A Leverage-based Model of Speculative Bubbles*

Gadi Barlevy
Economic Research Department
Federal Reserve Bank of Chicago
230 South LaSalle
Chicago, IL 60604
e-mail: gbarlevy@frbchi.org

June 25, 2009

Abstract

This paper explores whether various credit market interventions can give rise to or rule out the possibility of speculative bubbles. As in previous work by Allen and Gorton (1993) and Allen and Gale (2000), a bubble can occur in my model because traders purchase assets with funds borrowed from creditors who cannot monitor those to whom they lend. This paper adds to this literature by allowing creditors and traders to enter into more general contracts, and by allowing dynamic considerations to affect both contracting and trading strategies. The model suggests that limiting the use of exotic loan contracts need not rule out bubbles, and that the existence of a bubble hinges not on how low short-term rates fall during a monetary expansion but on where rates are expected to settle subsequently.

*I am grateful to Franklin Allen, Marco Bassetto, Christian Hellwig, Guido Lorenzoni, Rob Shimer, and Harald Uhlig for helpful comments, and to seminar participants at the Banque de France, the University of Chicago, Duke, Ohio State, NYU, Western Ontario, Wharton, the Society of Economic Dynamics, and the Federal Reserve Banks of Chicago, Cleveland, St. Louis, and Philadelphia. I also wish to thank David Miller and Kenley Pelzer for their research assistance. The views expressed here need not reflect those of the Federal Reserve Bank of Chicago or the Federal Reserve System.
Introduction

The spectacular rise and fall of stock prices in the late 1990s and housing prices in the mid 2000s have been cited by many pundits as examples of asset bubbles. Economists typically use the term “bubble” to mean that the price of an asset differs from its “fundamental” value, i.e. the present discounted value of dividends generated by the asset. Whether these episodes truly meet this definition is difficult to ascertain. However, the mere notion that asset prices may have become unhinged from fundamentals during this period has shaped the macroeconomic policy debate. For example, some have criticized the aggressive easing pursued by the Federal Reserve in response to the 2001 recession on the grounds that it allowed asset bubbles to arise. Others have faulted the Fed in its regulatory capacity for permitting the proliferation of exotic lending contracts that encouraged speculation, e.g. offers of low initial or “teaser” rates that are eventually reset to higher rates over the duration of the loan. Even setting aside the question of whether these episodes were in fact bubbles, it is hard to evaluate the merit of these critiques, since they rely on intuition rather than a clearly articulated channel for how such policies make bubbles possible.

The main difficulty with modelling such a channel is that in many standard economic models, bubbles cannot occur at all, regardless of credit market policy. This was demonstrated by Tirole (1982), who derived conditions for ruling out the possibility of bubbles in equilibrium. Although several models have been offered which violate these conditions and allow for bubbles, many of these have been criticized as implausible or not conducive for policy analysis. One example are overlapping generation models of money such as Samuelson (1958) and Diamond (1967), which Tirole (1985) interpreted as models of bubbles. Bubbles typically emerge in these models only if the economy grows at least as fast as the riskless rate of return on savings; yet Abel, Mankiw, Summers, and Zeckhauser (1989) show that a generalization of this prediction is rejected empirically. Santos and Woodford (1997) further argue that the bubbles in these models are theoretically fragile, since they would cease to exist as long as even some agents who own a non-vanishing share of the aggregate endowment have infinite horizons. Other model assume agents have different prior beliefs over the fundamental value of the asset, e.g. Harrison and Kreps (1978), Allen, Morris, and Postlewaite (1993), and Scheinkman and Xiong (2003), or that some agents trade in a way that does not depend on fundamentals, e.g. DeLong, Shleifer, Summers, and Waldmann (1990). But without a model for why agents disagree about fundamentals or ignore them when trading, it is hard to predict how changes in policy will affect the possibility of speculative bubbles. Moreover, in none of these models do credit markets play a role in allowing asset bubbles to emerge.

An alternative theory of bubbles which gives a more prominent role to credit markets was developed by Allen and Gorton (1993) and Allen and Gale (2000). These papers emphasize the role of agency problems as a source of bubbles. More specifically, they consider environments in which agents enter into contracts with financiers who cannot monitor what agents do with the funds they receive. Under these conditions,
agents may agree to buy overvalued assets, so bubbles become possible. This paper builds on these models to explore how various credit market interventions affect the possibility of a bubble. In particular, it extends the Allen and Gale (2000) model to allow for endogenous contracting and dynamics. This is because if we wish to study the role of particular lending contracts, we need to enrich the space of financial contracts to include such contracts in the first place. Likewise, to study the effect of temporary interest rate cuts, we need to introduce a time dimension into the model. Just as importantly, dynamics introduces a “speculative” motive for purchasing overvalued assets in the sense of Harrison and Kreps (1978), i.e. buying an asset in the hope of selling it later for a capital gain. This motive plays an important role in my analysis. Although Allen and Gorton (1993) already considered a dynamic model of speculation, their model is too stylized to explore the questions that motivate this paper. For example, since the asset in their model is intrinsically worthless, one can show that financiers could screen out speculators if they coordinated to extending only debt contracts rather than profit-sharing contracts. This makes their model particularly difficult for exploring the role of leverage in allowing bubbles to emerge.

My model offers several new insights regarding the role of policies in either enabling or curtailing the possibility of speculation, thus extending the work of Allen and Gale (2004) on the policy implications of such models of bubbles. First, I argue that precluding teaser rate contracts need not eliminate bubbles, and such contracts may in fact serve to rein in asset overvaluation rather than contribute to it. This suggests the focus on contracting arrangements as a cause of bubbles may have been misplaced. As for interest rate policy, the model suggests that the existence of the bubble hinges not on how low rates were when the Fed lowered them, but how high agents expected rates would be in the future. This is because traders who buy overvalued assets are speculating about their future value, and thus care about future conditions when deciding whether to buy assets for more than their inherent worth.

The paper is organized as follows. Section 1 works through a static version of the model with a restricted set of contracts to illustrate why bubbles can emerge in my framework. Section 2 lays out the full dynamic model with optimal contracting. Section 3 solves the contracting problem between borrowers and financiers. Section 4 discusses the relevance of the model for analyzing recent episodes that many suspect as examples of bubbles. Section 5 explores the effects of various policy prescriptions in the model. Section 6 concludes.

1 A Model of Leverage-Based Bubbles

To understand why the model I develop allows bubbles, it will help to start with a version of the model with only one period. This version is essentially the same as Allen and Gale (2000), a fact that highlights that a bubble emerges in my model for the same reason as in theirs: Those who buy assets can shift risk to their creditors. I then argue that addressing the questions posed in the Introduction requires extending the model to a dynamic setting, and I point out some issues that arise once we move to multiple periods.
In the one period version, agents can purchase assets at the beginning of the period that pay a stochastic dividend \( d \) at the end of the period. Suppose \( d = D > 0 \) with probability \( \epsilon \), where \( 0 < \epsilon < 1 \), and \( d = 0 \) otherwise. The expected profits from buying an asset at price \( p \) with one’s own funds are

\[
\epsilon (D - p) + (1 - \epsilon) (-p)
\]

This payoff is nonnegative if \( p \leq \epsilon D \), i.e. a trader will not pay more for the asset than its expected value. But this result need not hold when traders buy the asset with borrowed funds. Following Allen and Gale (2000), suppose a trader with no initial wealth enters a limited-liability debt contract with interest rate \( r \). The expected payoff from buying an asset at price \( p \) and defaulting if \( d = 0 \) is given by

\[
\epsilon \cdot \max (0, D - (1 + r)p) + (1 - \epsilon) \cdot 0
\]

This payoff is positive if \( p < D / (1 + r) \), i.e. a trader would be willing to pay up to \( D / (1 + r) \) for the asset. As long as the lender charges a low enough interest rate, specifically if \( 1 + r < 1/\epsilon \), the trader would be willing to buy the asset even if it was a bubble, i.e. if its price \( p \) exceeded its expected value \( \epsilon D \).

It is easy to confirm that if \( p > \epsilon D \) and \( 1 + r < 1/\epsilon \), lending to an agent so he can buy the asset yields a negative expected return to the lender. Lenders should thus refuse to fund such trades. But in practice, lenders may not always be able to tell whether borrowers are buying overvalued assets as opposed to engaging in activities that are profitable to finance at low \( r \). For example, while some borrowers buy real estate in case land rents turn out to be high, others wish to buy property they cannot currently afford and must borrow against safe future income to do so. Similarly, while some traders buy equity in case a firm proves to be profitable, others may have an informational advantage about the stocks they trade that makes it profitable to finance them. If lenders cannot distinguish good and bad borrowers but believe enough borrowers are good, they will agree to lend to both at a common low rate. For simplicity, I model good borrowers as entrepreneurs who own no resources but have access to a technology that converts one unit of resources into \( R > 1/\epsilon \) units. This technology can use at most one unit of input, implying entrepreneurs require a finite amount of resources. Entrepreneurs who choose to produce do not use the asset. They are only relevant for the asset market because they borrow in the same market as those who buy the asset. If enough borrowers are entrepreneurs who opt to produce, it will be profitable to lend 1 unit to both at rate \( 1 + r < 1/\epsilon \) despite expected losses from those who borrow to buy the asset.

