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Financial Markets and Investment Externalities

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ABSTRACT

This address explores the link between financial market shocks, investment choices, and various externalities that can arise from these choices. My analysis, which emphasizes differences between shocks to debt and equity markets, provides insights about some stylized facts from the macro finance literature. These insights are illustrated with a discussion of the technology boom and bust in the late 1990s and early 2000s, and the housing boom and bust in the mid-2000s.

IN THE AFTERMATH OF the 2008 financial crisis, financial economists have shown an increased interest in public policy. This is a sign that our field has matured. Our models now have sufficient realism and clarity to not only help us understand what is happening in the real world, but also provide insights about potential policy choices.

The most recent policy focus has been on what has loosely been described as financial market disruptions. The idea is that financial markets can be subject to shocks that are unrelated to future cash flows, but nevertheless affect market prices. This possibility, by itself, need not concern policymakers. The financial markets may simply be a sideshow, and have no effect on the real economy. However, there is a clear role for policy if financial market prices affect investment choices – especially when investment choices generate positive or negative externalities.

This address explores the link between financial market shocks, investment choices, and various externalities that can arise from these choices. In particular, I consider the effect of what I refer to as participation shocks, which are orthogonal to cash flow fundamentals and affect the extent to which investors participate in the debt and equity markets. These shocks are conceptually equivalent to the supply shocks introduced by Grossman and Stiglitz (1980)

*Presidential Address to the American Finance Association, San Diego, California, January 2013. The discussion of investment externalities draws from my joint work and discussions with Andres Almazan, Zhaohui Chen, Adolfo de Motta, Casey Dougal, and Chris Parsons. The discussion of the interactions between financial market shocks and investment externalities is closely related to my joint work with Avanidhar (Subra) Subrahmanyam. I would also like to thank David Chapman, Kent Daniel, Andrea Eisfeldt, Michael Gallmeyer, and Tyler Muir for help on the macro finance literature. Finally, I would like to thank Aydogan Alti, Jonathan Cohn, David Hirshleifer, the Journal of Finance editors, Bruno Biais, Michael Roberts, and Kenneth Singleton, and my current students, Nicholas Crain, Nathan Swem, and Parth Venkat, for helping me clarify my ideas.

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and the noise trader shocks and sentiment shifts described by Black (1986), Kyle (1985), and others. However, my focus is on shocks to investor participation that arise because of technical changes (e.g., Internet-based stock trading) or policy changes (e.g., shifts from defined benefit to defined contribution pension funds), which affect portfolio choices in ways that may not be apparent to most investors.

I argue that the interaction between these participation shocks and investment choices, with their various externalities, can potentially help us understand some of the stylized facts in the macro finance literature that I personally find puzzling. Specifically, I focus on the combination of the observed positive correlation between quarterly and yearly stock returns and aggregate economic activity, which by itself is not surprising, and the lack of correlation between stock returns and future changes in dividends, which was recently described in Cochrane's (2011) Presidential Address. If stock prices reflect expectations about future cash flows, they should predict their own payouts better than the cash flows of the entire economy. I also consider an observation about credit market conditions and future macroeconomic activities that has been discussed in the wake of the recent financial crisis, in particular, the link between loosening credit spreads and future downturns (e.g., Schularick and Taylor (2012)). If credit spreads reflect expectations of future downturns, we should expect the opposite.

To illustrate my intuition, I briefly outline two separate models that describe causal links from participation shocks to financial market prices and ultimately to real investment choices that influence economic activity. The first model is designed to provide insights that are particularly relevant for understanding the implications of participation shocks to equity markets; the second model is designed to shed light on the implications of participation shocks to credit markets. Of course, as I discuss below, most participation shocks affect debt and equity markets simultaneously. However, by considering polar cases of distinct shocks to debt and equity markets, I hope to illustrate how shocks to these markets can affect investment choices very differently, and as a result, how they can affect the overall economy in very different ways.

The equity market model, which I refer to as the "catalytic investment model," describes a setting in which an innovation or investment has a catalytic effect on other investment opportunities that complement each other. In this setting a positive shock to equity market participation spurs investment in emerging new firms that complement each other. However, since these entrants compete with incumbent firms, a participation shock that facilitates entry can make the existing public firms less profitable. The emergence of the electricity grid around the turn of the last century or the Internet in the 1990s illustrates the importance and intuition of this model. Indeed, the link between the 1990s bull market and the subsequent increase in complementary technology investments is the inspiration for this model.

The debt market model, which I refer to as the "pecuniary externality model," describes a setting in which a positive shock to debt market participation spurs investment in collateralizable assets. The link between the value of the

collateralizable asset value and credit conditions is consistent with the analysis in Kiyotaki and Moore (1997), that is, more favorable credit conditions produce a positive effect on collateralizable asset values. However, my focus is on the negative effect that the increased supply of these assets has on the price of the assets in the future, and the negative externalities associated with these lower prices. The mid-2000s credit boom and the subsequent boom and then bust in the housing market provide the inspiration for this model.

In each of these models, individual optimizers sometimes overinvest and sometimes underinvest relative to the social optimum. This point, of course, is well understood. Somewhat less understood is how shocks to financial markets interact with these externalities, and why shocks to debt markets can affect investment choices very differently than shocks to equity markets. As I argue below, shocks to equity markets are more likely to affect the types of investments (i.e., technology investments) described in the catalytic model, while shocks to credit markets are more likely to affect the types of investments (i.e., real estate) that are described in the pecuniary externality model.

My discussion of these issues builds on several literatures. First, the relation between participation shocks and market prices is based on the noisy rational expectations model of Grossman and Stiglitz (1980).[1] Specifically, since I assume there is asymmetric information about fundamentals, and the implications of the participation shocks are not readily apparent, investors have an inference problem: they cannot perfectly identify whether changes in stock prices reflect changes in participation (or equivalently, changes in discount rates) or changes in expected future cash flows. However, in contrast to the more recent applications of these ideas to the market microstructure literature, which focus on relatively short-term shocks that influence day-to-day price patterns of individual securities, my focus is on participation shocks that have a much longer-term effect on the overall market. As a result, participation shocks affect expectations about the future state of the economy and therefore real investment decisions.

