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Follow the money: The monetary roots of bubbles and crashes

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ABSTRACT

A reduced form model for the join dynamics of liquidity and asset prices is proposed. The self-reinforcing feedback between credit creation and the market value of the financial assets employed as collateral in the bank loans (the so called financial accelerator) is modeled by a coupled non-linear stochastic process. We show that such non-linear interaction produces explosive dynamics in the financial variables announcing a regime change in finite time in the form of a market crash which can also be modeled by the same coupled non-linear stochastic process with inverted signs. Casting the financial accelerator dynamics into a highly stylized macroeconomic model, we study its macro-dynamics implications for real economy and for monetary policy interventions. Finally, by exploiting the implications of the proposed model on the dynamics of financial asset returns, we introduce an extension of the GARCH process, that can provide an early warning identification of bubbles.

1. Introduction

In our current monetary system, liquidity is mainly created by the credit issued by the "banking systems", considered in a broad sense, i.e., including the shadow banking system and other financial institutions behaving de facto like banks. Credit creation is subject to cycles which often coincide with those in economic activity and asset prices. The coincidence of these cycles has already been well documented in the policy-oriented literature (e.g. IMF 2000, BIS 2001). However, only few studies have tried to formally assess the link between liquidity dynamics and the episodes of booms and bursts in the financial markets.

In standard real business cycle models, credit does not have any macroeconomic effects. Moreover, credit aggregates, in particular bank credit that constitutes the closest proxy for money, are usually assumed to be mainly demand-driven (Bernanke & Blinder, 1988; Calza, Gartner, & Sousa, 2001; Fase, 1995), depending on economic activity and financing costs. However, driven by the implication of asymmetric information, new theoretical approaches have attributed an important role to credit aggregates in the development of the business cycle (e.g. Bernanke, Gertler, & Gilchrist, 1999; Kiyotaki & Moore, 1997).

Moreover, on the empirical side, a growing body of literature (see Schularick & Taylor, 2012 and reference therein) consistently found that an acceleration of credit supply is the single best predictor of future financial instability (a result which seems to be robust to the inclusion of various other nominal and real variables). These empirical results on extensive sets of historical data, vindicate scholars like Minsky (1975, 1982) and Kindleberger (2005) who argued that the financial system is prone to endogenously generate cycles of credit boom and bursts. In particular, Minsky (1975, 1982) argued that financial systems are fundamentally unstable due to the procyclicality between debt and speculation (see also Keen, 2011 for a concise exposition).

Other scholars have emphasized the importance of how liquidity flows into the economic system. Werner (2012) has argued that the effect of credit creation depends on how the money injected in the economy is used for. He identifies three types of credit: for production, for consumption and for speculation. Only credit creation for production leads to GDP growth by increasing the quantity of goods and services. Credit creation for consumption increases GDP but it does so through inflation and not real growth. In this case, more money circulates in the economy but the quantity of goods and services remain the same. Credit creation for financial transactions increases the amount of money in financial markets, leads to asset inflation and is not part of GDP. Excessive credit creation of the last two cases can eventually lead to banking and economic crises.

Because of information asymmetries, agency problems, and incomplete contracts, banks tend to preferably extend loans with real or financial asset as collateral (see Aghion & Bolton, 1992; Hart & Moore, 1994,

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1998). Higher collaterals, in fact, reduce the influence of asymmetric information and improve lending conditions. This tendency of the banks for collateralizing loans introduces an important structure in the way money flows into the economy. Hendry (1984) and Muellbauer (1992) showed that availability of bank loans backed with some collateral asset is a major factor in the rise of those asset prices. When increasing new credit is granted for financial investments (so that the collateral of this credit becomes the investments itself) because of the relatively fixed short-run supply of collateral, it will tend to increase the corresponding financial prices. For example, a rise in the amount of issued mortgage will make house prices increase (see e.g. Greiber & Setzer, 2007), while easy lending (backed by financial asset) to, for instance, hedge funds, Special Investment Vehicles (SIV), and other financial investors will tend to increase financial asset prices.

Because borrowers are constrained in their demand for credit by the values of their collateral assets, an increase in their prices will expand their borrowing capacity augmenting the creation of liquidity which, in turn, increases the collateral prices in a self-reinforcing mechanism. Expansion of asset collateralizing loans pushes up the price of collateral, allowing banks to expand their collateralized loan books. Similar self-reinforcing interactions have been investigated in the literature which usually referred to them as "financial accelerator" mechanisms (Bernanke & Gertler, 1989; Bernanke, Gertler, & Gilchrist, 1996; Bernanke et al., 1999; Kiyotaki & Moore, 1997; Stein, 1998). The existence of a close link between ample liquidity and bubbles is also reported by practitioners and financial commentators.[1]

