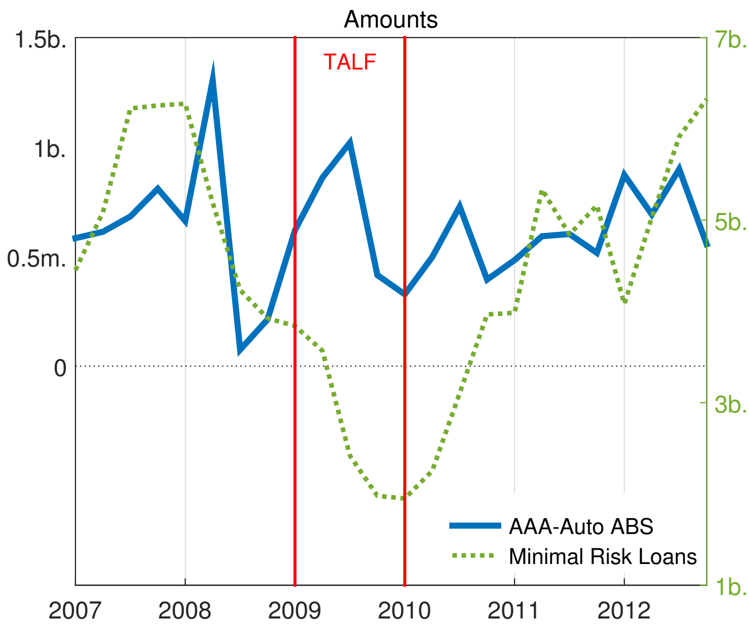

Figure 6: Total quarterly principal amounts issued in our sample for different categories of riskiness; the dotted line denotes the total amount of minimal risk loans agreed during the same period by US banks (3-quarter rolling window; scale on the right axis; source: ST. Louis FRED dataset.

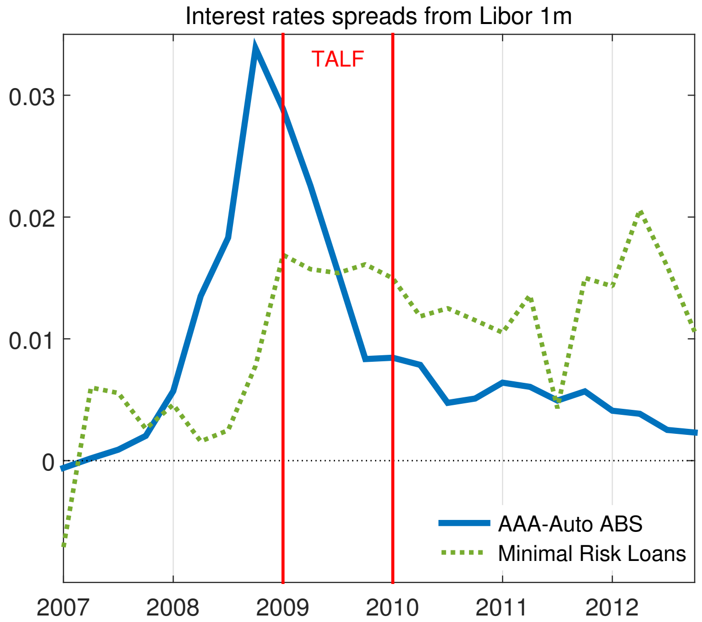

Figure 7: Quarterly weighted average (each company is weighted by its relative issued amount) of interest rate differentials from one-month Libor for different categories of riskiness; the dotted line denotes the interest rate differential from the one-month Libor on minimal risk loans agreed during the same period by US banks; source: ST. Louis FRED dataset.