The novel insights from this analysis arise because of the externalities associated with the investment decisions. My analysis of these externalities draws on the Bulow, Geanakoplos, and Klemperer (1985) characterization of investments as strategic complements and substitutes. The main idea here is that when the investment expenditures of firms are strategic complements, there can be coordination failures whereby each firm, acting independently, underinvests relative to the social optimum.[2] I also draw on the recent literature that considers pecuniary externalities that arise because of financing frictions.[3] The idea here is that by affecting prices, investment choices can affect other choices

[1] There is extensive discussion of financial market shocks in the macro literature; however, I am not aware of prior work that explicitly uses the noisy rational expectations framework to model exogenous shocks.

[2] See, for example, Cooper and John (1988).

[3] See, for example, Caballero and Krishnamurthy (2003), Lorenzoni (2008), and Stein (2012), who provide examples in which the price impact of an investment or liquidation choice can create a welfare-decreasing pecuniary externality because of its effect on collateral constraints.

that directly influence social welfare. Relative to the existing literature, where the relation between prices and financial frictions requires a more subtle argument, the channel generating the pecuniary externality in this address is fairly straightforward. Specifically, I assume that the price of the asset affects a decision that has a direct effect on the value of other assets. In the housing example used to illustrate this point I assume that housing prices affect maintenance choices, which in turn affect the value of one's neighbors' houses as well as one's own house.

In the next section I briefly review relevant observations from the macro finance literature. Section II outlines the two models described above. I first describe the catalytic model, which is fully solved in Subrahmanyam and Titman (2013). I next describe the pecuniary externality model and speculate about its proposed solution. Section III provides further thoughts about why shocks to debt and equity markets are different and provides conjectures about insights that may emerge when the two models are combined. Section IV describes potential avenues for extending the analysis, and Section V concludes with some thoughts about policy.

I. Some Stylized Macro Finance Observations

Starting with Prescott and Mehra (1985), a substantial literature attempts to link patterns of stock market returns to the cash flows generated by the corporate sector as well as to aggregate production and consumption. In this section I briefly review some of the pertinent stylized facts from this literature. Specifically, I describe correlations between financial market returns and subsequent changes in investment expenditures, aggregate dividends, and aggregate economic activity. I start with a discussion of stock returns and economic activity and then describe some more recent evidence regarding credit spreads. Finally, I discuss issues that relate to causation.

A. Stock Returns and Economic Activity?

Let's start by considering the following three observations that relate to stock returns and economic activity:

The first observation, emphasized in Cochrane's (2011) Presidential Address, is that changes in aggregate stock prices tend to predict future stock returns rather than future changes in dividends. This is somewhat surprising. Before looking at the data, I would have conjectured that changes in stock prices are likely to reflect changes in expected future dividends rather than changes in expected rates of return. However, in contrast to these plausible priors, we observe a reliable relation between stock returns and future expected rates of return, but no reliable relation between aggregate stock returns and future changes in aggregate dividends.

A possible explanation for this observation is that dividends are net of investment expenditures, and if firms invest more following high stock returns, then dividends will be lower in the short run. Indeed, the second observation

is that firms do tend to invest more following positive stock returns (Barro (1990)). However, presumably, if the investments have positive net present values, these investments should lead to higher dividends in future years, but again, there is no evidence of increased dividends when we look further into the future.

This lack of predictability can be explained at least in part by the fact that we are looking at a couple of noisy time series, so we may have very little power to predict a relation between stock returns and future dividends. However, as I mentioned above, there is sufficient power to detect a relation between stock returns and future expected returns. In addition, there is sufficient power to detect a positive relation between stock returns and the growth rate of GDP and other measures of aggregate output, which is the third observation of interest.[4] Indeed, stock returns are included as one of the leading economic indicators in most macro models, including the NBER model.[5]

That stock returns predict aggregate economic activity but do not predict dividends is a bit of a puzzle. If stock returns simply reflect information about future economic activity we should expect stock returns to predict dividend changes, which directly determine firm values, better than aggregate economic activity, which reflect returns to labor and private as well as public sources of capital. I discuss this puzzle shortly, after first reviewing recent evidence on the relation between credit market innovations and future economic activity.

B. The Relation Between Credit Markets and Aggregate Economic Activity

The literature on links between credit markets and aggregate economic activity is somewhat newer and is recently more active than the literature on stock returns and economic activity. In a noteworthy recent paper, Gilchrist and Zakrajsek (2012) show that widening credit spreads are associated with declines in economic activity three to 12 months in the future. This relation is consistent with the use of credit spreads by macro forecasters as a leading economic indicator. In a second noteworthy paper, Schularick and Taylor (2012) provide evidence that financial crises tend to be preceded by increases in the supply of credit and decreases in credit spreads. In contrast to Gilchrist and Zakrajsek (2012), Schularick and Taylor (2012) examine quantities rather than prices and consider the long-term predictive ability of the expansion of credit. They show that credit expansions predict financial crises up to five years in the future.

[4] See Fama (1990) and Schwert (1990) for an analysis of the relation between stock returns and future aggregate economic activity. More recently, Farmer (2012) observes a significant relation between aggregate employment and lagged stock returns. Although the relation between stock returns and future economic activity is statistically significant, the predictive power of stock returns is relatively weak. This may be due in part to the fact that negative shocks to future consumption results in lower interest rates, which dampens the decline in stock prices. Indeed, information from the bond market provides a stronger predictor of economic activity than stock returns (Harvey (1989)).

[5] See Stock and Watson (2003).

C. What Causes What?

Financial economists have traditionally thought about financial market prices reflecting future cash flows, with causation running from cash flows to market prices. However, as I mentioned above, this interpretation makes it difficult to understand why stock returns predict future changes in aggregate economic activity but not changes in aggregate dividends. The observed negative relation between credit spreads and real activity in the following year is consistent with financial market prices reflecting, but not necessarily causing, real activity. We expect credit spreads to widen when we are likely to be going into a recession. However, the fact that financial crises tend to be preceded by a narrowing of credit spreads is difficult to explain in a setting where there is no causation running from financial market prices to real activity.