In sum, imperfectly informed lenders might be willing to lend at low enough rates that leveraged traders can profit from buying overvalued assets. To confirm that assets can in fact be overvalued in equilibrium, I need to introduce additional structure to derive the equilibrium of this economy. Consider the asset market first. I assume assets are available in fixed supply and cannot be sold short. For a bubble to occur, demand for the asset must exceed its fixed supply when \( p = \epsilon D \). A sufficient condition for this is if the number of traders is at least \( D \) times as large as the number of assets. Since lenders will not lend to an agent more
than an entrepreneur requires, agents can only borrow 1 unit of resources. But since the asset will not trade above its maximal payoff of $D$, my assumption ensures buyers can collectively borrow more than the stock of assets could ever be worth. Profits from borrowing and buying the asset must then equal zero, or else demand for the asset will exceed its fixed supply. This implies

$$p = \frac{D}{1 + r}$$

(1)

Note that with zero profits from buying the asset, entrepreneurs will prefer to produce than buy the asset. Entrepreneurs can thus be allowed to choose between buying the asset and borrowing to produce.

Next, consider the credit market. I assume free entry by lenders, implying lenders earn zero profits in equilibrium. Let $\phi$ denote the fraction of borrowers who produce, and $1 - \phi$ the fraction who buy assets. The zero profit condition for lenders is given by

$$\phi r + (1 - \phi) \left[ \epsilon \cdot \min \left( r, \frac{D}{p} - 1 \right) + (1 - \epsilon) (-1) \right] = 0$$

(2)

Solving equations (1) and (2) yields

$$p = \phi D + (1 - \phi) \epsilon D$$

$$r = \frac{1 - \epsilon}{\epsilon + \phi / (1 - \phi)}$$

Thus, as long as some agents borrow to produce rather than to buy the asset, i.e. $\phi > 0$, and as long as the number of potential traders is large, the unique equilibrium price $p$ will exceed $\epsilon D$.

The one period example above illustrates how limited information on the part of creditors could lead to asset bubbles, i.e. situations in which assets trade at prices that exceed their fundamental worth. This insight was already made in Allen and Gale (2000). But to study how various credit-market interventions might affect the possibility of such bubbles, we need to move beyond this insight and extend the model sketched above in at least two ways: allowing for a richer set of contracts and introducing dynamics.

To appreciate the need for richer financing arrangements beyond simple debt contracts, recall that in the wake of the recent housing crisis, some critics argued that exotic financial arrangements such as teaser-rate contracts with low initial payments were responsible for luring in buyers and gave rise to a bubble. To determine whether restricting the use of these contracts could eliminate the possibility of bubbles, we need to allow for such contracts in the first place. More generally, allowing a richer contracting environment allows us to explore whether leverage-fueled bubbles are robust to more sophisticated contracts that may make it possible for lenders to screen out those wishing to invest in the bubble.

Allowing for contracts in which payments can rise after some time has passed obviously requires extending the model to include a time dimension. Adding dynamics is also essential for gauging whether interest rate
cuts could give rise to bubbles when these cuts are temporary. But the main advantage of casting the model in a dynamic framework is that it introduces the possibility of speculative trading in the sense of Harrison and Kreps (1978), i.e. buying the asset with the hope of selling it later for a higher price. The possibility of resale is absent in a static model, but is nevertheless important for understanding bubbles. Indeed, one implication of my model is that creditors prefer teaser contracts because they encourage those who buy overvalued assets to sell them. We shall also see that the possibility of resale may entice agents who are not leveraged to buy an overvalued asset. Finally, modelling speculative trading is especially desirable given that concern about bubbles is often due to evidence of speculation rather than evidence of overvaluation, which is much harder to establish. While Allen and Gorton (1993) already developed a dynamic model where speculation can arise, they did not use it to explore the role of policy in allowing bubbles. Their model also differs from mine in several key respects, and I point these out below.

Before turning to a version of the model that includes both a richer contracting environment and dynamics, it is worth pausing to discuss some complications that arise simply from introducing dynamics into the model. Towards this end, consider extending the static model above to two periods. That is, suppose assets still pay a single dividend \( d \) at a fixed date, where \( d = D > 0 \) with probability \( \epsilon \) and 0 otherwise. But now suppose there are two periods prior to this date in which agents can trade the asset. For simplicity, assume no discounting between periods. Traders who want to buy the asset must secure funds using limited liability debt contracts that are settled after \( d \) is revealed, with rate \( r_1 \) on loans made in period 1 and \( r_2 \) on loans made in period 2. Let \( p_1 \) and \( p_2 \) denote the price of the asset in the first and second periods, respectively. Borrowers arrive in the credit market sequentially, some in period 1 and some in period 2. Each period, a fraction \( \phi \) are entrepreneurs who can operate a fixed-scale technology that converts up to \( R > 1/\epsilon \) units of output that accrue after \( d \) is revealed.

If \( R \) is sufficiently large, entrepreneurs will prefer to produce than to buy assets with the resources they borrow. Hence, if \( \phi > 0 \), competitive lenders will again charge low \( r_1 \) and \( r_2 \) that make it profitable for traders to purchase assets at a price above \( \epsilon D \). The new wrinkle is that we need to determine what traders who buy the asset in period 1 do with it in period 2. Holding on to an asset yields an expected profit of \( \epsilon \cdot \max(0, D - (1 + r_1)p_1) \), while selling it yields a profit of \( \max(0, p_2 - (1 + r_1)p_1) \). To rule out uninteresting equilibria in which agents trade the asset even though they never profit from doing so, suppose there is a tiny but positive utility cost from both buying and selling the asset. Since agents who bought the asset in period 1 can guarantee themselves a continuation payoff of zero by holding on to their assets, they will sell only if \( p_2 \) exceeds \( (1 + r_1)p_1 \) plus the transaction cost. But since \( r_1 \geq 0 \), this implies \( p_2 > p_1 \), i.e. if the asset is resold, its price must increase. Since the absence of discounting implies the fundamental value of the asset is the same in both periods, the asset must become increasingly overvalued with time.\(^1\)

\(^1\)Note that if \( p_2 > p_1 \), traders who arrive in period 2 borrow more per asset than traders who buy it in period 1. As a result, their willingness to pay for the asset is higher, and there is scope for gains from trade between buyers and sellers.
At the same time, if the price of the asset were expected to rise over time, no agent who owns the asset would agree to sell it early rather than wait to sell it for a higher price. Thus, $p_2$ cannot exceed $p_1$ with certainty in equilibrium. This suggests there are two types of equilibria in this economy. In the first type, the asset does not appreciate, i.e. $p_1 \geq p_2$ with certainty, and assets change hands no more than once, from an original owner to a leveraged buyer. The asset will trade in period 2 in this case only if buyers did not already buy up the entire stock of assets from its original owners in period 1. If the asset trades in both periods, the price must be the same in both, i.e. $p_1 = p_2$. Whether this common price exceeds $\epsilon D$ depends on whether enough traders arrive over the two periods to buy out the entire stock of assets from its original owners at a price of $\epsilon D$. If so, the asset will be a bubble, but not a speculative bubble where agents buy the asset in order to resell it. Rather, agents agree to overpay for the asset in case $d$ turns out to be large.

In the other type of equilibria, assets may change hands more than once, but only with some probability. This type of equilibrium arises if demand for the asset in period 1 does not exceed its fixed supply, and traders are unsure whether demand for the asset in period 2 at a price $\epsilon D$ will exceed the amount of the asset still in the hands of original owners. If a large number of traders show up in the second period, $p_2$ will exceed $p_1$, and some of the traders who arrive in period 2 will have to buy the asset from those who bought it in period 1. Otherwise, $p_2 \leq p_1$ and all traders who arrive in period 2 buy assets from their original owners, while those who bought assets in period 1 prefer to hold on to them to see if they pay $d = D$.

The two-period model illustrates that the equilibrium price of the asset depends on how many new traders arrive and when. If it is not possible that enough traders will arrive to buy out all original asset owners before $d$ is revealed, the asset must trade at $\epsilon D$ to keep the original owners indifferent between holding the asset and selling it. But if it is possible for enough buyers to show up and buy out all original owners, the latter would demand more than $\epsilon D$ to sell the asset, since it will sell for at least this price and will fetch strictly more if a large number of buyers show up. If the number of traders will be enough to buy out the original owners with certainty, the price of the asset will exceed $\epsilon D$ but will not appreciate over time. But if in period 1 it is uncertain whether enough buyers will arrive in period 2 to buy out the remaining original owners, then the price will still exceed $\epsilon D$, and then will rise higher if enough buyers materialize in period 2. In the full model with both dynamics and optimal contracts I lay out in the next section, I assume agents are uncertain about future arrivals in a way that implies the price of the asset rises if and when new traders show up. Creditors will of course take this into account in designing the contracts they offer.

## 2 A Dynamic Model with Optimal Contracting

Building on the model in the previous section, suppose once again that assets pay a single dividend $d$ at a known terminal date, where $d = D > 0$ with probability $\epsilon$ and 0 otherwise. As in Allen and Gorton (1993), I find it convenient to work in continuous time, and I normalize the date in which $d$ is revealed to 1. However,
it is not essential that $d$ be revealed at a known date as opposed to a random date. One advantage of using a finite horizon is that I can assume no discounting and economize on notation.

Assets are available in fixed supply and cannot be sold short. I further assume that assets are indivisible and that each agent may purchase no more than one asset. These assumptions remove quantity as a choice variable for the agent, making it easier to solve an agent’s trading strategy. But it should be clear from the previous section that the existence of a bubble does not hinge on restrictions as to the number of assets agents can buy. Since indivisibility implies the price of the asset cannot exceed 1, the most an agent can borrow and bid, I assume $eD < 1$ so agents can at least bid the true worth of the asset.

