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Causes of Financial Instability: Don't Forget Finance

by

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ABSTRACT

Given the economy's complex behavior and sudden transitions as evidenced in the 2007–08 crisis, agent-based models are widely considered a promising alternative to current macroeconomic practice dominated by DSGE models. Their failure is commonly interpreted as a failure to incorporate heterogeneous interacting agents. This paper explains that complex behavior and sudden transitions also arise from the economy's financial structure as reflected in its balance sheets, not just from heterogeneous interacting agents. It introduces "flow-of-funds" and "accounting" models, which were preeminent in successful anticipations of the recent crisis. In illustration, a simple balance-sheet model of the economy is developed to demonstrate that nonlinear behavior and sudden transition may arise from the economy's balance-sheet structure, even without any microfoundations. The paper concludes by discussing one recent example of combining flow-of-funds and agent-based models. This appears a promising avenue for future research.

Keywords: Credit Crisis; Finance; Complex Systems; DSGE; Agent-based Models; Stock-flow Consistent Models

JEL Classifications: B52, C63, E32, E37, E44

1. INTRODUCTION

The 2007–08 credit crisis and ensuing recession was a sudden transition of the economy from one state to another, similar to such transitions in physical and biological complex systems (Scheffer 2009). Unsurprisingly therefore, critics of mainstream macroeconomics have called for the application of complex system theory as the new leading paradigm in macroeconomics. In particular, agent-based models (ABMs for short) have become widely discussed. A search in the economic literature database *EconLit* by this author shows that the number of studies with the phrase "agent-based" in the summary was 165 in the four years 2003–06 and 278 over 2007–10 (Econlit 2011). The first ABM-style macroeconomic textbook appears in 2011 under the title *Macroeconomics from the Bottom-Up* (Delle Gatti et al. 2011), a phrase now adopted for some mainstream models as well (De Grauwe 2010). *The Economist* (2010: 22) singled out ABMs as better financial crises predictors than the currently dominant "Dynamic Stochastic General Equilibrium" (or DSGE) approach to modeling the macroeconomy. And a recent World Bank Working Paper titled "A Flaw in the Model that Defines How the World Works" argues that this model "should be replaced by an approach using agent-based scenario analysis" (Bieta et al. 2010).

This present paper contributes to the ongoing discussion by noting that ABMs constitute a method rather than a theory, so that their acceptance still leaves open the question of which new theoretical framework is an alternative to DSGE models. If the problem with DSGE models is that they neither helped anticipate financial instability nor provided insights and policy implications after the fact, one conclusion is that we should turn to those models which did. Prominent among them were so-called flow-of-fund models. This leads to four questions pertinent to the paradigmatic shift in modeling financial instability. How is financial instability modeled in current macroeconomics, and what are the problems? What is the nature of models that have been empirically helpful in anticipating the latest financial instability? Can such models in principle capture the behavior of complex systems—in particular, nonlinearities and sudden transitions? And can these models be married to ABMs?

The failure of DSGE-style macroeconomics was a failure to meaningfully include finance in its models, not just a failure to model heterogeneous interacting agents. To augment the models with price rigidities (Smets and Wouters 2003) or heterogeneous interacting agents (De Grauwe 2010) is a solution to other problems of representative-agents equilibrium models, but not to the problem posed by the 2007–08 financial crisis. The difference is very widely neglected. To start addressing it, this paper first discusses how the structure of mainstream economic models prevents a meaningful modeling of finance. Section 3 introduces other economic theory that locates the source of credit cycles and financial instability in the financial nature of capitalism: in its use of money rooted in debt, and the interaction between asset markets and the real sector that gives rise to balance-sheet effects. It follows that the challenge is to explicitly model the economy's financial instability as residing in its financial structure, rather than in exogenous shocks in the real sector coupled with price rigidities (as DSGE models do) or only in the behavioral interactions of its agents (as in the behavioral finance approach). Both these approaches locate the source of instability ultimately (or exclusively, in the case of DSGEs) in individual behavior. But we know that causes of complex behavior (nonlinearities and sudden transitions) need not be exclusively micro-founded—they may also be meso-founded, in the interaction of components of the system. After all, "[c]omplex systems are comprised of multiple interacting components, or agents, whose interaction gives rise to new system qualities" (ACS 2011).