In contrast to the traditional finance view, where prices reflect expectations of future cash flows, the very recent macro literature emphasizes causation running from financial market activity to economic activity. Indeed, Farmer (2012) titles his recent paper "The Stock Market Crash of 2008 Caused the Great Recession: Theory and Evidence." In addition, although the evidence in Gilchrist and Zakrajsek (2012) is consistent with causation running in either direction, they emphasize the channel of causation running from credit spreads to economic activity. The authors argue that excess credit spreads (constructed to be orthogonal to the current state of the economy) "reflects a reduction in the effective risk-bearing capacity of the financial sector and, as a result, a contraction in the supply of credit . . . ." which "augurs a change in financial conditions with significant adverse consequences for macroeconomic outcomes." In other words, the authors argue that there are shocks to credit spreads that are orthogonal to the current state of the economy (perhaps due to sentiment) that cause changes in future economic activity. Although they are less precise about the exact channel, Schularick and Taylor (2012) argue that in addition to magnifying exogenous shocks, "the credit system seems all too capable of creating its very own shocks." Finally, the idea that the stock market causes rather than just reflects future economic activity is the preferred rationale of economic forecasters who include the stock market in their macro models.[6]

II. Modeling Feedback from Financial Markets to Real Economic Activity

This section describes two models that are designed to deliver the stylized facts described in the last section. The first ingredient required in these models is a source of exogenous shocks to financial market prices along with

[6] Forecasters tend to talk in terms of higher stock returns improving industrial production by lifting the confidence of consumers and companies, which increases investment in consumer durables and capital equipment. I appreciate discussions about economic forecasting with Edward Leamer, who heads the UCLA forecasting project.

asymmetric information, which amplifies the shocks. The second ingredient is a way in which the shocks affect economic decisions (specifically, investment choices) that in turn can affect the cash flows of publicly traded corporations as well as total economic output.

A. The First Ingredient: Unobservable Participation Shocks and Information Asymmetries

If we are going to think about financial market shocks causing changes in fundamentals, one needs to explain why financial market prices change apart from changes in fundamentals.[7] I assume that prices in the financial markets are affected by exogenous shocks to what I call financial market participation. Specifically, there are continual changes in technology as well as public policy that affect how individuals and institutions participate in both debt and equity markets. These shocks can include legislation that change pension allocations, technology advances that lower individual participation costs in the equity markets, shocks to savings in another market, etc. It should also be noted that the shocks could, but need not, be generated exogenously by what we can loosely call sentiment.

Ideally, one would like to think about participation shocks within the context of a general equilibrium where the supply of savings is funneled into debt and equity securities. Within such a setting, one can imagine technology and policy shocks that influence allocations to these alternative forms of financing. For example, a shock to the pension system (e.g., a shift from defined benefit to defined contribution pension plans) affects how investors make asset allocation decisions, and as a result, how savings are allocated between debt and equity markets. If the exact magnitude of these shifts is not immediately observable, the prices of both debt and equity securities can be materially affected. Later I will talk about the challenges associated with solving a more general model that accounts for simultaneous changes in debt and equity market participation. But, in this address, I consider a far simpler setting where we have only one source of capital, say a stock market, and a shock to the supply of equity financing that I assume is exogenous; for example, there may be an increase or decrease in the demand for U.S. stocks by Asian investors.

To be more specific, the models that I consider here include three types of investors. The first type includes informed investors who optimally select portfolios based on their special information (θ) about economic fundamentals. The second type includes uninformed investors, who optimally select portfolios based only on the observed asset price. Finally, the third type includes investors who make random investment choices. These "noise traders" capture the unpredictable element in the investment demands of the uninformed investors,

[7] The introduction of complementary investment opens the door to the possibility of multiple equilibria and self-fulfilling shifts in investor sentiment. To keep things relatively simple I ignore this possibility, but it should be noted that the assumed complementarities can make the equilibrium quite sensitive to the participation shocks that I consider.

that is, the participation shocks described above. We can thus write the total demand for a risky asset as

$$D = I(\theta, p) + U(p) + N, \tag{1}$$

where D is the demand from all investors, I is the demand from Informed investors, U is the demand from Uninformed investors, and N is the demand from noise traders.

In equilibrium the price of the asset must be such that the total demand equals an exogenously specified supply (S), which is assumed to be fixed:

$$D(p) = S. \tag{2}$$

The qualitative result – that increased participation leads to higher prices and lower discount rates – is straightforward. However, if the shocks are observable and not too large, the effect is likely to be small. For example, if U.S. investors observe an exogenous increase in demand for U.S. equity from Asia, they will understand that the resulting increase in share prices is due to a decline in the expected rate of return on equities, and will thus lighten their own allocation to U.S. equities. By doing so, their actions will partially offset the exogenous increase in the demand for equity and thereby dampen the price effect. However, as shown in Grossman and Stiglitz (1980), Kyle (1985), and others, the price effect of a participation shock is amplified if both the magnitude of the participation shock as well as information about economic fundamentals are observed by the informed but not the uninformed investors. When this is the case, uninformed investors can misinterpret stock price increases that are due to increased participation by Asian investors as favorable information about future cash flows. As a result, the uninformed investors offset the increased participation somewhat less, implying that prices respond more strongly to the participation shock.

B. The Second Ingredient: Investment Externalities

To complete this story we need to incorporate the Grossman and Stiglitz (1980) financial market setting into an economy with capital investment choices. Specifically, we need a model in which individuals learn from prices, and as a result, make investment choices that are contingent on those prices. As I explain below, the implications are more interesting when the investment choices generate externalities.

To illustrate my intuition, I describe two models. The first model, which is explicitly solved in Subrahmanyam and Titman (2013), incorporates what I earlier describe as the catalytic model, where investment choices can be strategic complements, with the Grossman and Stiglitz (1980) framework.[8] As I discuss

[8] Subrahmanyam and Titman (2013) builds on Subrahmanyam and Titman (1999, 2001), and Hirshleifer, Subrahmanyam, and Titman (2006), which examine situations where shocks to the supply or demand for securities affect prices and thereby decisions.