Recall that the asset will appreciate in price only if agents are unsure how many traders will arrive before $d$ is revealed. As such, suppose traders appear in the asset market at random dates in a way that makes it impossible to perfectly forecast how many buyers will arrive before date 1. More precisely, I assume arrivals occur with constant probability $\lambda$ per unit time, and the number of buyers $n_t$ who show up at each such arrival is potentially random (and may be zero). The probability of an arrival is thus independent of past arrivals, although the number of traders at each such arrival need not be independent of past arrivals. In other words, traders cannot use past arrivals to predict whether new buyers will show up, but they can potentially use past arrivals to predict demand for the asset in the event that they do show up.

Given that the focus of this paper is on whether various credit market interventions might make speculative bubbles possible, I will proceed as follows. Rather than specify the distribution of the number of agents $n_t$ at each arrival, I instead ask whether there could exist values of $n_t$ that are consistent with an equilibrium speculative bubble. To do this, I first conjecture that a bubble path exists. Taking this bubble path as given, I derive the optimal contracts lenders would offer and the optimal trading strategies agents would follow. After solving for the strategies of traders, I can check whether there exist values of $n_t$ that ensure the asset market clears in all dates at the originally conjectured price path. This approach allows me to verify whether a particular speculative bubble is an equilibrium, but it is silent on whether other equilibria exist or how a given equilibrium changes with the underlying environment. Questions regarding uniqueness and comparative statics, while important, are left to a companion paper.

In positing a price path for the asset, note that the price is not uniquely determined in the event that agents do not arrive; any price that makes it unattractive to sell the asset will be an equilibrium. Without loss of generality, I assume the price of the asset is zero in this event. Next, let $p(t)$ denote the price of the asset at date $t$ conditional on an arrival at date $t$. Rather than searching through all possible speculative bubble paths, I check whether there exist equilibrium price paths that satisfy the following two conditions:

**A1:** $p(t)$ is a deterministic and increasing function of $t$ for $t \in [0, 1)$.
A2: $\epsilon D < p(t) \leq 1$ for all $t \in [0, 1)$.

Showing that there exists an equilibrium path $p(t)$ which satisfies A1 and A2 is sufficient to establish that speculative bubbles are possible as equilibria in my model. However, to argue the converse that speculative bubbles are not possible, I would also need to rule out bubbles that do not necessarily adhere to A1 and A2. As will become clear below, in those cases where speculative bubbles that adhere to these restrictions fail to exist, the argument for ruling them out can be applied more generally to rule out any bubble.

The reason I look for speculative bubbles that satisfy A1 and A2 is that these conditions make it easier to analyze the optimal contracting problem. In particular, since the trading price is deterministic under A1, there is no need to specify contingencies for different price realizations, or to ensure that agents report the price truthfully if it is unobserved. The second condition, A2, is simply a restriction that any equilibrium price path respecting A1 must satisfy: The price of the asset is bounded above by 1 given the asset is indivisible, and for a bubble to occur in the first place, the initial price $p(0)$ must exceed $\epsilon D$. But if $p(t)$ is increasing, $p(t)$ must exceed $\epsilon D$ for any $t \in (0, 1)$. Once I derive the optimal contract and trading strategy taking $p(t)$ as given, I can then check whether there exist values of $n_t$ that ensure the original path is an equilibrium. It turns out that for any path $p(t)$ satisfying A1 and A2, it is quite simple to construct a process for $n_t$ that supports this path as an equilibrium.\(^2\) Hence, searching for bubbles that satisfy A1 and A2 is a particularly simple way to confirm that speculative bubbles are possible.

Once again, it is important that agents who buy assets can blend in with others who are profitable to finance. In particular, suppose that at each arrival, the $n_t$ buyers are joined by an additional $\phi / (1 - \phi) n_t$ entrepreneurs. These entrepreneurs can buy the asset as well, but unlike buyers, they also have the option to operate a technology that converts at most 1 unit of resources into $R > 1/\epsilon$ units at some future date. For a bubble to emerge, at least some production must result in output only after $d$ is revealed. This is because if all output was produced before $d$ were revealed, creditors could charge exorbitant rates to those who repay their debt after all production would have commenced, so buying the asset would be unprofitable.\(^3\) For simplicity, I assume all output is completed at date 1 regardless of when production was initiated.

As before, sustaining a bubble hinges on entrepreneurs cross-subsidizing those who buy the overvalued asset. Since entrepreneurs can pay up to $R$ and account for a fraction $\phi$ of borrowers, and since speculators

\(^2\)In particular, below I show that if $p(t)$ satisfies A1 and A2, agents who buy the asset at date $t$ will hold it until some cutoff date $s_t^*$ and then sell it at the next arrival. Suppose we restrict $n_t$ to two values, 0 and the number of available assets. We then set $n_t = 0$ if $t$ is less than the cutoff date of either the original asset owners or the traders who bought the asset most recently, i.e. who bought at date $\sup \{ \tau : n_{\tau} > 0 \}$, and set $n_t$ equal to the number of assets if $t$ exceeds these cutoffs. It is easy to confirm that the market for the asset will indeed clear at $p(t)$ for all dates $t$ given this arrival process.

\(^3\)Clearly, it will be unprofitable to buy and hold the asset. But buying and selling the asset won’t be profitable either. For suppose the first date in which it was unprofitable to buy the asset were strictly positive. One can show that it will be unprofitable to buy the asset just a little before this date, a contradiction.
lose at most what they borrow, the following condition ensures cross-subsidized lending can be profitable:

\[ \phi R - 1 > 0. \]  

(3)

Of course, lending will only be profitable if entrepreneurs produce output rather than buy assets. To ensure entrepreneurs prefer producing to buying and reselling the asset, the return \( R \) must be large enough to exceed the maximal gains from buying and reselling the asset:

\[ R - 1 \geq 1 - \epsilon D > \sup_{t \in [0,1]} \{ p(t) \} - p(0). \]  

(4)

Since I will focus on the case where \( \epsilon \) tends to 0, producing will also be preferable to buying and holding the asset, which yields at most \( \epsilon D \). Finally, it must be profitable for agents to buy the asset even when the asset is overvalued. A sufficient condition for this is for \( D \) to be sufficiently large, specifically

\[ D > R. \]  

(5)

This assumption ensures it will be profitable to buy the asset under any contract that induces entrepreneurs to produce. The most entrepreneurs will be asked to pay is \( R \). If \( D \) is at least as large as \( R \), non-entrepreneurs can guarantee themselves positive profits by buying the asset and holding it to date 1.\(^4\)

Whenever a group of agents arrive, the timing of actions is as follows. Agents must initiate all financial transactions immediately upon arrival, i.e. there is no possibility of strategic delay. Agents own no resources, and must borrow funds to undertake any transactions. I assume free entry into the credit market. Agents can approach any potential creditor, but can contract with only one. Since exclusivity imposes fewer constraints on what a contract can achieve, agents would be willing to commit this way. Creditors cannot observe whether an agent who approaches them is an entrepreneur or not. However, they can offer a menu of contracts and let agents select from this menu. The creditor's problem will be laid out more precisely in the next section. Since agents must secure funds immediately, creditors know that if all arriving agents sought funds, a fraction \( \phi \) of borrowers will be entrepreneurs.

If and when agents secure credit, those who wish to buy an asset or initiate a project must again do so without delay. Thereafter, agents who chose to produce do nothing until date 1 when their output materializes, while agents who purchased an asset must decide whether to sell it if they still own it. If no traders arrive, the equilibrium price will be zero by assumption and agents will prefer to hold on to their asset given transaction costs. If new traders do arrive, the price will equal \( p(t) \) and agents must decide

---

\(^4\)By contrast, Allen and Gorton (1993) set \( D = 0 \). Such an asset cannot be a bubble in my model: Given equilibrium contracts, asset prices must rise by a non-vanishing increment at each trade, yet the price is bounded by \( 1 \). Allen and Gorton still generate a bubble because of their timing assumptions. They assume agents borrow before knowing when they will buy the asset. After the agent borrows, lenders are indifferent about offering terms that make it profitable to buy the asset at all dates. The bubble thus arises from the failure of lenders to coordinate and prevent agents from buying the asset at late dates.
whether to sell or not.\textsuperscript{5} Once agents sell the asset, they are assumed to quit the asset market entirely.\textsuperscript{6}

The decision to hold the asset or sell it will depend on the terms in the contract an agent receives. But before we can derive the terms of the equilibrium contract, I need to specify what creditors can observe about agents once they enter into a relationship with them. Clearly, creditors must not be able to independently learn what an agent did with the funds they borrowed after receiving them. Otherwise, contracts would condition on this information and charge speculators a punitive fee. Hence, sustaining a bubble requires that creditors not perfectly observe an agent’s wealth. But this implies a creditor would be unable to tell if a fellow creditor approached him pretending to be an agent. In what follows, I explicitly allow creditors to pretend to be agents. This constrains the contracts creditors can offer in an important way: It precludes paying non-entrepreneurs not to speculate, since anyone offering such a contract would be flooded by applications from fellow creditors pretending to be non-entrepreneurs.