This is not to deny that exogenous shocks or behavioral interactions can also be sources of instability. But to confine the theoretical explanation to them would be to miss the structural tendency towards instability that is built into the financial relations found in every modern economy. The bulk of the paper is therefore devoted to addressing the third question above—can balance-sheet models capture nonlinearities and sudden transitions? From section 4, a deliberately simple model of a balance-sheet economy without explicit microfoundations is developed. It is demonstrated in simulations that this gives rise to complex behavior. The concluding section discusses recent work that combines the balance-sheet approach with agent-based modeling.

2. EQUILIBRIUM MODELS AND THE PROBLEM OF FINANCIAL INSTABILITY

The ruling paradigm of today's macroeconomics rests on two fundamental building blocks: its behavioral underpinning and its system view. The behavioral underpinning of neoclassical economics is methodological individualism with optimization. This entails that an economy can be modeled as representative agents optimizing some objective function reflecting their preferences and with given constraints—such as profit for entrepreneurs, consumption for consumers, and a welfare function for the government. Methodological individualism dictates that all economic phenomena, whether observed on the level of firms, sectors, economies, or globally, should be explained in terms of individual optimization. In the strong version, this implies that the whole is not more than the parts. A weaker version allows for interactions between agents to modify the economic system's properties, with a feedback loop to individual behavior. This allows for a separate, though still micro-founded, role of system properties. Methodological individualism with optimization has also won currency in other social sciences, a development known as "economics imperialism" (Lazear 2000). One reason why ABMs enjoys growing popularity among economists may be that they safeguard methodological individualism.

The second foundation of neoclassical economics is the notion of the economy as a system in equilibrium. The outcome of individual optimization processes, and thus the solution of the model, is a stable equilibrium (or several equilibria), which is a set of parameter values that characterizes the economy as a system and from which it can only deviate due to shocks from outside. There is no endogenous instability. Markets are conceived as always in a state of, or tending towards, a stable equilibrium. In an economy modeled as several markets (e.g., for labor, for goods, and for financial assets), each market reaches equilibrium in such a way that this is consistent and interconnected with equilibrium conditions in other markets. This is the multi-market or "general" equilibrium model, first developed by Léon Walras in the 1870s.

General equilibrium models have become the workhorse models for modern macroeconomics since the demise of Keynesianism in the late 1970s. Their latest incarnation is the "Dynamic Stochastic General Equilibrium" (or DSGE) model, which allows for distributions of realizations (hence stochastic), and studying transitions from one equilibrium to another (hence dynamic). De Grauwe (2010) is a good recent discussion of DGSE limitations and possible extensions. An and Schorfheide (2007: 113) note that they "have become very popular in macroeconomics over the past 25 years. They are taught in virtually every PhD program and represent a significant share of publications in macroeconomics." DSGE models are also ubiquitous in policy analyses by international institutions and central banks—see, for instance, introductions to the DSGE model used by the IMF (Botman et al. 2007), the European Central Bank (Smets and Wouters 2003), or the Reserve Bank of New Zealand (Lees 2009).

Given their predominance at the time of the crisis, DSGE models have come in for vocal criticism from within the profession. Well-know economists such as Buiter (2009) have argued that DSGE models are unable to describe the highly nonlinear dynamics of economic fluctuations, making training in "state of the art" macroeconomic modeling "a privately and socially costly waste of time and resources." Solow (2010), one of the grandfathers of current macroeconomic theory, testified in July 2010 for the US Senate that DSGE models "take it for granted that the whole economy can be thought about as if it were a single, consistent person or dynasty carrying out a rationally designed, long-term plan, occasionally disturbed by unexpected shocks, but adapting to them in a rational, consistent way. The protagonists of this idea make a claim to respectability by asserting that it is founded on what we know about microeconomic behavior, but I think that this claim is generally phony." The defense (as by Chari [2010]) has typically been to point out that DSGE models are more sophisticated than their critics suppose, especially because they can incorporate frictional unemployment, financial market imperfections, and sticky prices and wages.