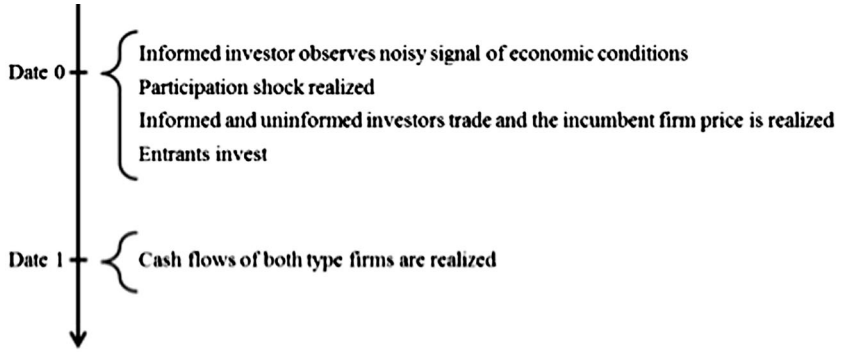

Figure 1. Timeline for catalytic model.

below, the first model is capable of generating the observed qualitative relation between stock returns, aggregate dividends, and aggregate economic activity described in the previous section. The second model incorporates what I earlier refer to as the pecuniary externality model, which is designed to explain the relation between credit spreads and the macro economy. For technical reasons it is more difficult to incorporate this model into a setting with asymmetric information, so my discussion of it is somewhat speculative. I also describe two very salient examples that provide further intuition about the two models.

C. The Catalytic Model: An Analysis of the Relation between Stock Prices, Dividends, and Macro Activity

In addition to including three types of investors, this model includes two types of firms, a single incumbent public firm and two emerging private firms. For example, if we look back to 1980, we can think of IBM as the incumbent and Microsoft and Apple as the new entrants. To simplify our analysis assume that the public firm, which has a stock price that is determined within the model, does not invest. The private firms do invest, and their investments are strategic complements, that is, each of the firms chooses to invest more when the other invests more. However, the private firms ultimately compete with, and therefore impose negative externalities on, the incumbent public firm.[9]

As shown in Figure 1, the model starts with an initial date when the price of the public firm is determined. As I describe earlier, on this initial date both informed and uninformed investors select their portfolios based on their private information (if they are informed) and the endogenously determined price, and the emerging private firms invest. The model ends with a final date when the cash flows of all of the firms are simultaneously determined.

[9] The model thus incorporates the Schumpeterian idea of creative destruction (Schumpeter (1939)). Shocks that facilitate investment by new firms ultimately supplant incumbents.

The cash flow of the public incumbent firm can be described by the following equation:

$$\pi^I = \theta + \delta + F\left(p\left(\theta, N\right)\right), \tag{3}$$

where θ is the portion of economic fundamentals that informed investors know in advance and δ is the portion that is unknown. $F\left(p\left(\theta, N\right)\right)$, which is negatively related to the stock price, captures the feedback that arises because, as I describe below, the stock price of the incumbent influences the investment expenditures of the entrants.

The investment expenditures of the emerging firms are determined by their beliefs about the state of the economy, which is captured with noise by the incumbents' stock prices, and by their beliefs about the investment choices of other firms, which are correct in equilibrium. Given that the emerging firms cannot distinguish between stock price increases due to shocks to economic fundamentals and stock price increases due to participation shocks, positive shocks of either type result in higher investment expenditures by the emerging firms.

Specifically, the entrants invest K_i to maximize the expected value of

$$\pi_i^E = E\left[\pi\left(\theta, K_i, K_j\right)\right], \tag{4}$$

where K_i is their own level of investment and K_j is the level of investment of the other entrant. The function $\pi\left(\theta, K_i, K_j\right)$ is parameterized to have the property that each entrant invests more when the other invests more (strategic complementarity) and both invest more when θ is expected to be higher, that is, when the incumbent firm's stock price is higher. Finally, since the entrants compete more aggressively with the incumbent when they invest more, we get the feedback expressed in equation (3).

Equations (1) through (4) describe a rational expectations equilibrium. The equilibrium is solved (see Subrahmanyam and Titman (2013) for details) by finding the function that maps the two random shocks, that is, the participation shock and θ, to a price that clears markets given the effect of the price on the entrants' investment expenditures and the effect of the entrants' investment expenditures on the incumbent's cash flows.

Within the context of this model, a positive participation shock increases the incumbent's stock price, thereby increasing the entrants' investment expenditures, which in turn lowers the incumbent's cash flows. This feedback effect offsets the positive relation between the incumbent's stock price and its cash flow that arises because of the link between θ, cash flows, and stock prices. Indeed, if the participation shock is sufficiently volatile relative to θ, the correlation between the incumbent's stock price and its cash flows can actually be negative. It should also be noted that because of the coordination failure that arises because of the strategic complementarity of the entrants' investment expenditures, the Nash equilibrium level of investment expenditures without participation shocks may be less than the level of investment expenditures that maximizes output. In this case, a positive participation shock leads to

both higher stock prices and higher levels of aggregate output, reinforcing the positive relation between aggregate output and stock prices that arises because of the link between stock prices and θ.

As shown explicitly in Subrahmanyam and Titman (2013), this setting can deliver, at least qualitatively, the previously mentioned stylized facts about stock returns, cash flows, and overall economic activity. It should also be stressed that the various ingredients included in the model, that is, participation shocks, asymmetric information, and externalities, provide the flexibility that potentially allows us to calibrate a model that can also capture the magnitudes of the previously mentioned stylized facts. In particular,

- When participation shocks are sufficiently volatile relative to the shocks to fundamentals, the model generates zero or even a negative correlation between stock returns and the future cash flows generated by public firms. Intuitively, the competition from emerging firms that cause cash flows to decline in response to participation shocks can outweigh the positive effect on cash flows associated with a positive shock to economic fundamentals.
- The model delivers a positive correlation between public stock returns and aggregate output because, at least on the margin, a participation shock that increases investment by emerging firms offsets their tendency to underinvest.
- Finally, the model can deliver stock returns that are excessively volatile, relative to fundamentals. This will be the case if investors believe that participation shocks are less volatile than they turn out to be, in which case stock prices will be too volatile relative to the volatility of fundamentals.