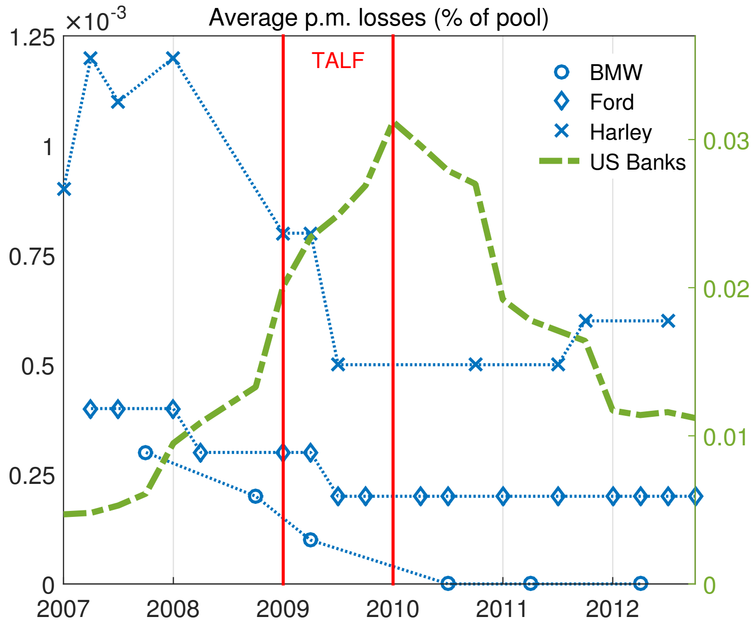

Figure 8: Average monthly loss for each tranche in the sample plotted in its quarter of issuance; the dashed line denotes losses experienced by US banks in the same period (scale on the right axis).

The comparison of the evolution of our sample with macro benchmarks - such as the ones represented by dotted/dashed lines in each figure - is suggestive of the specific effect of the introduction of the TALF into the Auto ABS market. At a first glance, we can distinguish between two periods: a pre-TALF period where interest rate differentials increase, volumes suddenly fall and losses are high, and a post-TALF where interest rate differentials fall and stay low, volumes recover and losses decrease.

4.2 Testing H1 and H2

Here, we present two econometric tests which differ for use of the available information and the set of controls that we use. Both validate our hypothesis on the existence of public learning induced by TALF.

A differential approach

Our first specification is designed to capture the point of view of an observer that wants to assess ex-post how the introduction of the TALF affected the impact of the interest spread on the losses. This is:

$$Y_{i,t,T} = \beta_0 + \beta_1 D_T + \beta_2 X_{i,T} + \beta_3 D_T X_{i,T} + \beta_4 Val_{i,T} + S_i + S_t + S_p + \epsilon_{i,t,T}, \quad (33)$$

where behind $Y_{i,t,T}$, $X_{i,T}$ and $Val_{i,T}$ we introduce: D_T, S_i, S_t and S_p.

D_T denotes a dummy which is 1 when the tranche has been issued after the introduction of TALF (i.e. $T > 03/2009$), and 0 otherwise. Thus, β_3 measures the differential effect of $X_{i,T}$ on $Y_{i,T}$ when $X_{i,T}$ has been fixed after the introduction of TALF (and then also after TALF expires). Therefore, the estimation of β_3 does not include information on losses realized after the introduction of TALF but that belong to tranches issued before that date.

We include a number of fixed-effects as controls. S_i denotes a company fixed-effect. S_t introduces a fixed-effect for each date, which is intended to capture all common factors acting across companies on the same date; among them there are business-cycle fluctuations but also specific measures adopted by the Auto sector in this period.[34] S_p includes a fixed-effect capturing the dependence of monthly losses from the number of the payment in the life of the security. This is intended to control for the non-linear deterministic trend, documented in appendix B.3, which shows that most of the losses occur in the first half of the security life. The presence of fixed-effects allow us to then isolate the muted impact of interest rate differentials when comparing simultaneous losses belonging to tranches issued before and after TALF.

[34] See, for example, Agarwal et al. (2015) and Ramcharan et al. (2015).

It is important to observe once again that all the regressors in (33) are pre-determined to losses, so coefficients should be interpreted as measures of *causal* effects.

Global Linear Regressions (dependent variable $Y_{i,t,T}$)

Variable		Coef	se
D_T		-0.0003^{**}	(0.0001)
$X_{i,T}$		-0.0042^{***}	(0.001)
$D_T X_{i,T}$		0.0108^{***}	(0.003)
$Val_{i,T}$		2.19^{-14}	(3.06^{-14})
R^2	0.6560		
Obs.	4169		

Standard errors clustered by issuing company. The model includes a constant, issuing company fixed-effects, time fixed-effect and payment number fixed-effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Effect of interest rates on cumulative losses controlling for time-fixed effects.

The results in table 2 confirm our hypotheses H1 and H2. The impact of the rate differential on the losses – that is β_2 – is negative and statistically significant; however, the differential effect conditional on the TALF being implemented – that is β_3 – is positive and statistically significant. Finally, the latter is larger than the former in absolute terms, and, therefore, the overall effect of spread on losses is positive during and after the introduction of the TALF.