However, such "stable-with-friction models" (Leijonhofvud 2009) can mimic nonlinear dynamics but not the financial causes of those nonlinearities. This is because DSGE models are characterized by the "absence of an appropriate way of modeling financial markets" (Tovar 2008: 29). The reason is that in DSGEs, the monetary side of the economy is fully determined in the real sphere. Agents make decision about producing, consuming, and investing based on the available resources, preferences, and prices. Money is treated as an add-on to the real economy, a mere unit of account that allows for comparing the values of goods and services, facilitating individual optimal choice. Given the outcome of the optimization process, the financial sector is modeled as passively providing the means to execute the necessary transactions in labor, goods, and services. Therefore money must exist strictly in proportion to the sum value of all real-sector transactions—that is, to real-sector output.

This determinateness is a problem when it comes to understanding financial instability, which can arise only if financial liquidity is created in excess of real output, as discussed in more detail below. DSGE models so exclude the possibility of financial instability. Moreover, the equilibrium concept also prevents the explicit modeling of financial variables that are not fully determined in the real-sector optimization processes that drive the model. Even though the tacit assumptions are that financial flows (e.g., of profit and interest) exist, Godley and Shaikh (2002) demonstrate that explicating the financial flows implied by DGSE model outcomes would undermine key model properties such as optimization in real (not nominal) terms, and leads to anomalies, such as falling prices, when the money supply expands. Making finance explicit is disastrous for DSGE models, because financial variables then are shown to move in ways that are incompatible with the determinate equilibrium path of DSGE models.

That is why DSGE models cannot, in principle, incorporate the financial sector and credit creation. And in a model world where credit does not exist, a credit crisis cannot be anticipated. This was due not to bad luck or exceptional conditions, but to the very structure of macroeconomics' core models: the price for model consistency on DGSE terms is that finance cannot be modeled and financial crisis cannot exist. Alan Greenspan professed to "shocked disbelief" while watching his "whole intellectual edifice collapse in the summer of [2007]." Glenn Stevens, Governor of the Reserve Bank of Australia, asserted in December 2008: "I do not know anyone who predicted this course of events. This should give us cause to reflect on how hard a job it is to make genuinely useful forecasts."

All attempts to notionally integrate finance into a DSGE or other equilibrium models must picture the financial sector as a mere conduit of existing money from savers to investors, strictly proportionate to current output in the real sector—as if money's only function was to circulate goods and services. This denies the nature of finance, which is leverage: the creation of debt claims and credit instruments in excess of current output. Banks *create* money, they do not just pass it on from savers to investors (FRBC 1992; FRBD 2001; Werner 1997). Where credit cycles are ostensibly treated in neoclassical macroeconomics, what is really modeled are *external* (not financial) shocks exacerbated by finance. Imperfections in financial markets may amplify and exacerbate shocks from outside the financial sector, as in the seminal Kyotaki and Moore (1997) model titled *Credit Cycles*. But there is nothing special about finance in this respect; the same role could be fulfilled by wage rigidity in labor markets. Instability is modeled, but not the sort of instability that finance precipitates by the build-up of debt relative to the size of the economy. A quarter century ago, Bernanke (1983: 258) already wrote that "only the older writers seemed to take the disruptive impact of financial breakdown for granted." This neglect was the intellectual background for the rise of DSGE models to prominence—a state of affairs which left mainstream economists impotent to anticipate the 2007 credit crisis.

3. UNDERSTANDING FINANCIAL INSTABILITY: FLOW OF FUND MODELS

Outside of the neoclassical confines in which Chairman Greenspan and Governor Stevens moved, the crisis had been anticipated by (literally) scores of nonorthodox economists, often with remarkable precision regarding the timing and the mechanism of the collapse (AFEE 2010). One example is the work by Godley and collaborators of the Levy Economics Institute of Bard College (NY). They consistently argued from 2000 that the stability of the 1990s and 2000s was unsustainable, as it was driven by households' debt growth, in turn fuelled by capital gains in the real estate sector and its derivative products (Godley and Wray 2000; Godley and Zezza 2006). They correctly predicted recession in the United States while official forecasters (e.g., the US Congressional Budget Office) were still optimistic—for details, see Bezemer (2009b, 2009d, 2010b, 2011a).