Although I do not want to extrapolate too much from one episode, it is useful to think about the 1990s technology boom within the context of this model. With the benefit of hindsight, we can interpret the 1990s bull market as coming from a combination of two factors: the perceived catalytic effect of the Internet on investment opportunities – the fundamental shock – and various policy changes and innovations that allowed for the introduction of discount and online brokers,[10] and a substantial expansion of 401K and 403B plans – shocks that greatly increased stock market participation by smaller individual investors.[11]

If these participation shocks, and their effects on discount rates, had been observable and fully appreciated, the increased participation by some investors would have been partially offset by decreases in the equity holdings of other investors who would have optimally reduced their exposure to equities because of the resulting decrease in the equity risk premium. However, investors and entrepreneurs could only imperfectly decipher the extent to which the observed stock price increase reflected increased participation versus a favorable change

[10] See Bogan (2008) for a discussion of the increase in stock market participation of individual investors due to the emergence of online trading.

[11] The ICI Fact Book reports that equity mutual fund holdings increased in the 1990s by more than a factor of 10.

in expectations about future cash flows. Indeed, in the 1990s, both explanations of the bull market received considerable attention in the media.

This brings us to the most important implication of our analysis of a shock to stock market participation, namely, its effect on capital investment. Consistent with the q-theory of investment, the stock price run-up in the 1990s was associated with substantial increases in information technology investment, both by existing firms like Microsoft, Intel, Cisco, and the telecoms, as well as by emerging new hardware, software, and e-commerce firms. To the extent that these investments tend to be strategic complements, the increased investment expenditures fed on each other, offsetting, at least partially, the underinvestment that arises because of the coordination failure. By offsetting this coordination problem, the positive participation shock may have generated real as well as perceived wealth increases.

Although a number of people lost significant amounts of money as a result of the boom and bust of the technology sector, a number of commentators expressed the idea that on balance the stock market boom created real wealth. For example, in his book *The World is Flat*, Thomas Friedman (2005) describes Bill Gates' interpretation of the implications of the Internet bubble at the 1999 World Economic Forum in Davos as follows:

> *"Over and over again, Gates was bombarded by reporters with versions of the question, "Mr. Gates, these Internet stocks, right? Surely they are a bubble. They must be a bubble?" Finally, an exasperated Gates said to the reporters something to the effect of, "Look, you bozos, of course they're a bubble, but you're missing the point. This bubble is attracting so much new capital to this Internet industry, it is going to drive innovation faster and faster."*

In an article in the New York Times magazine section, Michael Lewis expressed similar sentiment:[12]

> *"Good new technologies are a bit like good new roads: their social benefits far exceed what any one person or company can get paid for creating them. Even the laissez faire wing of the economics professions has long agreed that government might profitably subsidize innovation by, for instance, financing university engineering departments. Government has obviously done this, albeit in a haphazard fashion. Still, there remains a huge gap between the optimum investment in technical progress and the amount we usually invest to achieve it. In this respect, the late 1990's were an exception. That suggests another interesting question. Not: Were the late 1990's a great disaster for the U.S. economy? But: As a social policy, might we try to recreate the late 1990's?"*

Michael Lewis (2010) (in *The Big Short*) as well as most other commentators had very different views about the welfare effects of my second example of a

[12] Lewis, Michael, 2002, In defense of the boom *New York Times Magazine*, October 27.

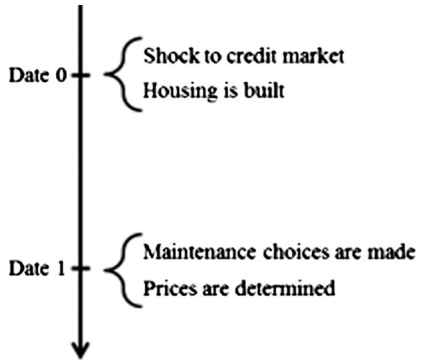

Figure 2. Timeline for pecuniary model.

major participation shock – the shock that contributed to the credit boom in the mid-2000s. Indeed, in my search of the academic literature as well as the popular press, I could not find any positive interpretations of the narrowing of spreads and the easing of credit standards that occurred in the mid-2000s. The potential negative effects of what is sometimes referred to as a credit bubble is illustrated by the model outlined in the next subsection.

D. The Pecuniary Model: An Analysis of Credit Conditions and Macro Activity

In this section I briefly outline what I refer to as the pecuniary model, which provides a framework for considering the potential negative effects of a shock to participation in credit markets. The setting of the pecuniary model is quite similar to the catalytic model: it includes investment choices that have externalities along with a Grossman and Stiglitz (1980) setting where prices are influenced by fundamental information as well as participation shocks. However, the pecuniary model includes two investment choices, namely, an investment choice at the initial date and a follow-on investment choice at the subsequent date.

To be more concrete, as shown in Figure 2, I assume that the initial investment is in residential housing and the follow-on investment is in the maintenance and improvements of the houses. The initial investment choice is determined in part by financial market prices, that is, the mortgage rate, which is determined in a market that includes informed and uninformed investors as well as participation shocks. The second investment, that is, the maintenance choice, is determined by the price of the initial investment asset, which is in turn determined by both the realization of an exogenous state of the economy and the amount of the initial investment. Specifically, I assume that people invest more in their houses when prices are higher.[13] This could be due to credit constraints that are relaxed when homeowners can use home equity

[13] Choi, Hong, and Scheinkman (2011) note that home improvement expenditures increased about 50% from 2003 to 2007, when housing prices were increasing, and then dropped precipitously

loans to finance maintenance, or could simply reflect the possibility that home improvement is a less attractive investment when housing prices are lower. In any event, I also assume that maintenance affects the value of neighbors' houses as well as one's own house (i.e., there are direct externalities). These spillover benefits are consistent with a vast literature that considers, among other things, a causal relation between foreclosures and crime.[14]

To be more precise, consider the following two-date model. At date 0, as described by the following supply function, more houses are built when the price of housing is higher:

$$S = S(p_0). \tag{5}$$

The demand at date 0 for these identical houses is specified by the equation

$$D = D(p_0, \theta, N), \tag{6}$$

where again θ is a component of the future state of the economy, known by some investors, and N is a participation shock. In aggregate, investors demand more houses when the future state of the economy is expected to be higher, and exogenously demand more houses when there is a positive participation shock. Either type of positive shock leads to higher date-0 prices and a greater supply.