At the same time, creditors cannot be totally uninformed about borrowers. Otherwise, agents would claim to have run down their wealth and avoid repayment, and creditors would refuse to extend funds in the first place. I therefore impose the following assumptions. First, I allow creditors to verify whether an agent has zero or positive wealth at date 1, but not the value of wealth if it is positive. This is meant to capture the fact that creditors can sue agents who claim to have exhausted their wealth, but have no legal standing against those who make no such claims. However, even this coarse information structure allows creditors to deduce the agent’s exact wealth, since they can always ask an agent to hand over all of his wealth, verify that the agent has no additional wealth left, and then transfer resources back to the agent. To rule this out, I assume creditors cannot credibly commit to transfer funds. For example, if creditors can make it prohibitively costly for agents to sue them, they cannot be trusted not to shirk their contractual obligations. Agents would then refuse to transfer resources back-and-forth. As I argue in the next section, these assumptions effectively limit contractual arrangements to debt contracts where the creditor transfers resources to the agent when the latter arrives and the agent transfers resources back at subsequent dates.

3 Contracting

I now turn to the creditor’s problem of how to design the financial contracts they enter into with agents. I follow the usual route of modelling a contract as a direct revelation mechanism where those with private

\textsuperscript{5}In particular, agents sell the asset when the expected profits from selling the asset exceed the expected profits from holding on to the asset and trading optimally thereafter. By contrast, Allen and Gorton (1993) assume agents have a bliss point over consumption and sell the asset as soon as they reach this bliss point, regardless of the contract they face.

\textsuperscript{6}Since $p(t)$ is increasing, traders who sell the asset will need to secure some funds to buy it again in the future. If creditors can observe whether agents borrowed in the past, they would turn down agents seeking to borrow a second time, knowing their only use for funds is to speculate. Thus, agents couldn’t return to the asset market even if they didn’t have to quit.
information (in this case, agents) disclose it to those without (in this case, creditors), and the parties take actions and transfer resources deterministically depending on the information reported.\footnote{Creditors will find lotteries beneficial in my setup given their different appeal to those who buy the asset and to those who engage in production. But they will not be able to use lotteries to deter speculators from borrowing to buy assets. Since in practice we rarely observe financing arrangements that explicitly rely on randomization, I ignore such contracts in my analysis.} A contract will be defined as \textit{incentive compatible} if it induces those with private information to disclose it truthfully and if it induces those with unverifiable actions to follow the recommendations of the contract. Let $X$ denote the set of all incentive-compatible contracts. An incentive compatible contract $x \in X$ is said to be an \textit{equilibrium contract} if there exists no other incentive compatible contract $x' \in X$ that is strictly preferred to $x$ by some agents and which yields strictly positive expected profits to the creditor who offers it.

To preview my results, I find that creditors cannot design contracts that deter speculators from borrowing. Their only recourse is to minimize the losses speculators inflict. In particular, they will want to design contracts that encourage speculators who purchased an overvalued asset to sell it rather than hold it. This is done by offering speculators a contract with backloaded payments, i.e. a contract with low initial rates that are eventually reset if agents haven’t sold the asset and settled their debt by some specified date.

Formally, a contract requires the agent to reveal his private information, and then recommends actions and transfers to both the agent and the creditor given these announcements. With little scope for verifying the truthfulness of these reports or the actions the parties took, a contract must be designed so that agents agree to report truthfully and both parties agree to follow through with the actions and transfers recommended by the contract. Agents are partly constrained by the fact that creditors can observe whether an agent’s terminal wealth is positive or zero, and cannot falsely claim to have run down their wealth by date 1. Creditors, by contrast, are unconstrained, and must voluntarily agree to any transfers stipulated by the contract. This restricts what transfers they can credibly commit to. In particular, any funds the creditor transfers \textit{after} the date in which the agent arrives must be transferred back to the creditor in full. This is because agents cannot use these funds by assumption, so creditors know agents possess these resources. Since transferring funds to the agent does not reveal any information about his wealth, such transfers do not benefit creditors in any way, and creditors would refuse to make them unless they were fully recouped.

Since transfers from the creditor after the agent arrives must be repaid in full, they cannot be used to provide incentives. I can therefore assume without loss of generality that the equilibrium contract involves no transfers to the agent beyond the initial transfer when he arrives. This initial transfer must be the same for entrepreneurs and non-entrepreneurs. Otherwise, agents would have to disclose their type prior to the transfer, and creditors would refuse to fund non-entrepreneurs. But non-entrepreneurs would then have incentive not to be truthful. Any incentive compatible contract must therefore stipulate a transfer from the creditor before the agent makes any announcement. Let $x_t$ denote the amount the creditor transfers to
an agent who arrives at date $t$. Since entrepreneurs have no productive use for funds beyond one unit of resources, creditors will not offer more than one unit of resources to any one agent, i.e. $x_t \leq 1$.

Once the agent receives $x_t$, he must choose what to do and what to report he did to the creditor. An agent could potentially do nothing, initiate production, or buy the asset, although these choices may be restricted by the level of $x_t$ and whether the agent can produce. Let $\omega \in \{\emptyset, e, b\}$ denote this choice, where $\omega = \emptyset$ implies doing nothing, $\omega = e$ implies being an entrepreneur and producing, and $\omega = b$ implies buying the asset. Let $\hat{\omega} \in \{\emptyset, e, b\}$ denote the action the agent reports choosing. A contract would then recommend transfers to the creditor depending on $\hat{\omega}$. Since forcing agents to transfer resources as soon as possible can limit their scope to misrepresent themselves as types that can make earlier transfers, there is no reason not to have the contract recommend that agents transfer resources when it is first feasible to do so. Thus, an agent who reports doing nothing, i.e. $\hat{\omega} = \emptyset$, will be asked to make a single transfer at date $t$. An agent who reports producing, i.e. $\hat{\omega} = e$, will be asked to make at most two transfers, one at date $t$ and one at date 1 when the output from his production is realized. An agent who reports buying the asset, i.e. $\hat{\omega} = b$, will also be asked to make at most two transfers, one at date $t$ and one either when he reports selling the asset or else at date 1 when $d$ is revealed. In the latter case, the transfer may depend on what he reports as the dividend, $\hat{d}$. Finally, since the creditor can verify at date 1 whether the agent has zero or positive wealth, the contract may demand additional transfers from an agent depending on this information. For example, an agent who falsely claims to have no wealth can be forced to pay a fine. Since the agent’s exact wealth isn’t observable, equity contracts are not enforceable. The only contracts that can be enforced are debt agreements where the repayment amount depends on when the debt is repaid.$^8$

After the agent chooses $\omega$ and reports $\hat{\omega}$, he may face additional choices that must be taken into account in designing the contract. If he does nothing or opts to produce, he faces no additional choices, other than possibly refusing to make the transfers stipulated under the contract. But since the creditor can always threaten to seize all of the agent’s wealth, the contract can always be designed to discourage this. If the agent buys the asset, he must choose whether to sell it at each date he still owns it. For any date $\tau \in [t, 1]$, let $h^\tau$ denote the history the agent observes at that date, i.e. any arrivals until date $\tau$, the price of the asset until date $\tau$, and the agent’s own past choices. Let $\sigma_t(h^\tau) \in [0, 1]$ denote the probability an agent who bought the asset at date $t$ assigns to selling it after history $h^\tau$ if he still owns the asset.

Of course, the agent must not only choose whether to sell the asset but what to report to the creditor. Let $A_t(\hat{\omega}, \tau)$ denote the set of announcements the contract allows an agent to make at date $\tau$ if he announced $\hat{\omega}$ at date $t$. Since agents who do nothing or opt to produce face no choices, they should not have anything

---

$^8$ By contrast, Allen and Gorton (1993) allow creditors to observe the agent’s wealth, but they assume wealth is uninformative about what the agent did. This would be equivalent to making the return to production $R$ in my setup random in a way that mimics the distribution of positive profits speculators may earn in equilibrium. Since speculators could still pass themselves off as entrepreneurs, equity contracts with limited liability as in their model would also allow speculative bubbles.
to report. Thus, we can set $A_t(\tilde{\omega}, \tau) = \emptyset$ for $\tilde{\omega} \in \{\emptyset, e\}$. If instead $\tilde{\omega} = b$, i.e. if an agent reports that he bought an asset, then at each date $\tau$ he should have private information on whether he still owns the asset. At date $t$, let $A_t(b, t) = \{0, 1\}$, where an announcement $\tilde{a}_t(t) = 1$ implies the agent sold the asset at date $t$ and 0 implies he did not. For $\tau > t$, I then define $A_t(b, \tau)$ recursively. Specifically, let $A_t(b, \tau) = \{0, 1\}$ if $\tilde{a}_t(\tau') = 0$ for all $\tau' \in [t, \tau)$, and let $A_t(b, \tau) = \emptyset$ if $\tilde{a}_t(\tau') = 1$ for some $\tau' \in [t, \tau)$. That is, an agent who has yet to report selling the asset will be asked to report if he sold it, while an agent who already reported selling the asset has nothing further to report. If $\tilde{a}_t(\tau) = 0$ for all $\tau \in [t, 1]$, so the agent reported not selling the asset before date $d$ is revealed, he would know its dividend. In that case, let $A_t(b, 1) = \{0, D\}$. Otherwise, set $A_t(b, 1) = \emptyset$. Let $a_t(\tau) \in A_t(\omega, \tau)$ denote the true action of the agent given he chose $\omega$ at date $t$.