Godley made his predictions based on a flow-of-funds framework (presented in Godley [1999] and Godley and Lavoie [2007]) which built on an older strand of economic thinking outside the general-equilibrium orthodoxy. Theorists including MacLeod, Wicksell, Mises, Hayek, Irving Fisher, Veblen, Schumpeter, Keynes, Kalecki, Minsky, and Tobin theorized true finance-induced macroeconomic instability. Because of their emphasis on the economy's financial nature reflected in balance sheets, Skaggs (2003) and others have identified this line of thinking as the "accounting approach" tradition in economics. Minsky (1986: 34), for instance, wrote that his analysis would be "based on accounting identities." Godley and Lavoie (2007b) introduce an "accounting framework" (p. 18) to macroeconomics by writing that the aspiration is to "describe the evolution of the whole economic system, with all financial transactions (including changes in the money supply) fully integrated" (p. xxxiv). "The fact that money stocks and flows must satisfy accounting equalities in individual budgets and in an economy as a whole provides a fundamental law of macroeconomics analogous to the principle of conservation of energy in physics" (Godley and Cripps 1983: 14).

This strand of theories locates the economy's instability in its *financial structure*, not only in the behavior of its agents. Skaggs (2003) notes that critical elements linking these analysts are their "treating money as rooted in debt (so emphasizing that every credit is mirrored in a debit); avoiding equilibrium analysis, but rather thinking in terms of unfolding processes; and treating banks as creators of credit, not mere intermediaries"; and they "refused to net out assets and liabilities, and rejected extreme aggregation." Specifically, the key features of their and others' credit cycle theories are: (1) "free" credit flows not determinately linked to real-sector growth; (2) assets distinguished from money; (3) debt as the counterpart of credit and, especially in Minsky; (4) the economy as shaped by accounting constraints implied in its financial nature (Bezemer 2011a). Consider these in turn.

"Free" credit flows can only exist if credit (and credit-money) is recognized to be created "out of nothing." There are no "free resources" (or savings) in the real sector, which are the loanable funds that limit the expansion of the credit system. Rather, crediting bank accounts is how financial resources are created and, in the short run, there is no necessary and direct link to real-sector income. Credit expansion or contraction can be self-propelled for long periods of time. Moreover, credit flows over and above those linked to current output have to be linked to some other market, namely asset markets (dispensable in (DS)GE models). Realistic models of finance-real sector interactions therefore need a dual economy, with finance explicitly modeled and distinct from the real economy and assets distinguished from money. Finally, by balance-sheet identity credit is also debt, so that the economy is subject to an overarching accounting constraint. This constraint is key to the peaking of a credit boom and the real-sector consequences of a debt deflation.

Thus, the effects of credit and debt are not addressed by introducing sticky wages or price rigidity (as in DSGE models), nor agent heterogeneity and interaction effects (as in ABMs). The accounting approach captures the financial nature of modern capitalism, neglected in neoclassical macroeconomics and also most other (including most ABM-based) work. Financial structure is nevertheless one source for the economy's complex-system behavior. The next section develops a model that reflects this in the simplest possible manner. In particular, it explicates the economy's balance sheets but abstracts from specifying individual behavior in order to bring out that instability is (partly) based in the economy's financial structure.

4. A SIMPLIFIED BALANCE-SHEET APPROACH

Schumpeter (1954: 717) advised to "look upon capitalist finance as a clearing system that cancels claims and debts and carries forward the differences—so that 'money' payments come in only as a special case without any particularly fundamental importance." This might serve as the motto for the stock-flow consistent approach to macroeconomics as explained in Godley and Lavoie (2007); for recent theoretical contributions, see e.g., Dos Santos and Zezza (2007) and van Treek (2009). All financial transactions are credit/debit operations and the whole system is always subject to an overarching balance-sheet identity of the type "credit = debt." In particular, as Schumpeter emphasizes, money is just one type of credit and interacts with other types; since money creation is debt creation, the counterpart debt growth needs to be traced so as to understand dynamics. These are the two organizing principles in explaining how finance induces instability: a balance-sheet approach to the economic system, and distinction between money and other types of credit. To do this in a model as simply as possible (but not simpler), the economy is represented by the following balance-sheet identity:

$$L + S = D + W$$

where L denotes loans, S securities, D deposits, and W wealth. With assets on the left-hand side and liabilities on the right-hand side, this is a balancesheet identity from the financial sector's point of view. Its assets are bank assets (loans to the nonfinancial sector L) and nonbank financial sector instruments, generically labeled "securities" (S). Its liabilities are the nonfinancial nonbank (or "real") sector's deposits (D) and its wealth (W). "Wealth" is the aggregate of all nondeposit assets held by the nonfinancial sector.[1] (In what follows, we will use "the real sector" and "the economy" interchangeably.) Identity 1 brings out the overarching accounting identity that whenever the economy's assets (deposit money and wealth) increase, its liabilities increase. In particular, the sum total of the money stock D and the value of transactions in wealth W, both held by the real sector, can grow in nominal value only if banks and nonbank financial institutions create the liquidity needed for these transactions by lending to real-sector agents, accumulating debt claims against the real sector.[2] In the remainder of this section the identity is explained. It is convenient to do this in flow terms (denoted d).