The finding suggests that, the absence of TALF would have seen the market completely shut down and the available evidence would have been that higher interest rate differentials compress losses. Based on such evidence, no investor would have ever accepted low interest rate ABS. Moreover, none could have blamed the Fed for not taking risks. In fact, extrapolating from this evidence a policy aiming at lowering risk premia would have just generated higher losses. In contrast, the introduction of TALF produced the counterfactual that, once differential rates are sufficiently low, higher interest rate differentials increase losses, which induce persistent market stabilization.

Truncated samples

Our second specification is designed to capture the point of view of an observer who a day before the introduction of TALF, uses the available market information of the previous two years to assess the impact of interest rate differentials on losses[35]. In this specification we will also use business variable controls instead of fixed time-effects to check how this particular market correlates with the business cycle.

We run two regressions on two different subsamples of our dataset, with a similar number of observations. The first sample - Sample I - consists of all the data available before 25 March 2009, which is the date of implementation of TALF. The second,

[35] Recall that 2 years is the horizon of Krugman in the quote at the beginning of our Introduction.

Sample II, consists of all the data relative to tranches issued after 25 March 2009 for the following two years, i.e. until 1 April 2011.

On each sample we run the following linear regressions:

$$Y_{i,t,T} = \beta_0 + \beta_1 X_{i,T} + \beta_2 Val_{i,T} + \beta_3 Lib_T + S_i + \\ + \beta_4 Lib_t + \beta_5 u_t + \beta_6 Inf_t + \beta_7 Gdp_t + \beta_8 Vix_t + \epsilon_{i,t,T}$$

where u_t is the US monthly unemployment rate; Vix_t is the monthly VIX volatility index; Lib_t is the one-month Libor at time t; Lib_T is the one-month Libor at the time of the issuance T; Inf_t is the monthly US inflation rate; Gdp_t is the monthly US national GDP growth rate.

The regression aims at capturing the linear relation between interest rate differentials, which is a choice variable of the financing companies, and resulting losses, controlling for a number of tranche-specific factors, and business-cycle variables.[36]

Sample I provides information on the evolution of losses that one could have *expected* as a consequence of lower interest rates at the time of the introduction of the TALF. As Table 3 shows, the estimated coefficient is significant and negative, i.e. lower interest rates were expected to generate higher losses. This finding would explain the upward escape of interest rates documented in figure 7. Based on these beliefs, the mechanical decrease in interest rates due to TALF would be expected to generate higher losses for the policy maker.

Sample II is informative about the *actual* impact that the large decrease in interest rate differential induced by the TALF had on losses. The relevant coefficient is now significant and positive, meaning that lower interest rate differentials were yielding lower, rather than higher, losses. This result explains why there was no need to actually implement the TALF subsidy. This result also explains the tendency of firms to further decrease interest rates even after the TALF expired, in line with the evolution documented in figure 7.

Finally, the variables our business cycle control have all the expected signs when significant. In particular, note that the Lib_t, which closely tracks changes in federal fund rates, impacts on losses with a negative sign in both samples, in line with several studies that have identified the risky channel of monetary policy. This result tells us that the effect of lowering Fed fund rates would not have been a substitute for TALF in this specific market.

Furthermore, Lib_t is statistically significant in Sample I but not in Sample II, whereas the opposite occurs for Lib_T. The reason is that in Sample II Lib_t does not move much as it is constrained by the zero lower bound. Another effect of the presence of a zero lower bound in Sample II is the significance of u_t, which as a matter of fact, becomes a proxy for a change in shadow policy rates.

[36]This specification does not capture eventual non-linearities in our micro-data or in business-cycle series. However, the truncation of the sample reduces the eventual misspecification as argued by Hahn et al. (2001).

Local Linear Regressions (dependent variable $Y_{i,t,T}$)		
Variable	Coef	se
Sample I: Pre-TALF issuances, payments until March 2009		
$X_{i,T}$	-0.0237^{**}	(0.0075)
$Val_{i,T}$	2.07^{-14}	(2.59^{-14})
Lib_t	-0.0113^{**}	(0.0041)
Lib_T	-0.0043	(0.0057)
u_t	-0.00001	(0.00001)
Inf_t	0.0020	(0.0014)
Gdp_t	-0.0039^{*}	(0.0020)
Vix_t	0.00001^{***}	(2.59^{-06})
R^2	0.5445	
Obs.	536	
Sample II: Post-TALF issuances, payments until April 2011		
$X_{i,T}$	0.0200^{**}	(0.0072)
$Val_{i,T}$	-1.11^{-14}	(4.25^{-14})
Lib_t	-0.0520	(0.0441)
Lib_T	-0.0100^{***}	(0.0029)
u_t	0.0001^{***}	(0.00004)
Inf_t	-0.0010	(0.056)
Gdp_t	0.014	(0.0033)
Vix_t	-0.00001^{**}	(5.48^{-06})
R^2	0.5378	
Obs.	589	

Standard errors clustered by issuing company. The model includes a constant and issuing company fixed-effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Effect of interest rates on cumulative losses controlling for business cycle variables.