Next, let $y$ denote the agent’s cumulative income by date 1, i.e. $y = 0$ if the agent did nothing, $R - 1$ if the agent initiated production, $p(s) - p(t)$ if the agent who bought the asset and sold it at date $s$, and $d - p(t)$ for an agent who held on to the asset until date 1. I will use the notation $y = y(\omega, \sigma_t(h^\tau))$ to reflect the fact that income may depend on the actions of the agent after date $t$. Let $x_t^\tau$ denote the transfer the agent would be asked to make at date $\tau$ under the contract. This transfer would depend on his announcements, i.e. $x_t^\tau = x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau))$. As explained above, we can restrict attention to contracts in which agents make transfers as soon as they can, so that $x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau))$ differs from zero at finitely many dates. Specifically, agents who announce $\tilde{\omega} = \emptyset$ will make a single transfer at date $t$, so $x_t^\tau(\emptyset, \tilde{a}_t(\tau)) = 0$ for all $\tau > t$. Agents who announce they initiated production will be asked to make at most two positive transfers, at dates $\tau = t$ and 1. Agents who announce they bought the asset will be asked to make at most two positive transfers, at dates $\tau = t$ and sup $\{\tau' \leq 1 : a_t(\tau') = 0\}$. The terminal wealth of the agent can thus be expressed as

$$x_t + y(\omega, \sigma_t(h^\tau)) - \sum_{x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau)) \neq 0} x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau))$$

We can now define a contract as incentive compatible if it meets the following conditions:

**IC-1:** Agents prefer to report $\omega$ truthfully at date $t$, i.e.

$$\omega = \arg \max_{\tilde{\omega}} E \left\{ \max_{\omega} \max_{\sigma_t(h^\tau)} \max_{\tilde{a}_t(\tau) \in A_t(\tilde{\omega}, \tau)} \left\{ x_t + y(\omega, \sigma_t(h^\tau)) - \sum_{x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau)) \neq 0} x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau)) \right\} \right\}$$

(6)

**IC-2:** Given they report $\omega = \tilde{\omega}$ at date $t$, agents announce $a_t(\tau)$ truthfully at all dates $\tau \in [t, 1]$, i.e.

$$a_t(\tau) = \arg \max_{\tilde{a}_t(\tau)} E \left\{ \max_{\sigma_t(h^\tau)} \left\{ x_t + y(\omega, \sigma_t(h^\tau)) - \sum_{x_t^\tau(\omega, \tilde{a}_t(\tau)) \neq 0} x_t^\tau(\omega, \tilde{a}_t(\tau)) \right\} \right\}$$

(7)

**IC-3:** Creditors will not find it profitable to pretend to be agents under the contract, i.e.

$$x_t - \sum_{x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau)) \neq 0} x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau)) > 0 \text{ only if } y(\omega, \sigma_t(h^\tau)) = \sum_{x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau)) \neq 0} x_t^\tau(\tilde{\omega}, \tilde{a}_t(\tau)) - x_t$$

13
The last IC constraint arises because creditors can disguise themselves as agents and enter into contracts with other creditors. This possibility deters creditors from offering positive net transfers to agents except when they can verify that the agent has zero wealth. Any creditor who would offer positive net transfers would be flooded by applications from fellow creditors posing as agents.

Not all of the incentive constraints above will be binding. Consider IC-1, the constraint that agents must prefer to accurately report what they did with the funds they received. IC-3 requires that agents who declare they did nothing with their funds, i.e. \( \omega = \emptyset \), must transfer \( x_t \) back in its entirety. Agents who use their funds to purchase assets or engage in production would be unable to pay back \( x_t \) in full. Thus, they could not pretend to have done nothing with the funds, so this incentive constraint will not be binding. For the same reason, if \( p(t) < 1 \), agents who engage in production will not be able to pass themselves off as having bought the asset, since the latter would be required to make a positive transfer at date \( t \) that an agent who chose to produce could not make. As long as \( p(t) \) is below 1, the only potentially binding incentive constraint is the one that ensures speculators do not wish to pass themselves off as entrepreneurs.

Next, consider IC-2, which says that agents should report their actions truthfully. This is only relevant for agents who announced they bought the asset, since only they will be asked to make reports beyond date \( t \). An agent cannot falsely claim to have sold the asset before he did, since he would not be able to transfer any resources at that point. However, he can falsely claim to have sold the asset later than he actually did, or claim not to have sold it at all. To ensure agents report truthfully, it must be the case that \( x_t^\tau(b,1) \) is increasing in \( \tau \) for \( \tau \in [t,1) \), and that \( x_t^1(b,D) \geq \lim_{\tau \to 1} x_t^\tau(b,1) \). In other words, the interest rate schedule is non-decreasing over time, so that those who pay the creditor back later must pay back a larger amount.

To summarize, equilibrium contracts are essentially debt contracts with repayment schedules. Agents receive an amount \( x_t \) when they arrive, then choose among possibly two repayment schedules, designed to appeal to entrepreneurs and speculators who bought the asset, respectively. Both schedules specify (weakly) rising payments over time. I now set out to characterize these terms. I begin with a result concerning the terms of contracts in particular states. Proofs for all claims can be found in an Appendix.

**Claim 1**: In equilibrium, an agent who does nothing or who holds on to an asset which pays no dividends will have zero terminal wealth.

In words, the equilibrium contract confiscates all wealth from agents who fail to earn positive income. This follows directly from (IC-3), since otherwise creditors would have incentive to pass themselves off as agents who earned no income and pocket the resources owed to them under the contract.

The next series of claims characterize what actions agents choose in equilibrium.
Claim 2: Let $\epsilon \to 0$. Then agents will be able to buy the asset under the equilibrium contract if they wanted, i.e. $x_t \geq p(t)$.

Claim 3: Let $\epsilon \to 0$. Then non-entrepreneurs will prefer to buy the asset under the equilibrium contract.

Claim 4: Let $\epsilon \to 0$. Then $x_t = 1$ under the equilibrium contract and entrepreneurs will invest in the project in equilibrium.

Claim 5: Under the equilibrium contract, expected profits to the creditor must be zero.

These results can be understood as follows. Assumption (3) ensures that creditors will find it profitable to lend to an agent of unknown type if they could collect all of his output if he were an entrepreneur, even if they collect nothing from non-entrepreneurs. Hence, in equilibrium, creditors will prefer to lend than to stay out of the credit market altogether. Since competition among creditors drives profits to zero, agents who claim to be entrepreneurs will be asked to repay less than $R$ at date 1. Given $D \geq R$, a non-entrepreneur can ensure himself positive expected profits by pretending to be an entrepreneur, buying the asset, then holding it until date 1 to see if it pays out $D$ and repay the amount demanded from entrepreneurs. Since creditors cannot pay non-entrepreneurs not to speculate, speculation must occur in equilibrium. All creditors can hope to do is minimize the cost of funding speculators by tailoring the terms of the contracts they offer.

I now turn to the terms of the contract offered to the two types. Since $x_t = 1$ in equilibrium, an agent who announces $\hat{\omega} = e$ at date $t$ should not have any funds left over at date $t$. Hence, his contract will be a simple debt contract in which he receives $x_t = 1$ when he arrives and is asked to repay this amount plus an interest charge $r^*_t = x^1_t(e, \emptyset) - x_t$ at date 1. Claim 5 implies $r^*_t < R - 1$. The next claim shows $r^*_t > 0$:

Claim 6: Under the equilibrium contract, $r^*_t = x^1_t(e, \emptyset) - x_t > 0$.

Next, I turn to the terms offered to those who announce they bought the asset, i.e. $\hat{\omega} = b$. Let $V(b, \hat{\omega})$ denote the maximal expected utility for an agent who bought the asset but reports $\hat{\omega}$. (IC-1) requires

$V(b, b) \geq V(b, e)$.

The next claim establishes that this constraint will hold with equality in equilibrium.

Claim 7: In equilibrium, the incentive constraint for type $b$ will be binding, i.e. $V(b, b) = V(b, e)$

A non-entrepreneur thus expects to earn the same under the equilibrium contract as he could earn by pretending to be an entrepreneur, buying the asset with the funds he receives, then trading optimally and defaulting if he cannot afford to transfer $x^1_t(e, \emptyset)$. Denote the payoff to this strategy by $V_0(r^*_t) \equiv V(b, e)$.
to reflect that it depends on the terms of the contract \( r_t^e \). The creditor will choose the terms to offer a speculator in order to maximize expected profits subject to the non-entrepreneur achieving an expected utility of at least \( V_0 (r_t^e) \). In general, these terms will differ from those offered to entrepreneurs. The reason for this is that creditors would like to encourage traders to unload the asset as soon as possible. This is because if the trader holds on to the asset, the most the creditor can seize is the dividend \( d \). But since \( p(t) > \epsilon D \), this would imply an expected loss for the creditor. Offering traders a contract with different terms can induce them to sell the asset sooner than they would under a standard debt contract.