I assume that at date 1 no new houses are built, but existing houses can be maintained or improved. As I mention above, individuals spend more on maintenance when the average price of houses in the neighborhood is higher,

$$M_i = M(\bar{p}_1), \tag{7}$$

which is the case when houses in the neighborhood are better maintained.

Finally, the price of individual houses at data 1 is determined by the quantity of housing supplied at date 0, the state of the economy, θ and δ, which is revealed at date 1, and the maintenance of each of the houses:

$$p_{1i} = p_1\left(S_0, \theta, \delta, M_i, M_j\right). \tag{8}$$

in the wake of the financial crisis, when housing prices fell. See also Melzer (2012), who ties the decrease in home improvements and maintenance during this time period to a debt overhang problem. Other follow-on investments that may be tied to housing prices can also have spillover benefits and feed back into housing prices. For example, a recent paper by Corradin and Popov (2012) documents a relationship between entrepreneurial start-ups and housing prices that arises because houses are used as collateral to fund new businesses. See also, Adelino, Schoar, and Severino (2013). Chaney, Sraer, and Thesmar (2012) find that this is also the case for publicly traded companies. Specifically, they find that public firms that hold real estate invest more when residential real estate prices in their cities increase.

[14] The idea that the maintenance of housing in a neighborhood could have a causal effect on crime was first raised by Wilson and Kelling (Wilson, James Q., and George L. Kelling, 1982, Broken windows, *The Atlantic*). Their "broken window" theory is based on the idea that "a broken window is a signal that nobody cares, so breaking more windows costs nothing. . . . " The idea is that one things leads to another and pretty soon the entire neighborhood falls apart. More recently, the link between foreclosures (which is associated with lack of maintenance) and crime is documented in Ellen, Lacoe, and Sharygin (2013).

The date-1 price of housing and the level of maintenance can be solved as a fixed point problem. To see this, first note that because maintenance choices are determined in part by the average value of houses in the neighborhood, the maintenance choices of neighboring houses are strategic complements. If one house in the neighborhood chooses a higher level of maintenance, its value increases, causing other homeowners to spend more on maintenance, increasing their values, further increasing the incentives of neighbors to maintain their houses, etc. Hence, the equilibrium price of housing at date 1 is the fixed point that satisfies the condition that each homeowner is optimally maintaining their house given the values of neighboring houses, and the price of housing clears markets given the number of houses built at date 0, the state of the economy, and the level of maintenance in the neighborhood. Given the equilibrium determined at date 1, the supply of housing and housing prices at date 0 is the fixed point that satisfies the condition that homeowners optimally consume the amount of housing that is produced given both the current price and expectations about future prices.

Although the above model has not been fully solved, one should be able to generate implications along the following lines. First, because maintenance choices are strategic complements, homeowners invest less than the socially optimal amount on maintenance. Second, as a consequence of the externalities associated with maintenance, and given the link between maintenance and housing prices, the initial investment in housing creates pecuniary externalities. Specifically, since housing prices at date 1 are higher if less housing is built at date 0, decreasing the amount of housing built at date 0 increases maintenance at date 1, partially offsetting the underinvestment in maintenance. As a result, a participation shock that increases the date-0 supply of housing decreases date-1 prices and exacerbates the date-1 tendency to under-invest in maintenance, potentially reducing welfare.

In this general setting there can be situations in which a small increase in the supply of housing at date 0 can have a large negative effect on prices in the future. Specifically, the combination of greater supply and a negative realization of the state of the economy can generate low prices, leading to an unfortunate spiral whereby reduced maintenance further lowers prices, leading to further decreases in maintenance, higher crime rates, etc. In other words, because of the link between prices and maintenance choices, along with the complementarity of maintenance choices, date-1 prices can be fragile.

The above intuition suggests that a model along these lines can deliver the causal relation between the narrowing of credit spreads and future financial crises described by Schularick and Taylor (2012) and others. In particular, a date-0 participation shock that decreases credit spreads can lead to an oversupply of housing relative to the subsequent state of the economy. The subsequent lower price that results from the oversupply can trigger an undermaintenance/lower price spiral that can potentially have a deleterious effect on the overall economy.

It is useful to reexamine the most recent financial crisis from the perspective of this model. The first ingredient was a participation shock that caused credit spreads to narrow and housing construction to boom. Participation shocks were in fact a popular explanation for the narrowing credit spreads in the mid-2000s: some argued that the boom in credit was due to policy choices at the Fed, and others argued that it was due to what has been characterized as a savings glut in emerging markets like China, which increased the demand for holding debt.[15] Another explanation was financial innovations that allowed for the securitization of mortgages and bank loans and facilitated the conversion of lower quality debt to AAA securities.[16] However, there was an inference problem as well because, in addition to the discussion of these shocks to participation, there was substantial discussion of fundamental events that could generate an observationally equivalent change in credit spreads. Indeed, a popular explanation for the reduction in credit spreads in the mid-2000s that was put forth at the time came to be known as "The Great Moderation." The idea was that because of more enlightened policy choices, business cycles would be moderated and market volatility would be reduced. For example, in his Presidential Address to the American Economics Association, Lucas (2003) declared that the "central problem of depression-prevention has been solved. . . . " Moreover, Bernanke (2004) titled his speech at the Eastern Economics Association "The Great Moderation."

The above fundamentals-based interpretation of the narrowing of credit spreads was at least partially responsible for the willingness of financial institutions to lend and of home builders to build. Of course, with the benefit of hindsight, most commentators argue that the mid-2000s credit boom was attributable to a participation shock rather than a shock to fundamentals.[17] The participation shock, which led to cheaper and easier mortgage debt, contributed to an oversupply of housing and subsequent house price declines that were amplified because of the unfortunate consequences of the previously mentioned externalities.