5 Conclusions

This paper presents a new approach to monetary policy in situations of high economic uncertainty, where private agents and policy makers may misperceive – and possibly underestimate – the actual strength of the economy. By developing and applying the concept of Self-Confirming Equilibrium to a competitive financial market we can characterize a (previously non-captured) form of credit crisis and, more importantly, we show that *Credit Easing* can be the optimal policy response, breaking the credit freeze. While we present a new theory, the paper also emphasizes that the Fed TALF experience in 2009 can be seen as a frontrunner example, which we empirically investigate in support of our theory.

A Appendix: Proofs

A.1 Proposition 1

Proof. To find $\hat{R}_s$ and $\hat{R}_r$ we just solve (17) with (1) to (5). Hence, $\hat{R}_s$ and $\hat{R}_r$ result after imposing incentive-compatibility and participation constraints and noting that the two interiors solve well-defined convex problems (so the closer to the interior the higher the payoff). Note that, at the risky equilibrium, lenders' participation constraint $\alpha R_r^* - \delta \geqslant 0$ is always satisfied whenever borrowers' participation constraint $y - R_r^* \geqslant 0$ is too: in fact $y \geqslant R_r^*$ implies $y \geqslant \delta/\alpha$ which in turn yields $R_r^* \geqslant \delta/\alpha$. ∎

A.2 Proposition 2

Proof. The two values $\underline{\alpha}(k)$ and $\bar{\alpha}(k)$ correspond respectively to $\bar{R} = \hat{R}_s$ and $\bar{R} = \delta$.

For $\alpha < \underline{\alpha}(k)$ we have

$$\mu(R_r^*) = \pi^b(R_r^*; \alpha, \omega)^{\frac{\gamma}{1-\gamma}} \pi^l(R_r^*; \alpha, \omega) < \mu(\hat{R}_s) = \pi^b(\hat{R}_s; k, \omega)^{\frac{\gamma}{1-\gamma}} \pi^l(\hat{R}_s; k, \omega),$$

that is,

$$\gamma^{\frac{\gamma}{1-\gamma}}(1-\gamma) \max\left\{(\alpha y - \delta)^{\frac{\gamma}{1-\gamma}}, 0\right\} < \gamma^{\frac{\gamma}{1-\gamma}}(1-\gamma)(y-k-\delta)^{\frac{\gamma}{1-\gamma}},$$

whenever $\bar{R} > 0$ which is true for $\alpha < \underline{\alpha}(k)$. We conclude that whenever $R_s^* = \hat{R}_s$ thenR_s^* is an REE.

For $\alpha > \bar{\alpha}(k)$, contracts that induce the safe adoption require a R lower than the cost of money δ, which violates the participation constraint of the lender; therefore R_r^* will be the unique REE for $\alpha > \bar{\alpha}(k)$.

For $\alpha \in (\underline{\alpha}(k), \bar{\alpha}(k))$ we have that $R_s^* = \bar{R}$. The relevant equation for $R_s^* = \bar{R}$ to be unique REE is

$$\mu(R_r^*) = \pi^b(R_r^*; \alpha, \omega)^{\frac{\gamma}{1-\gamma}} \pi^l(R_r^*; \alpha, \omega) < \mu(\bar{R}|\rho = k) = \pi^b(\bar{R}; k, \omega)^{\frac{\gamma}{1-\gamma}} \pi^l(\bar{R}; k, \omega),$$

that is,

$$\gamma^{\frac{\gamma}{1-\gamma}}(1-\gamma) \max\left\{(\alpha y - \delta)^{\frac{\gamma}{1-\gamma}}, 0\right\} < \left(\left(y - \frac{k}{1-\alpha} - \delta\right)\left(\frac{\alpha k}{1-\alpha}\right)^{\frac{\gamma}{1-\gamma}}\right).$$