One way to induce agents to sell the asset earlier is to backload interest payments and charge those who sell the asset early a lower rate than those who sell it late. In fact, creditors would like to charge a negative rate to those who repay their debts early, but this would violate (IC-3). Instead, the best creditors can do is charge a zero interest rate to those who sell the asset early and a high rate to those who sell late. Formally, the optimal contract is characterized by two parameters: a cutoff time \( T_t \in (t, 1] \) and an amount \( R_t^n \) the agent must pay if he fails to sell the asset and it pays \( D \). If the agent sells the asset before the cutoff date \( T_t \), he will only have to pay back \( x_t \) in total. If he sells the asset after \( T_t \), he must hand over all of his wealth. If an agent never sells the asset, he will have to pay \( R_t^n \) if \( d = D \). Formally, we have

\[
x_t^0 (b, 0) = 1 - p(t), \quad x_t^1 (b, 1) = \begin{cases} p(t) & \text{if } \tau < T_t \\ p(\tau) & \text{if } \tau \geq T_t \end{cases}
\]

and at date 1, the required repayment is given by

\[
x_t^1 (b, D) = R_t^n
\]

Under the optimal contract, these two parameters are jointly determined, so \( R_t^n \) equals \( D \) if \( T_t < 1 \) and \( T \) equals 1 if \( R_t^n < D \). In other words, if the contract ever seizes all of the agent’s wealth if he sells the asset, it must also do so if he keeps the asset and \( d = D \). We can show there exists a unique \((T_t, R_t^n)\) that leaves the agent with utility \( V_0 (r_t^e) \). The next claim proves that this contract is optimal.

**Claim 8:** Given a path \( p(t) \) that satisfies A1 and A2, the contract in (8) and (9) maximizes the expected profits to a creditor among all contracts that deliver utility \( V_0 (r_t^e) \) to a non-entrepreneur.

The proof of Claim 8 involves solving for the optimal trading strategy of those who already own the asset. As can be seen in the Appendix, traders who buy the asset at date \( t \) and face the backloaded contract above will hold on to the asset until some cutoff date \( s_t^e \) and then sell at the next arrival. The supply of the asset at each arrival date is then just the number of traders who are past their cutoff date. Setting the number of buyers \( n_t \) equal to this supply ensures that the asset market will clear at the price \( p(t) \).

Note that the optimal contract satisfies (IC-2), since speculators would never gain from claiming they sold their asset later than they did. In the special case where \( T_t = 1 \) and \( R_t^n = p(t) + r_t^e \), the backloaded contract
is essentially equivalent to the one offered to entrepreneurs. Thus, the contracts offered to entrepreneurs and to speculators need not be different, although often they will be. The fact that the equilibrium contract might be separating distinguishes this model from Allen and Gorton (1993) and Allen and Gale (2000), where all agents receive identical terms. The difference arises because agents in my model trade strategically, and creditors structure contracts to affect trading strategies. If the two contracts differ, creditors will know which of the agents they fund are speculators. However, creditors learn this only after agents accept contracts, and cannot use this information to reject speculators. The existence of a bubble hinges on creditors not distinguishing speculators from safe borrowers when they seek credit, not afterwards.

The dynamic model with optimal contracts confirms that the bubble Allen and Gale (2000) describe can emerge under more general conditions, although their occurrence in a dynamic environment requires more stringent conditions on the information creditors can observe and on what agents can do. The new insight that emerges here is that creditors who anticipate that some of their borrowers are speculators will want to design contracts to encourage them to unload the asset. Contract design is thus important, and restrictions on the set of available contracts can matter for both the credit and asset markets.

4 Empirical Relevance of the Model

Given the model produces a dynamic speculative bubble whose existence is due to leverage, it is quite suited for studying the effect of credit market interventions on the possibility of bubbles. First, though, it is worth pausing to reflect on whether the model is useful for thinking about the very episodes that many have cited as examples of bubbles. In this section, I argue that the model matches some features of the U.S. housing market. This does not mean that housing was in fact a bubble, but it suggests the model is not a priori irrelevant for thinking about this episode to the extent that housing was overvalued.

One assumption that plays a key role in generating a bubble in the model is that agents stake little of their own wealth in the asset, and thus stand to lose little if they fail to sell the asset and its dividends turn out to be low. In that regard, it is noteworthy that the period of rising housing prices was accompanied by an increase in real estate purchases involving little or no down payment, or in which the down payment was financed by additional “piggyback” loans rather than with funds put up by the buyer. Since mortgages in many U.S. states are structured as non-recourse loans in which borrowers can settle their debt obligation by transferring the asset even if its value is less than the outstanding debt, some fraction of home buyers during this period would have been reasonably protected from a collapse in property values, and thus could have found it profitable to buy overvalued property at sufficiently low interest rates.

Another key element that is necessary for a bubble to emerge in the model is that lenders be willing to extend credit to borrowers even if they know that some of them are intent on speculating. That is,
there must be enough borrowers to whom lending offers a positive expected return that they can cover the expected losses from speculators. On this point, it is noteworthy that during this period, financial pundits were arguing that improvements in contract design and securitization created a previously non-existent market that allowed mutually beneficial trade between lenders with a higher tolerance for risk and low-income households willing to pay high rates to obtain access to credit. Thus, the notion that speculators could have blended in with borrowers that lenders would have viewed as profitable targets seems plausible.

The key conditions that the model suggests are needed to make speculation profitable do seem to have been present in U.S. housing market. At the same time, the model suggests that lenders should have vigorously tried to protect themselves against losses, e.g. by offering contracts that encourage those borrowers who choose to speculate to unload their assets quickly. On this dimension, it is worth noting that the optimal contracts that emerge in the model bear a striking resemblance to teaser-rate mortgages with soft prepayment penalties, contracts that became increasingly more popular during the period of rapid house price appreciation. In particular, contracts in the model are exclusive arrangements that reward agents for selling the asset sooner rather than later. Prepayment penalties work towards maintaining exclusivity by punishing agents for refinancing with other lenders, but at the same time work against encouraging agents to sell their assets early if these penalties applied to early repayment if the asset were sold. Thus, the ideal contract would forgo the prepayment penalty if an agent can prove he sold the asset. This is precisely what a soft prepayment penalty does; in contrast to a hard prepayment penalty that imposes a fine for early repayment regardless of the reason, a soft penalty waives the fine if the asset is sold. Anecdotal evidence suggests soft prepayment penalties were rarely used before the run-up in housing prices, but became increasingly more common, especially among subprime borrowers, as housing prices kept their rapid ascent.

The model thus appears to match some of the broad patterns of the U.S. housing market over the recent decade. Again, this does not imply that the housing market over the past decade necessarily involved an asset bubble. That said, there is some evidence of active speculation in the housing market during this period, in the sense that investors bought houses with the express intent of “flipping” them and selling them to others. This suggests there is some value in exploring the implications of the model concerning the role of various credit market policies in contributing to or precluding the formation of speculative bubbles.

5 Policy Analysis

I now turn to the question of how various credit market interventions affect the possibility of speculative bubbles. I focus on three types of interventions. First, motivated by the claim that exotic financial contracts encouraged speculation, I consider restrictions on the type of contracts creditors can offer. Next, I consider policies that force agents to use their own funds to buy assets, i.e. down-payment or margin requirements. Lastly, I consider the effects of changes in the opportunity cost of funds for lenders.
5.1 Restrictions on the Type of Contracts Creditors can Offer

As noted above, contracts that resemble the ones offered to speculators in the model have come under intense scrutiny lately, with some arguing that low initial teaser rates encouraged speculation and contributed to bubbles. Given this, we can ask whether a restriction forcing creditors to offer only flat rate contracts would eliminate the possibility of a speculative bubble. A key insight of the model is that these teaser-rate contracts can be a response to a speculative bubble that already exists rather than a force that gives rise to bubbles that wouldn’t occur otherwise. Preventing lenders from offering these contracts will not necessarily eliminate bubbles, and, perhaps surprisingly, may only drive asset prices further away from fundamentals.

Formally, as long $R \geq 1/\phi$ and $D \geq R$, the same arguments used to establish Claims 1-5 would apply even if creditors were restricted to simple debt contracts. Thus, a bubble would remain possible. Intuitively, the condition that $R \geq 1/\phi$ ensures that creditors will prefer to fund an agent drawn at random than to stay out of the credit market. This is because when no credit is supplied, an agent with excess resources could write a contract agents would accept and which extracts enough profits from entrepreneurs to cover the losses on speculators. The condition that $D \geq R$ ensures non-entrepreneurs can guarantee themselves positive expected profits even if the asset is overvalued, since they can pretend to be entrepreneurs, buy the asset, then hold it to date 1. Restrictions on which contracts lenders can offer will thus not prevent agents from buying overvalued assets, although it may affect their incentives to sell the asset once they bought it.

If precluding teaser rate contracts does not eliminate bubbles, will it have other consequences? One natural question is whether these restrictions affect welfare. To address this issue, suppose that all agents in the model – creditors, entrepreneurs, and speculators – act on behalf of a representative household that takes in their profits. Since speculative trading is a zero-sum activity, it has no effect on the aggregate income of the household: any profits it gains from speculation correspond to forgone profits of other agents. Entrepreneurial activity, by contrast, creates surplus for the household. But since entrepreneurs can borrow even when lenders are restricted to flat rate contracts, they create the same surplus as before. Restricting contracts thus has no effect on the welfare of the representative household in my model.

Nevertheless, precluding teaser rate contracts will redistribute resources across agents. Thus, while the representative household will continue to earn the same total income, it will receive this income from different agents. Recall that the feature of the backloaded contract that makes it attractive to creditors is that for a fixed path of asset prices, this contract lowers the price that an agent who already owns the asset would require to sell it. On its own, this would tend to raise the price of the asset going forward beyond when the contract is signed. To study the full effects of changing the contracting environment, we would need to solve for the new equilibrium price path holding fixed the arrival process that we reverse-engineered to sustain the original equilibrium price path. This exercise is somewhat involved, and so I provide only a sketch argument. Intuitively, if agents are more reluctant to sell at a particular point in time, market clearing would drive
the price up in that period. This in turn would raise the price of the asset both at earlier and later dates. Those who own the asset earlier will demand a higher price to sell it if they know the price can be higher in the future, and those who buy the asset later would need to sell a higher price to cover their larger debt obligations. Thus, precluding backloaded contracts would result in higher prices for the asset at all dates, i.e., the asset would be even more overvalued. Creditors would thus incur greater losses on speculators, and would need to charge entrepreneurs higher premia. As a result, less of the income the household earns would come from the entrepreneurs who generate it, and more would come from speculators.