[15] See the debate between Taylor (2009), who blames Fed policy, and Greenspan, who claims that the decline in long-term rates was due to the savings glut (Greenspan, Alan, 2009, The Fed didn't cause the housing bubble, *Wall Street Journal, March 11, 2009*). Taylor points out that if we consider the entire world, there was no savings glut – the increase in savings in emerging markets was offset by a decline in savings in the U.S. However, Taylor does not consider the possibility that the shift in savings from the U.S. to governments in emerging markets can dramatically change the composition of assets, that is, the relative supply of debt and equity.

[16] It should also be noted that around the same time there were tax changes (a reduction in the capital gains and dividend tax rates) that reduced the tax advantages associated with the use of corporate leverage. Hence, there may have been an increase in the demand for holding fixed income securities and a simultaneous decrease in the supply of debt from the corporate sector.

[17] See, for example, Mian and Sufi (2009) for evidence that the boom in housing prices during this time period was generated by securitization that increased availability of lower credit quality mortgages.

III. Why are Shocks to Equity and Debt Market Participation so Different?

Although we do not generally like to base theory on two data points, we have two historic observations that should at the very least lead us to explore the differences between shocks to equity and credit market participation. It is tempting to argue that I have provided a framework for understanding the different implications of participation shocks to debt and equity markets. However, up to this point I have finessed this question by offering two separate models and loosely arguing that the catalytic model applies to stock market shocks and the pecuniary model to credit market shocks. It would, of course, be better to have an integrated model that allows us to simultaneously consider shocks to stock and debt market participation. Indeed, one would expect most shocks to shift resources between debt and equity markets, so an integrated model is clearly needed.

There are a number of directions that one might take along these lines. One possibility, which extends the noisy rational expectations' framework, is to allow for the possibility of two types of information. The first type is information about the mean of the productivity shock and the second type is information about the volatility of the productivity shock. In this setting, changes in credit spreads and stock prices can convey different types of information and, as a consequence, affect investment choices differently. For example, stock price changes might convey information about future growth opportunities while changes in credit spreads might convey information about volatility. If the value of shorter-duration and potentially reversible investments, such as investment in information technology, is more closely tied to expected growth rates, expenditures on such investments will be more influenced by changes in stock prices. However, as we know from real options theory,[18] since there is an incentive to delay long-lived capital investments, such as real estate, when volatility is high, expenditures on these investments are more likely to be influenced by credit spreads.

A second possibility, which is less in the spirit of the models that I outline above, is to simply assume that there exist violations of the Modigliani and Miller (1958) theorem, which imply that different types of investments are optimally financed with different combinations of debt and equity. For example, moral hazard considerations can make it costly to sell outside equity on owner-occupied housing, and because of financial distress costs, high-tech firms cannot be too highly levered. Finally, in addition to frictions that limit how much firms deviate from their preferred capital structures, one can assume that there exist

[18] See, for example, Titman (1985) and McDonald and Siegel (1986) for a discussion of the incentives to delay long- duration investments when volatility is high. Real estate development can be viewed as the exercise of an option, which is likely to be delayed when volatility is higher. In contrast, some technology investments can be viewed as acquisitions of real options, which might be optimally accelerated when volatility is higher.

frictions that affect suppliers of capital that slow down the movement of capital between the debt and equity markets.[19]

In the above setting, participation shocks that affect the relative costs of debt and equity can affect the mix of investments that get undertaken and thus can have real effects on the economy. For example, a shock to Asian savings rates that funnel capital to U.S. debt markets rather than equity markets will lower the cost of debt relative to equity. On the margin, the change in the expected rates of return on debt and equity securities will be partially offset by asset allocation choices by investors and capital structure choices by firms, but because of the above-mentioned frictions, the relative costs of capital of investment projects with higher and lower debt capacities will also be affected. If these different investments generate different external benefits and costs, then there are likely to be implications for the overall economy.[20]

IV. Extensions and Other Issues

This section discusses three potential areas in which the analysis in this address can be extended. First, I discuss spillovers that relate to workers' effort and the various interrelationships between worker effort and capital expenditures. Since the spillovers between capital and labor relate to liquidations as well as investments, the second extension I discuss relates to liquidation choices. Finally, I briefly speculate on the implications of the models outlined in this address for innovation.

A. Labor and Capital Market Interactions

The interactions between capital investments and labor provide a fruitful avenue for extending this analysis. Because investment choices and labor choices tend to be complementary, it is possible to generate either over- or underinvestment relative to the social optimum through a labor channel. For example,

[19] The general idea of slow-moving capital is discussed in Duffie's (2010) Presidential Address. See, for example, an analysis of inertia in 401K accounts by Agnew, Balduzzi, and Sunden (2003). Also, a recent paper by Chernenko and Sunderam (2012) provide evidence that retail flows into high yield debt mutual funds have an effect on the investment choices of non-investment grade firms.

[20] Although a substantial amount of the increased supply of debt in the mid-2000s was used to finance single-family homes, there were also substantial increases in debt financing by commercial property owners. For example, outstanding commercial mortgages in the U.S. went from a historical average of approximately 15% of GNP to close to 25% of GNP in 2006 (this information is available from the Federal Reserve Flow of Funds data). My favorite example of a transaction motivated by an increase in the supply of debt was the leveraged buyout of Equity Office Properties by Blackstone in 2007, which transferred the properties of a relatively unlevered office REIT into a variety of very highly levered structures. This transaction provides a fairly clean illustration of the effect of supply shocks on financing and organizational choices because there is no tax advantage associated with leverage in either the REIT or the partnership structure, where most of the real estate ended up, and agency problems associated with managing office buildings are not a particularly important consideration.

within the context of a labor search model, investments by individual firms that increase their demand for labor create a positive externality on unemployed workers searching for work and a negative externality on other firms that are also trying to add to their work force.[21]

Spillovers can also potentially arise when worker effort and investment expenditures are strategic complements. For example, a worker employed by a firm that plans to invest more might work a little harder, knowing that the opportunities as well as gains associated with advancement are likely to be greater.[22] In addition, when human capital improves with effort, there can be externalities across firms that arise when workers are mobile. For example, the expected growth and hiring requirements of neighboring firms may offer potential opportunities to each other's firms' workers that motivate them to work harder. To the extent that harder working employees lead to better investment opportunities, a virtuous circle can be created where harder working employees generate better opportunities, inducing greater effort and thus better investment opportunities in neighboring firms.[23]

The above arguments suggest that a positive shock to stock market participation can potentially influence both worker effort and investment expenditures in socially beneficial ways. In addition to affecting current investment choices, shocks to debt and equity markets affect capital structure choices, which in turn influence future investment choices. As described above, in addition to the direct externalities associated with these future choices, the anticipation of future opportunities (or a lack thereof) is likely to have an effect on worker morale and effort, which also have spillover costs and benefits.