On the one hand, $\mu(R_r^*)$ is always monotonically increasing in α. On the other hand, $\mu(\bar{R})$ is always monotonically decreasing in α, given that:

$$\frac{\partial\left(\left(y - \frac{k}{1-\alpha} - \delta\right)\left(\frac{\alpha k}{1-\alpha}\right)^{\frac{\gamma}{1-\gamma}}\right)}{\partial \alpha} = \frac{(1-\alpha)\gamma(y-k-\delta) - 2k\alpha}{\alpha(1-\alpha)^2(1-\gamma)}\left(\frac{\alpha k}{1-\alpha}\right)^{\frac{\gamma}{1-\gamma}} < 0,$$

holds for $\alpha \in (\underline{\alpha}, \bar{\alpha})$.[37] Hence, we can conclude that

$$\left(y - \frac{k}{1-\alpha} - \delta\right)\left(\frac{\alpha k}{1-\alpha}\right)^{\frac{\gamma}{1-\gamma}} = \gamma^{\frac{\gamma}{1-\gamma}}(1-\gamma)\max\left\{(\alpha y - \delta)^{\frac{\gamma}{1-\gamma}}, 0\right\},$$

defines a threshold $\hat{\alpha}(k)$, such that for $\alpha < \hat{\alpha}(k)$ $R_s^* = \bar{R}$ is the unique REE, whereas for $\alpha > \hat{\alpha}(k)$, R_r^* is the unique REE. The hedge case $\alpha = \hat{\alpha}(k)$ is the only one where two REE exist. To conclude, note that

$$\frac{\partial\left(\left(y - \frac{k}{1-\alpha} - \delta\right)\left(\frac{\alpha k}{1-\alpha}\right)^{\frac{\gamma}{1-\gamma}}\right)}{\partial k} = \frac{(1-\alpha)\gamma(y-\delta) - k}{k(1-\alpha)(1-\gamma)}\left(\frac{\alpha k}{1-\alpha}\right)^{\frac{\gamma}{1-\gamma}} < 0$$

holds for $\alpha \in (\underline{\alpha}(k), \bar{\alpha}(k))$.[38] This implies that $\hat{\alpha}(k)$ has to be decreasing in k. ∎

A.3 Proposition 3

Proof. Suppose lenders play R_r^* and that $\alpha < \hat{\alpha}(k)$. By definition of SSCE their expectations about $\rho^*(R_r^*, \omega)$ are correct at the equilibrium, which implies that lenders know α but can have misspecified beliefs about k. In particular, for a $E[k]$ sufficiently high, such that $\hat{\alpha}(E[k])$ is sufficiently low (by proposition A.2), we can have $\alpha > \hat{\alpha}(E[k])$ that implies that lenders wrongly believe that R_r^* is the unique REE (i.e. the global maxima when evaluated by β).

On the other hand, R_s^* cannot be SSCE without being REE. Suppose such an equilibrium exists, then it would arise as a corner solution posted at the frontier $\bar{R}$ because it turns out that interior solutions $\hat{R}_s$ are always REE (i.e. the global maxima when evaluated by ϕ). Nevertheless, by definition of an SSCE, agents would have correct beliefs for marginal deviations from the equilibrium that, at the frontier, are indeed sufficient to induce safe project adoption. Therefore at an SSCE posted along the frontier $\bar{R}$, agents would know the actual α. Hence lenders can correctly forecast $\rho(R, \omega)$ at any R, and so they cannot sustain a safe SSCE that is not an REE. A contradiction arises. ∎

B Appendix: Data

B.1 Data on ABS in the Automotive Industry

The data that we have collected are information on Asset Backed Securities (ABS) in the US automotive sector. The data include information on: Cumulative Losses with respect to the original Pool Balance, Interest Rates, Principal Amounts in US

[37] Note that $\alpha k/(1-\alpha(k))$ in increasing in α and $k\underline{\alpha}/(1-\underline{\alpha}) = \gamma(y-k-\delta)$.

[38] Note that $k/(1-\alpha)$ is increasing in α and $k/(1-\underline{\alpha}(k)) = \gamma(y-\delta) + (1-\gamma)k$.

dollars. The information is collected for 9 issuers in the automotive sector, namely: BMW Vehicle Lease Trust, CarMax Auto Owner Trust, Ford Credit Auto Owner Trust, Harley-Davidson Motorcycle Trust, Honda Auto Receivables Owner Trust, Hyundai Auto Receivables Trust, Nissan Lease Trust, Nissan Auto Receivables Owner Trust, World Omni Auto Receivables Trust.