In a richer model where we allow the return to production $R$ to vary across entrepreneurs, the fact that creditors would need to charge entrepreneurs higher rates could crowd out entrepreneurs with lower values of $R$, even though this production is socially efficient when $R > 1$. Thus, restricting the set of contracts may lower welfare in addition to redistributing income. But the more important point is that teaser-rate contracts, which have been identified by some as a factor that contributed to more rapid price appreciation, may actually serve to rein in overvaluation. This is because they encourage traders who already purchased overvalued assets to sell them at lower prices than they would under alternative contracting arrangements.

### 5.2 Restrictions on Leverage

The next intervention I consider involves restrictions on the degree to which agents can leverage their asset purchases. An important trend during the period of rapidly escalating housing prices was that both households and financial institutions increasingly financed their asset purchases with borrowing rather than internal funds. This is important, since a key element that allows a bubble to emerge in the model is that leveraged agents are sheltered from losses if their purchases fail to be profitable. This suggests creditors might be able to ward off speculators by stipulating in their contracts that agents stake some of their own funds in their investments. The notion that limiting the extent to which agents leverage their purchases can safeguard against moral hazard problems has been raised in previous work, e.g., Holmstrom and Tirole (1997). Of course, if such stipulations discouraged speculators, there would be no need to compel creditors to insist that borrowers stake some of their own funds in their purchases. But the insight of the model above is that as long as there are enough agents who lack resources but whose activities are still profitable to finance, creditors would still be willing to finance agents who stake little or none of their own resources. Policymakers intent on avoiding bubbles might therefore consider preventing creditors from lending to agents who cannot stake any of their own resources. Examples of such policies would include mandatory margin and down payment requirements that limits how much agents can leverage their asset purchases.

The model offers two insights on such policies. The first observation is that since bubbles can only occur if there are profitable lenders to cross-subsidize those who borrow to buy overvalued assets, restricting lending to highly leveraged agents will also prevent some beneficial trades from taking place. Hence, relying on
leverage restrictions to discourage speculative bubbles is likely to incur a social cost that must be balanced against any potential benefits of ruling out bubbles.

The second observation that emerges from the model is that restricting how much agents are allowed to be leveraged for some period of time will not always prevent speculation, even when these restrictions are in place. Essentially, if traders expect to be able to sell the asset at a higher price in the future, they might be willing to purchase an overvalued asset even using their own funds. Hence, temporary restrictions on leverage that are lifted too early may not be effective in warding off speculation. This result stands in contrast to Allen and Gorton (1993) and Allen and Gale (2000), where agents would always refuse to buy a bubble if required to do so using their own funds. Thus, while leverage restrictions can be used to rule out bubbles, they must be put in place throughout the period in which speculation could occur to be effective.

To demonstrate this claim, I first need to modify the model to include agents who can shoulder at least part of the cost of the asset on their own. Thus, assume that at each arrival, a negligible fraction of arriving agents have a vast amount of resources and can purchase an asset if they want. Since these agents represent a negligible fraction of all agents, we can assume their presence will not affect the equilibrium price of the asset when agents without any resources can buy the asset. However, we can still ask whether these agents would be willing to buy the asset if it were overvalued. If we can show that these traders are willing to buy the asset, it follows that margin requirements couldn’t possibly deter speculation: traders finance even a small part of their asset purchases gain more from speculation than those who are entirely self-financed.

Suppose we impose a restriction on the amount of leverage agents can assume between date 0 and some date $t^* \in [0,1)$, but not between dates $t^*$ and 1. This restriction precludes agents who lack resources from either buying the asset or investing in the project before date $t^*$, since they have no resources to meet any down payment. However, agents who do own some resources could buy the asset before date $t^*$ if they wanted. The next claim establishes that they would want to buy the asset.

**Claim 9:** Suppose positive margin requirements are applied only at dates $t \in [0, t^*)$. Then there exists an equilibrium in which the price of the asset is the same at dates $t \in [t^*, 1)$ as the equilibrium price when $t^* = 0$, and the price of the asset exceeds $\epsilon D$ at all dates $t \in [0, 1]$. In addition,

i. Non-entrepreneurs wish to purchase the asset at all dates, but can only do so from date $t^*$ on.

ii. Agents with vast resources would purchase the asset using their own wealth up to some date $t^{**} \in [0, 1)$.

iii. If $\lambda > 0$, then $t^{**} \geq t^*$, i.e. wealthy agents will buy the asset when margin requirements are in place.

The intuition behind Claim 9 is that for an unleveraged agent, opting not to sell the asset is equivalent to paying $p(t)$ to hold on to it. Thus, if the original owner finds it profitable to keep the asset, an unleveraged
agent would be willing to purchase it. Since the number of agents with vast resources is assumed to be negligible, there will always be some original owners who do not sell the asset prior to date \( t^* \). Hence, prices must be such that the original owners are willing to hold on to the asset. But then wealthy agents who arrive before date \( t^* \) would be willing to buy the asset as well. Unlike leveraged buyers who can profit from buying the asset and seeing if its dividend is high, those who buy the asset with their own wealth benefit only by “riding the bubble” in the sense of Abreu and Brunnermeier (2003) and Temin and Voth (2004), i.e. by holding on to an asset whose price is rising and letting go of it before its price “pops”. Riding the bubble will not be profitable unless other buyers can arrive before the bubble pops. Hence, if margin requirements were permanently put in place, a bubble could not occur: if there were a last date \( t^{**} > 0 \) at which agents would be willing to buy the asset using their own wealth, it would be unprofitable to buy the asset just before \( t^{**} \) given the small odds that buyers would arrive before date \( t^{**} \), which is a contradiction. But if restrictions on leverage are only put in place temporarily, the asset could still trade above its true value.

5.3 Changes in the Opportunity Cost of Funds

The last policy intervention I consider involves changes in the opportunity cost of creditors. This policy corresponds to what central banks attempt to do in practice when they intervene in the market for short-term funds. To see how we can incorporate such interventions in the model, suppose creditors in the model are not individuals out to lend their own wealth but banks who can borrow on the overnight market whenever a lending opportunity arises and they do not have funds on hand. The can be seen as a special case in which creditors can borrow and lend to one another this way at zero interest. But we can always contemplate changes in this implicit cost of funds. This allows us to explore questions such as whether lowering rates can cause a bubble that would otherwise not have occurred, in line with the claim that the Fed created the bubble when it lowered interest rates in the wake of the 2001 recession.

Formally, let \( r_{FF}^t \geq 0 \) denote the instantaneous rate of return on a loan made at date \( t \), i.e. \( r_{FF}^t \) represents the limit of the return per unit time on a loan due at date \( t + \Delta \) as \( \Delta \to 0 \). Let \( R_{t,s}^{FF} \) denote the compound return between any two dates \( t \) and \( s \), i.e.

\[
R_{t,s}^{FF} = \exp \left( \int_t^s r_{x}^{FF} \, dx \right)
\]

As the notation suggests, \( r_{FF}^t \) is meant to capture the Federal Funds rate. Note that the overnight rate here represents a real rate, while in practice the Fed sets a nominal rate. I am therefore implicitly assuming that the Fed can affect real rates, at least over the relevant horizon. Agents and creditors are assumed to treat the path of \( r_{FF}^t \) as given. I also assume that any agent in the model who has funds can save them overnight at the same rate \( r_{FF}^t \). This is equivalent to assuming a competitive banking sector in which depositors earn the same rate of return that banks face in the Federal Funds market.

22
Before proceeding with the analysis, I first need to examine how allowing the overnight rate to differ from 0 affects the contracting problem between creditors and agents. Since agents can earn an instantaneous return of \( r_{FF}^t \) on their funds, it is immaterial who holds on to resources that are not committed to an asset or a project: either party would earn the return \( r_{FF}^t \). As a result, the timing of payments does not matter, other than in constraining agents in what they can credibly report. A borrower who wishes to delay his payment can always compensate the lender for the opportunity cost of waiting to receive these funds. As before, I proceed assuming contracts require agents to repay lenders as soon as they are able to.