B. Liquidations

Thus far I have focused on the links between shocks to the financial markets and investment expenditures. However, there are clearly important spillovers associated with liquidations and firm exits that are also worth considering. For example, the above-mentioned labor literature describes negative externalities

[21] See Pissarides (2000) for an analysis of the externalities associated with the entrance and exit of firms in labor search models and Almazan, de Motta, and Titman (2013) for a model that considers these externalities within the context of the capital structure choice.

[22] This will be the case if increased corporate investment directly increases the marginal product of an employee's effort or conveys information that firm prospects are more favorable, suggesting that the employee's effort may generate higher returns. Almazan, Chen, and Titman (2012) consider the latter possibility and show that firms may overinvest relative to the full information optimum to induce greater effort by employees.

[23] Almazan, de Motta, and Titman (2007) consider a case in which firms benefit from locating in a more liquid job market, since a liquid job market motivates workers to put in more effort. The intuition is that workers capture more of the gains associated with the improvement in their human capital when the job market is more liquid. One can extend this idea to show that effort is further increased when neighboring firms invest more. See Saxenian (1994) for a discussion of similar types of feedback in Silicon Valley. The observation in Dougal, Parsons, and Titman (2012) of a strong city effect in investment expenditures is consistent with this feedback between worker effort and investment expenditures across firms within a city.

imposed on unemployed workers when firms liquidate and discharge workers, as well as positive externalities that benefit emerging firms that have the opportunity to hire workers in a less constrained job market. Similar liquidation spillovers can affect suppliers and customers.[24]

Given the link between liquidation, bankruptcy, and capital structure, financial market shocks can influence liquidation through ex ante channels, which affect how firms are financed, as well as ex post channels, which affect the resolution of financial distress. Specifically, positive shocks to the availability of debt financing (or equivalently, a negative shock to the availability of equity) can lead to higher ex ante debt ratios, which in turn can lead to more firms being financially distressed during future downturns. In addition, conditions in the credit markets can affect whether lenders, ex post, offer workouts that allow distressed borrowers to continue operating. In both cases, financial market shocks affect liquidation choices that can have important spillover effects on economic activity more generally.

C. Financial Shocks and Innovation

The link between labor market externalities and financial market shocks can also provide a channel through which shocks to the financial markets affect innovation. On the one hand, because debt tends to fund more collateralizable/tangible assets, increases in the supply of debt capital tend to facilitate the expansion of existing technologies' capacity, perhaps stifling the introduction of new technologies that may have inherent spillover benefits.[25] On the other hand, as discussed above, debt may facilitate the exit of old technologies if it leads to future bankruptcies. Finally, as I note above, in the context of the 1990s stock market boom, shocks to the supply of equity capital are more likely to facilitate investment in more innovative technologies.[26]

V. Conclusions and Thoughts About Policy

This address raises the possibility that shocks to investor participation in the debt and equity markets affect not only the amount invested and how the investments are financed, but also the types of investments that are taken. Specifically, a shock to the supply of debt generates a tilt towards the types of investments that have greater debt capacities, while a shock to the supply of equity generates a tilt towards investments that are better suited for equity financing. As I emphasize, this distinction is important because new

[24] In 2009 the U.S. government provided financing that allowed for the reorganization of General Motors. In a congressional hearing, the CEO of Ford, arguing in favor of the bailout, claimed that the liquidation of GM would lead to the demise of suppliers that also provide auto parts for Ford.

[25] For example, there is current excess capacity of photovoltaic solar cells, which has kept solar cell prices low and inhibited the introduction of thin film and other "next generation" solar technologies.

[26] Michelacci and Suarez (2004) describe a model in which venture capitalists recycle their capital by taking firms public.

technology, which tends to generate positive externalities, is typically financed with equity, while investments in real estate and other fixed assets, which tend to be associated with negative pecuniary externalities, tend to be funded with debt.

To illustrate these issues, I focus on the two historic financial events of the last 20 years: the stock market boom and bust around the turn of the millennium, which contributed to the subsequent boom and bust in information technology investment, and the credit boom and bust that contributed to the boom and bust in residential housing in the mid-2000s. With the benefit of hindsight we can argue that there were benefits as well as costs associated with the technology boom. Specifically, the participation shock may have offset a tendency to underinvest in complementary technologies. However, very little positive can be said about the housing boom and bust.

In the aftermath of both events there were calls for intervention in the financial markets. Indeed, following the technology boom, Bernanke and Gertler (2001) raised the question, "Should Central Banks Respond to Movement in Asset Prices?" More recently, Mishkin (2011) discusses what he describes as the "Lean versus Clean" debate about whether monetary policy should *lean* against asset price bubbles or simply *clean* up the mess afterwards. Consistent with the observations in this address, Brunnermeier and Oehmke (2012) claim that there is "an emerging informal consensus that ... regulators and central banks should lean against credit bubbles, but not against bubbles not fueled by credit."

An important element of this debate is whether policymakers have a comparative advantage in identifying these bubbles, at least relative to hedge funds and other sophisticated investors that have clear incentives to make bets that offset the effect of irrational behavior. While I share the skepticism of commentators who have expressed these concerns, the models described in this address illustrate that observing shocks to participation can be as important as observing shocks to cash flow fundamentals. While it is likely that central banks and policy makers have no comparative advantages associated with the evaluation of fundamental values, they may be privy to special information that can help them interpret shocks to flows in and out of the financial markets, especially flows associated with the debt markets. Indeed, the Office of Financial Research, which was established under the Dodd-Frank Act, was set up to collect and interpret financial market data. The primary motivation for this data effort is to help regulators. However, if this effort provides better information to market participants, it can dampen the volatility of unanticipated participation shocks and as a result reduce their negative consequences.

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