Every year, each of these companies delivers a variable number of tranches. For instance, World Omni in 2008 extended loans in two tranches (2008-A, 2008-B), while the same company extended only one tranche in 2009 (2009-A). As far as our analysis is concerned, we collected all the free available online information on tranches issued from 2007 till 2012, a time span which includes the introduction of the Term Asset-Backed Securities Loan Facility (TALF). Table 1 reports the tranches sorted by issuers for which we have found information. Each of these Trusts issued loans of different "Class" (or Asset Backed Notes): A1, A2, A3, A4, B and C. Obviously, the Principal Amount of these loans differs by Class, and each Class is also characterized by a different degree of risk (interest rate). It goes from the more secure loan with the lowest interest rate (A1) progressively to the riskier categories (A2, A3 and so on). The Trust will pay interest and principal on the notes on the 15th day of each month (or the next business day).

All the issuing entities listed in **bold** in Table 1 were eligible for the TALF program. The number of tranches that were eligible varies by issuer. The program started on 25 March 2009. The tranches covered by the TALF program that are included in the database are sufficiently representative of the whole sample of Asset Backed Securities covered by TALF in the US automotive sector; more precisely, the sum of the loan amounts mentioned above represents around 46.5% of all Auto-ABS covered by TALF (calculations are our own, reference "TERM ASSET-BACKED SECURITIES LOAN FACILITY DATA" from FED). The data have been collected one piece of information at a time from prospectuses publicly available online. The major source utilized is *https://www.bamsec.com/companies/6189/208* where the majority of observations are available. The other sources are the issuers' websites which sometimes contain the Trusts' prospectuses.

Concerning the controls for the business cycle, the data were collected from several sources: the monthly US Inflation is calculated as $(CPI_t - CPI_{t-1})/CPI_{t-1}$ and the US Consumer Price Index (all items) are taken from OECD (MEI); The US Civilian Unemployment rate not seasonally adjusted comes from the US Bureau of Labor Statistics; the CBOE Volatility Index (VIX) along with the one-month Libor correspondent to the 15th day of each month are from the St. Louis FED data. Lastly, the monthly GDP Index used to calculate the GDP growth rate is from *Monthly GDP Index - Macroeconomic Advisers*.

B.2 Construction of the variables for the Empirical analysis

Cumulative Losses with respect to the original Pool Balance. The cumulative net losses for each issuing entity and for every tranche refer to the total pool, which includes all risk classes. Therefore, data on losses are not available at disaggregated class level. The losses are reported monthly and the time span of monthly losses varies depending on the date Trusts are issued and the number of payments expected.

Interest Rates. Interest rates vary within tranches according to seniority. For some Asset Backed Notes the loans are issued as a combination of fixed and floating components of interest rates. For instance, in the case of Ford credit Auto Owner Trust 2007-A the Class A2 is divided into the 'a' and 'b' components, where the 'a' component extends loans with a fixed interest rate of 5.42% and the 'b' component has the floating rate of one-month Libor + 0.01%. In those few cases we calculate the weighted average of class A2, where the weights are the principal amounts in US dollars for each component and the floating component is substituted by the corresponding FED one-month Libor at the time when the prospectus was made (source: *http://www.fedprimerate.com/libor.htm*). Following this particular example, the weighted interest rate for the A2 Class of Ford credit Auto Owner Trust 2007-A whose prospectus was made in June 2007, equals $((5.42 * 300) + (5.33 * 287.596))/(300 + 287.596)$ where the one-month Libor in June 2007 equals 5.32%.

The dataset contains both the weighted average of interest rates expressed in levels, as well as the differentials with respect to the corresponding one-month Libor at the time when the prospectus was made. The latter is utilized as the variable of interest in our empirical analysis. It is calculated as follows: within each tranche we first obtain the differential of the interest rates of every class with respect to the corresponding one-month Libor at the time when the prospectus was made. Then we calculate the inter-Class global weighted average of these differentials using Principal amounts as weights.

As an example we use World Omni Auto Receivables Trust 2009-A where for the Classes A1,A2,A3 and A4 the calculated interest rate differentials are 1,17%, 2.43%, 2.88% and 4.67%, respectively, while the corresponding principal amounts in US million dollars are 163, 192, 248 and 147, respectively. Table 4 gives an example of the structure of the data and how the information on Principal Amounts and Interest Rates are presented for each tranche in all prospectuses. The resulting weighted average of interest rate differentials for each Trust is $((1.17\% * 163\text{m.}) + (2.43\% * 192\text{m.}) + (2.88\% * 248\text{m.}) + (4.67\% * 147\text{m.}))/(163\text{m.} + 192\text{m.} + 248\text{m.} + 147\text{m.})$.