When banks lend, the real sector receives the newly created liquidity on deposit and then uses it in transactions of goods and services or in wealth transactions (Caporale and Howells 2001; Werner 1997). So far, that means dL = dD + dW. In words, fresh lending monetizes (i.e., provides the financial resources for) the additional transactions in goods and

[1] This representation implies a balance sheet aggregation choice. Common stocks, issued by firm to households, or public debt, issued by the government, remain implicit in Wealth. Its distribution over firms, households, and government is not specified, so that (for instance) common stock held as a household's asset and a firm's liability cancels out. Debt from nonfinancial firms to households does not appear on the financial sector's balance sheet. Also, we do not separate out a foreign sector.

[2] Note that the value of the total wealth stock is larger than the value of transactions in wealth. The valuation of nontraded wealth titles may change as a result of rising transaction prices of traded wealth titles. Below we capture the difference in parameter q_W. This wealth change has real effects (e.g., consumption) but in monetary terms it is "virtual" in that it occurs without an attendant rise in liquidity dL.

services that constitute economic growth dD as well as the additional transactions in wealth dW. But lending also induces return flows of interest and principal repayment. Repayment is from deposits and this reduces the levels of loans and of deposits in equal measure. These interest-driven repayment flows are key to finance-induced instability of the system, even though "it is standard practice… to ignore interest payments" (Godley 1999: 405).

The economy's repayment of loans does not simply accumulate in the financial sector. They are capitalized into new loans or into investment instruments. We label this new asset class generically "securities," denoted S. For the financial sector to reinvest return payments means to plow it back into the real sector, replenishing dD to its initial level before repayment, and raising S accordingly. S epitomizes the nonbank financial sector. Including it means adding its assets to the left-hand side of the identity, resulting in

dL+dS=dD+dW, or (in stock terms) the above identity L+S=D+W.

There are two types of securities S. Part of S is equity investment, allowing the nonbank financial sector to establish non-interest-bearing claims on output (i.e., to buy shares ands bonds). As a result, the real sector has increased in size (by dD) and in liabilities (by dS; it now has both loan and equity liabilities). Equity, by establishing new claims on output, changes the distribution of income between the real and the nonbank financial sector.

The other destination for repayment flows is securitization as we know it: the returns on loans are repackaged as new interest-bearing financial instruments. This has future repayment implications. Either way, repayment flows from the real to the financial sector are converted into claims held by the nonbank financial sector on the real sector.