The fact that the opportunity cost of funds can be positive has no effect on incentive constraints (IC-1) and (IC-2), but it will slightly alter the formulation of (IC-3) which ensures creditors do not have incentive to falsely enter into contracts with other creditors. If the agent reports he did nothing, i.e. \( \tilde{\omega} = \emptyset \), then he will have to pay back the transfer \( x_t \) in full immediately at date \( t \) to ensure a creditor cannot profit from pretending to be this type. If the agent reports he initiated production, i.e. \( \tilde{\omega} = e \), then he would be required to pay back \( x_t - 1 \) at date \( t \) and then at least \( R_{t,1}^{FF} \) at date 1, since otherwise a creditor could pretend to be an entrepreneur, earn \( R_{t,1}^{FF} \) rolling one unit over in the overnight market, and then repaying only a part of the profits this strategy nets. Finally, if the agent reports that he bought the asset, i.e. \( \tilde{\omega} = e \), then he would be required to pay back \( x_t - p(t) \) at date \( t \) and then at least \( R_{t,\tau}^{FF} p(t) \) if he reports selling the asset by date \( \tau \) and \( R_{t,1}^{FF} p(t) \) if he reports not having sold it but that it paid a positive dividend. The last condition can be summarized as follows:

\[
x_t^T (b, \cdot) \geq R_{t,\tau}^{FF} p(t)
\]  

Constraint (10) is key for understanding why an increase in the opportunity cost of funds can discourage speculation. Increasing the cost of funds will lead creditors to demand higher repayments from borrowers regardless of when these repayments are made. If the cost of funds is sufficiently large, agents will be forced to hand over any profits they earn from speculation, rendering this activity unprofitable. Intuitively, raising the cost of funds creates an alternative that is more profitable for creditors than lending to speculators: lending funds at the Federal Funds rate. By raising the real opportunity cost of funds, the Fed can siphon off the credit that is essential for speculation. Of course, such a policy would also siphon off funds that would have gone to entrepreneurs who need it for socially useful production. Once again, this policy imposes a social cost that must be balanced against any potential benefits of ruling out bubbles.

Although the model implies that setting the Federal Funds rate to a high level should deter speculative trades while rates are high, it also shows that the converse is not true: setting a low rate will not necessarily encourage speculative trading while rates are low. This is because the possibility of a bubble depends on the entire future path of the Federal Funds rate rather than its value at a particular point in time. To some extent, this should not be surprising, since speculation is inherently forward looking: Agents are willing to buy an overvalued asset in case it either pays out a large dividend or in case they can sell it later at a higher
price. Whether these bets pay off depends on what agents can keep if they hold the asset and it pays a large dividend or if they sell the asset, and whether future traders would be willing to buy the asset. But these depend on the path of the Federal Funds rate in the future. If \( r_{t}^{FF} \) is expected to be high at future values of \( t \), a low value today will not be enough to make speculation profitable.

To show this result formally, I now argue that if \( r_{t}^{FF} \) were set to sufficiently high levels close to the terminal date, a speculative bubble will not emerge even if rates earlier were set arbitrarily close to zero. For technical reasons that will become clear below, relying exclusively on the opportunity cost of funds to discourage agents from buying the asset at dates that are arbitrarily close to the terminal date requires \( r_{t}^{FF} \) to shoot off to infinity as \( t \to 1 \). To avoid having a path in which the cost of funds grows without bound, I assume policymakers put in place a margin requirement from some date \( t^{*} \in [0, 1) \) until date \( 1 \). This will preclude non-entrepreneurs from buying the asset beyond date \( t^{*} \), regardless of the path of \( r_{t}^{FF} \) over this period. However, if the opportunity cost of funds \( r_{t}^{FF} = 0 \) for all \( t \in [0, 1] \), the asset could continue to trade above its fundamental value up until date \( t^{*} \). Thus, these margin requirements do not preclude a bubble by themselves. But I now argue that if \( r_{t}^{FF} \) is set to a high but finite level in the interval \( [t^{*}, 1] \), a speculative bubble will not be possible in equilibrium even if we set \( r_{t}^{FF} \) arbitrarily close to \( 0 \) before date \( t^{*} \).

Claim 10: For any \( r^{*} > 0 \), suppose \( r_{t}^{FF} = r^{*} \) for all \( t \in [0, 1 - t^{*}) \) and \( r_{t}^{FF} \) for \( t \in [t^{*}, 1] \) is set to ensure

\[
R_{t^{*}, 1}^{FF} \equiv \exp \left( \int_{1-t^{*}}^{1} r_{t}^{FF} \, dt \right) \geq \frac{1}{\epsilon} \tag{11}
\]

Then a bubble cannot occur equilibrium.

Note that if we let \( t^{*} \to 1 \), we could only satisfy (11) by letting \( r_{t}^{FF} \to \infty \) as \( t \to 1 \). Thus, in the absence of margin requirements, ruling out bubbles requires the opportunity cost of funds to be infinite near the terminal date. The reason for this is that the expected rate of return per unit time from buying the asset and holding it to maturity becomes infinite near the terminal date, since the expected profit from this strategy remains bounded away from zero regardless of how close to the terminal date the asset is purchased. Discouraging agents from buying the asset close to the terminal date would thus require an increasingly larger instantaneous rate of return. Since margin requirements already discourage agents from buying the asset near the terminal date, we do not need to worry about relying on \( r_{t}^{FF} \) to do so.

Claim 10 demonstrates that a temporary rate cut need not automatically give rise to bubbles: as long as rates are eventually raised to a high enough level, a bubble should not emerge even if the Federal Funds rate were set to nearly zero at earlier dates. This finding raises an important caveat to the claim that the dramatic cuts in the Federal Funds rate (and in the effective real rate) following the 2001 recession and the slow pace at which they were reversed were responsible for the bubble that emerged in the housing market. In particular, the existence of a bubble in the model hinges on the entire path of interest rates, not just on
interest rates at a point in time. As such, it may well be the case that low interest rates contributed to a bubble that would not have occurred otherwise. However, the case against interest rate policy depends crucially on when agents expected the Fed to reverse their rate cuts and by how much. Ultimately, the existence of a bubble hinges not on how low short-term rates might fall, but on where rates are expected to settle eventually when the policy of easing will eventually be scaled back.

An interesting implication of Claim 10 is that raising the opportunity cost of funds can rule out speculative bubbles without necessitating constant intervention as with margin requirements alone. So long as the Fed is willing to raise rates to high levels in the final stages of the bubble, perhaps in combination with temporarily high margin requirements, it need not take any action beforehand. However, concentrating this intervention over a short period may require setting the cost of funds to very high levels. In particular, discouraging non-entrepreneurs from buying the asset at all dates \( t < t^* \) requires setting \( R_{t^* - 1}^{FF} \) high enough to exceed some threshold as in (11). The later is \( t^* \), the higher the values of \( r_{t^*}^{FF} \) must be for \( t \in [t^*, 1] \) to meet a given threshold. Likewise, setting a higher \( r^* \) prior to date \( t^* \) will lower the rates needed beyond date \( t^* \) to curb speculation. In other words, the longer the Fed allows the cost of funds to be lower, the higher rates must be when they eventually clamp down. In addition, such a concentrated intervention only works if traders are forward-looking, as is the case in my model, and understand the unravelling argument for why they would not be able to sell the asset in the future. Continuously intervening does not require that traders reason this way, and thus might prove to be a more robust approach to avoiding bubbles.

6 Conclusion

The dramatic rise and fall in equity and housing prices in the past decade has focused attention on bubbles, i.e. assets that trade at prices above their fundamental value. The prospect of bubbles is often viewed as a source of concern, and recent events have generated considerable debate as to the role of policy both in causing and preventing bubbles. Some have argued that easing of credit conditions by the Fed in the wake of the 2001 recession and the slow pace at which they were tightened led to a housing bubble during the subsequent years. Others have faulted the Fed in its regulatory capacity for not preventing financing arrangements that supposedly lured in speculators and drove up asset prices. This paper constructed a model in which credit plays an essential role in allowing for speculative bubbles that can be used to explore these claims. This model suggests some of the intuition concerning credit and bubbles may be misguided: contracts that many view as encouraging bubbles may in fact rein in asset prices, and the possibility of bubbles depends not on how low central banks set rates but on whether they will subsequently raise them.

While the model reveals new insights, it also abstracts from several important issues. This paper focused on the existence of bubbles. But more generally, we also care about uniqueness and comparative statics of equilibria. By focusing on arrival processes that yield equilibria that are easy to work with, I have side-
stepped these issues. But we would like to know what drives fluctuations in asset prices, how the optimal contract would take these into account, and how interventions affect not just the existence of bubbles but asset price dynamics if they allow bubbles to continue to exist.

The model also abstracts from uncertainty in terms of when the bubble bursts. In the model, the bubble bursts when $d$ is revealed and is found to be 0. This event occurs at a known date. However, we could alternatively think of an asset whose dividend is revealed at a random date, and on which information may arrive at more than just a single point in time. Note that even if the date at which the dividend was revealed has unbounded support, so that agents are never sure when the true worth of the asset will be revealed, the analysis of the model will be quite similar to the model analyzed here. This is because the price would be naturally bounded above, either by the amount of resources agents can borrow if we maintain the assumption that assets are indivisible, or by the largest possible realization for dividends. As a result, trade in the asset would cease in finite time. Despite this important similarity, adding uncertainty as to when the dividend is revealed would add more realism and may reveal interesting new implications.

Finally, the model as specified is not useful for exploring whether bursting a bubble is inherently desirable. Recall that a bubble merely redistributes income from some agents to others, so that if we think of all agents as acting on behalf of a representative household, bursting the bubble would have no effect on welfare. However, with heterogeneity in production, the emergence of a bubble may make it unprofitable for entrepreneurs with socially valuable but not very productive projects to borrow and initiate production. In that case, a bubble may reduce welfare. This in itself would be an interesting result, since bursting bubbles is Pareto worsening in many of the models of bubbles mentioned in the Introduction, and there are few if any models in which bursting a bubble is shown to be Pareto improving. However, even if we can show in a richer model that bubbles are bad, the gains to preventing a bubble may be more than offset by the costs of precluding entrepreneurs from generating social surplus if the way to prevent a bubble is to choke off credit entirely to those who have little of their own funds to invest.
References