Principal Amounts in US dollars. Principal Amounts vary within Trusts according to the Class being considered. In our empirical exercise, it stands for a control; it is included as the sum of the Amounts within each Trust of all Asset Backed Notes. In the previous example for World Omni Auto Receivables Trust 2009-A, it enters the model as $(163\text{m.} + 192\text{m.} + 248\text{m.} + 147\text{m.}) = 750\text{m.}$

Asset Backed Notes 2009-A	Class A1 Notes	Class A2 Notes	Class A3 Notes	Class A4 Notes
Principal Amount	163m.	192m.	248m.	147m.
Interest Rate	1.62%	2.88%	3.33%	5.12%
Payment Dates	Monthly	Monthly	Monthly	Monthly
Initial Payment Date	May 15,2009	May 15,2009	May 15,2009	May 15,2009
Final Scheduled Payment Date	April 15,2010	October 17,2011	May 15,2013	May 15,2014

Table 4: World Omni Auto Receivables Trust 2009-A (04-2009; 1m. libor at 0.45)

B.3 Non-linear trend in monthly losses

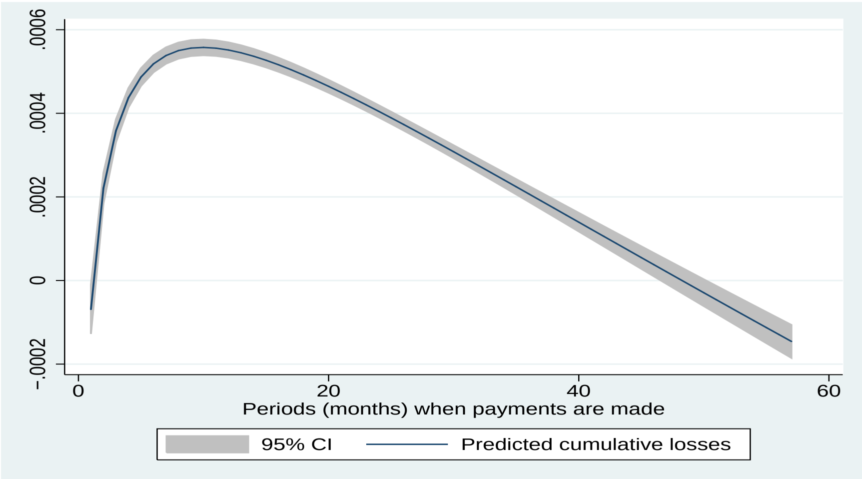

Figure 9: Predicted mean of ABS monthly cumulative losses over time: the y axis has the first differences of cumulative losses with respect to initial pool balance for each tranche $q(t)$, the x axis reports the time span of ABS repayments

There is a common pattern that emerges for each tranche in the evolution of monthly losses over time, which tends to peak around the 15th-20th month and then progressively dies away as time goes by. This means that losses concentrate in the first half of the life of each trend, whereas late losses can even be positive due to the recovery of earlier delinquencies. The pattern is well illustrated in Figure 9 which shows the predicted mean of monthly cumulative losses of ABS over time within a 95% confidence interval. The resulting decreasing trend over time is determined by clients' debt repayments of past instalments (reduction of delinquencies) which contributes to the flattening of the curve.

References

Agarwal, S., G. Amromin, S. Chomsisengphet, T. Piskorski, A. Seru, and V. Yao (2015): "Mortgage Refinancing, Consumer Spending, and Competition: Evidence from the Home Affordable Refinancing Program," NBER Working Papers 21512, National Bureau of Economic Research, Inc.

Agarwal, S., J. Barrett, C. Cun, and M. D. Nardi (2010): "The asset-backed securities markets, the crisis and TALF," *Economic Perspectives, Federal Reserve Bank of Chicago*, Q IV, 101 – 115.

Ashcraft, A., N. Garleanu, and L. H. Pedersen (2011): "Two Monetary Tools: Interest Rates and Haircuts," in *NBER Macroeconomics Annual 2010, Volume 25*, National Bureau of Economic Research, Inc, NBER Chapters, 143–180.

Ashcraft, A., A. Malz, and Z. Pozsar (2012): "The Federal Reserve's Term Asset-Backed Securities Loan Facility," *The New York Fed Economic Policy Review*.

Battigalli, P. (1987): "Comportamento Razionale ed Equilibrio nei Giochi e nelle Situazioni Sociali," *Undergraduate Dissertation, Bocconi University*.

Battigalli, P., S. Cerreia-Vioglio, F. Maccheroni, and M. Marinacci (2015): "Self-Confirming Equilibrium and Model Uncertainty," *American Economic Review*, 105, 646 – 677.