In addition, the sustained growth of liquidity and financial prices during the boom phase will create capital gains that will easily repay interest payment and make financial investments appear safe and profitable, thereby reducing the estimated probability of default, the risk premia, and the costs for access to external funds. Because investing in the roaring markets will yield high and consistent capital gains, more and more investments will be re-directed from the real sector to the financial one. During this period, competition among banks for higher profits will induce them to increase their financial leverage. Moreover, firms will also start to invest more on financial instruments and financial acquisitions (e.g. stocks repurchases) and less on physical and productive investments (such as new machineries or R&D). Hence, because of the financial accelerator and investment substitution (from real to financial sector), a growing share of new credit will be channeled to financial investments exerting further pressure on financial prices, which in turn will expand borrowing capacity and hence banks lending to financial investments. As the financialization of the economy increases, the increasing reliance by firms on earnings realized through financial channels progressively marginalizes the role of the real economy in the global economic growth and also leads to significant income inequality (Lin & Tomaskovic-Devey, 2011). This has a negative effect on the growth of the real economy, leading eventually to the change of regime from boom to bust.

In this paper we focus on the macro-dynamic implications of the financial accelerator by proposing a simple reduced form model[2] for the Minskian-type of dynamics generated by the financial accelerator. Although, we do not provide any explicit microfoundations to our stochastic model, we build on the results of several microfounded papers that employ standard neoclassical economic modeling, like Stein (1998), Bernanke and Gertler (1989), Bernanke et al. (1996, 1999) and Kiyotaki and Moore (1997). However, to our perspective, this literature tends to mainly focus on a few individual macroeconomic linkages and not the complete macro-dynamic picture. The contribution of this paper is, therefore, to try to put together the many individual insights from these distinct microfounded works in a simple aggregate model of the dynamics of financial booms and bursts.

We start by considering credit creation as driven by the market value of the financial asset employed as collateral in bank loans. This leads to a self-reinforcing mechanism between financial prices and liquidity that we model by coupled non-linear stochastic processes. We show that the resulting non-linear dynamics are characterized by super-exponential growth. If left unchecked, such super-exponential growth would lead to a finite time singularity. The singularity expresses the unsustainable dynamics of the economy and announces a regime change, such as a crash and/or economic recession. During a financial crisis, a self-reinforcing interaction between liquidity and collateral prices also develops. Being the exact image of the financial accelerator in reverse, we model financial crises with the same coupled non-linear stochastic processes used in the financial accelerator only with the opposite sign. The occurrence of the sign inversion, i.e., the shift of the financial accelerator into a downward spiral, is modeled as a stochastic regime switching process with endogenous transition probabilities.

Casting the financial accelerator dynamics into a simple macroeconomic model, we show that the relations between liquidity and asset prices have important consequences on general macroeconomic variables. Fluctuations in asset prices and liquidity heavily impact on borrowing capacity, cost of external funds, and probability of default, hence, strongly affecting aggregate demand and real GDP. Moreover, by providing a quantitative modeling of the non-linear feedback dynamics at work in the financial sector, our model permits to have a first quantitative comparison of alternative intervention policies within a non-linear Minskian type of framework. Finally, exploiting the implication of the super-exponential dynamics of prices on log returns, we propose a simple modification of the standard GARCH model, that we coin FTS-GARCH, with which it becomes possible to investigate the presence of finite time singularity behaviors, and hence bubbles, in financial series. We apply this procedure to various financial time series during a bubble period and find evidence for super-exponential behaviors.

Our analysis is related to the literature on the credit channel view of monetary policy transmission and on that of non-linear feedback mechanisms leading to financial bubbles and bursts. Some recent papers addressing these topics (mainly from an empirical point of view) include Adrian and Shin (2008) on the procyclical nature of leverage, Benmelech and Bergman (2010) on credit traps, and Sornette and Woodard (2010), Johansen and Sornette (2010), and Lin, Ren, and Sornette (2009) on the diagnostic and modeling of financial bubbles with super-exponential price dynamics.

The paper is organized as follows. Section 2 describes the coupled stochastic processes induced by the financial accelerator mechanism for the dynamics of financial prices and financial investments. Section 3 describes the real sector part of the macroeconomic model. Section 4 illustrates the dynamic behavior of the model by means of Monte Carlo simulations. Section 5 proposes the modified FTS-GARCH model to identify the presence of bubble and applies it on empirical data. Section 6 summarizes the implications of the model for economic stability and policy decisions. The Appendix A presents the exact solution of the finite-time singular behavior of a deterministic toy version of the model.

2. Liquidity and asset prices: A reduced form model for the financial accelerator

In this section we present the reduced form model for the dynamics of financial prices and financial investments induced by the financial accelerator mechanism.

[1] Mauldin and Tepper (2011), for instance, recently wrote "[…] liquidity has to go somewhere, and emerging markets look like the most likely destination […] Emerging markets could easily be the next bubble.".

[2] We use the term "reduced form model" in the broad sense of directly modeling the dynamics of aggregated quantities.