Bebchuk, L. A. and I. Goldstein (2011): "Self-fulfilling Credit Market Freezes," *Review of Financial Studies*, 24, 3519–3555.

Campbell, S., D. Covitz, W. Nelson, and K. Pence (2011): "Securitization markets and central banking: An evaluation of the term asset-backed securities loan facility," *Journal of Monetary Economics*, 58, 518–531.

Chari, V., A. Shourideh, and A. Zetlin-Jones (2014): "Reputation and Persistence of Adverse Selection in Secondary Loan Markets," *American Economic Review*, 104, 4027–70.

Cho, I.-K. and T. J. Sargent (2008): "self-confirming equilibria," in *The New Palgrave Dictionary of Economics*, ed. by S. N. Durlauf and L. E. Blume, Basingstoke: Palgrave Macmillan.

Cole, H. L. and T. J. Kehoe (2000): "Self-Fulfilling Debt Crises," *Review of Economic Studies*, 67, 91 – 116.

Correia, I., F. De Fiore, P. Teles, and O. Tristani (2014): "Credit Spreads and Credit Policies," *C.E.P.R. Discussion Papers, n.9989*.

Eeckhout, J. and P. Kircher (2010): "Sorting versus screening: search frictions and competing mechanisms," *Journal of economic theory*, 145, 1354 – 1385.

Evans, G. W. and S. Honkapohja (2001): "Learning and Expectations in Macroeconomics," *Princeton University Press*.

Farhi, E. and J. Tirole (2012): "Collective Moral Hazard, Maturity Mismatch, and Systemic Bailouts," *American Economic Review*, 102, 60–93.

Fudenberg, D. and D. K. Levine (1993): "Self-Confirming Equilibrium," *Econometrica*, 61, 523–45.

——— (2006): "Superstition and Rational Learning," *American Economic Review*, 96, 630–651.

——— (2009): "Self-confirming equilibrium and the Lucas critique," *Journal of Economic Theory*, 144, 2354–2371.

Gertler, M. and P. Karadi (2011): "A model of unconventional monetary policy," *Journal of Monetary Economics*, 58, 17–34.

Gorton, G. and G. Ordonez (2014): "Collateral Crises," *American Economic Review*, 104, 343–78.

Hahn, F. H. (1977): " Exercises in Conjectural Equilibria," *Scandinavian Journal of Economics*, 79, 210–226.

Hahn, J., P. Todd, and W. V. D. Klaauw (2001): "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design," *Econometrica*, **69**, 201–209.

Hosios, A. J. (1990): "On the Efficiency of Matching and Related Models of Search and Unemployment," *Review of Economic Studies*, 57, 279–98.

Johnson, K. W., K. M. Pence, and D. J. Vine (2014): "Auto Sales and Credit Supply," *Finance and Economics Discussion Series, Federal Reserve Board*.

Kim, K., B. Lester, and B. Camargo (2012): "Subsidizing Price Discovery," *Society for Economic Dynamics 2012 Meeting Papers*, 338.

Lucas, R. J. (1976): "Econometric policy evaluation: A critique," *Carnegie-Rochester Conference Series on Public Policy*, 1, 19–46.

Moen, E. R. (1997): "Competitive Search Equilibrium," *Journal of Political Economy*, 105, 385–411.

Peters, M. (1984): "Equilibrium with Capacity Constraints and Resticted Mobility," *Econometrica*, 52, 1117 – 1127.

Primiceri, G. (2006): "Why Inflation Rose and Fell: Policymakers' Beliefs and US Postwar Stabilization Policy," *Quaterly Journal of Economics*, 121, 867–901.

Ramcharan, R., A. Kermani, and M. D. Maggio (2015): "Monetary Policy Pass-Through: Household Consumption and Voluntary Deleveraging," Tech. rep.

Rhee, J. (2016): "Term Asset-Backed Securities Loan Facility (TALF)," Yale School of Management.

Sargent, T., N. Williams, and T. Zha (2006): "Shocks and Government Beliefs: The Rise and Fall of American Inflation," *American Economic Review*, 96, 1193–1224.

——— (2009): "The Conquest of South American Inflation," *Journal of Political Economy*, 117, 211–256.

Sargent, T. J. (2001): "The Conquest of American Inflation," *Princeton University Press*.

Shi, S. (2006): "Search Theory; Current Perspectives," Working Papers tecipa-273, University of Toronto, Department of Economics.

Tirole, J. (2012): "Overcoming Adverse Selection: How Public Intervention Can Restore Market Functioning," *American Economic Review*, 102, 29–59.