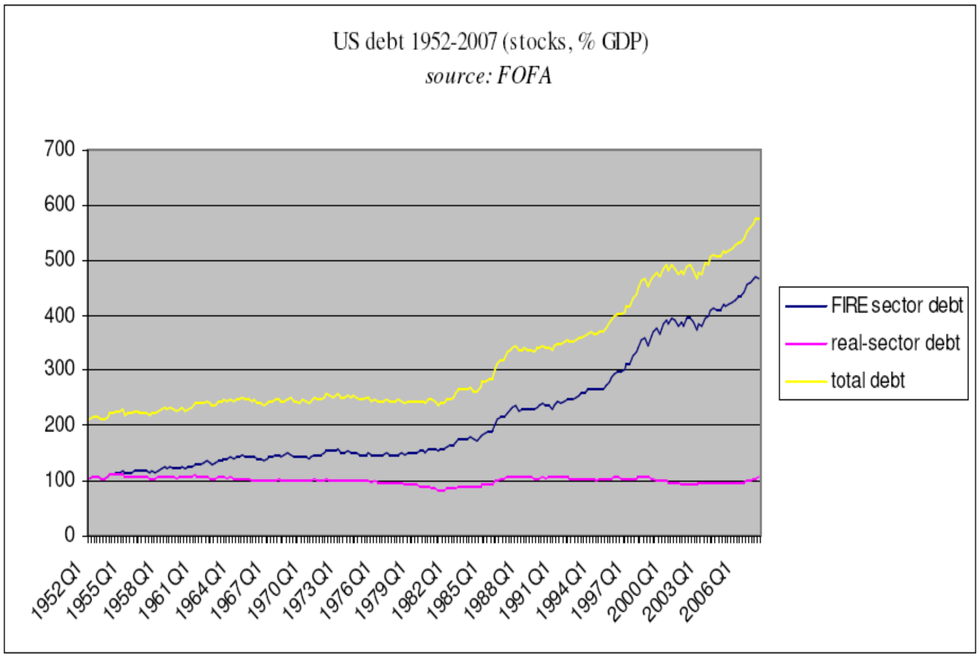
5. LINKING FINANCE AND THE ECONOMY

Recall that the problem in (DS)GE models is that finance is linked to the economy by assuming away "free" credit flows, as if money's role is only to circulate goods and services in the real sector. In model terms, this is to assume that dD is the only monetary variable that matters and that dL, dS, and dW can be safely left out of the model. By assuming that money is a unit of account, it is assumed that any growth of the economy (denoted Y) that increases real-sector transactions by amount dY is always automatically accommodated by growth of money dD. In sum, in standard macro models the assumptions are that dL=dS=dW=0 and dD=dY. In this section we show that the second assumption has very strong credentials while the first precludes any meaningful analysis of credit cycles or financial instability.

Theoretically, any increase in the sum of all final goods-and-services transactions that make up the gross domestic product (GDP, or Y) must be mirrored in bank credit creation supporting transactions of final goods and services.[3] In other words, bank lending to the real economy D should indeed be constant in proportion to the size of the economy, and so dD = dY. To equate growth in bank lending to the real sector to nominal economic growth is not a novel idea. Marx in *Capital* wrote of "productive credit, whose volume grows with the growing volume of production," implying parity of credit for goods-and-services transactions with the volume of production of goods and services—true by definition. Werner (1997) found for the case of Japan that fluctuations in credit to the real sector and in GDP indeed have a correlation coefficient very close to one. Federal Reserve analysts also note for the United States that "over long periods of time there has been a fairly close relationship between the growth of debt of the nonfinancial sectors and aggregate economic activity" (Board 2009: 76). We may also show this long-term relation for the United States from the 1950s to just before the 2007 crisis. The growth of lending to the nonfinancial sector maps indeed virtually one-on-one onto growth of aggregate economic activity (GDP) since the beginning of the time series in 1952.

[3] Effects on GDP of changes in inventory and interfirm trade credit are abstracted from.

Figure 1: Lending to the Real Sector Equates to Nominal Economic Growth



Source: Bezemer (2009a)

The contrast is to flows of other, "free" credit issued by US banks, defined in the US National Income and Product Accounts (NIPA) classification as the Finance, Insurance, and Real Estate (or FIRE) sectors. They rose five-fold in proportion to the US economy since the 1950s. Thus, the bulk of the economy's financial flows are left out of DSGE models. These flows constitute what Minsky termed the "managed money" that is the domain of savings institutions, credit unions, funding corporations, property-casualty and life insurance companies, mortgage pools, closed-end funds, exchange traded finds, private pension funds, money market mutual funds, real estate investment trusts, security brokers and dealer, and the like. In terms of instruments, US domestic FIRE-sector debt is mainly (for about 95%) credit market instruments, primarily bank debt and some bonds (see Bezemer [2009] for further detail). In model terms, this credit other than used for goods-and-services transactions is by definition comprised of "free" financial flows, to the amount (W+S).

Key to understanding finance-induced instability is "leverage" (Geanakoplos 2008), which is the ratio of the real sector's IOUs (the sum of debt-financed wealth W and securities S) to its deposit base D. If leverage will be measured by (W+S)/D, it follows that the rise in debt that is the balance-sheet counterpart to FIRE sector credit flows (W and S are both debt financed) must imply an increase in the economy's leverage, that is: in its debt-to-

GDP ratio[4] or, in the model terms defined above, in (W+S)/D. Analysts have indeed noted that each postwar US business cycle started at a higher level of leverage (Hudson 2006).

6. DYNAMICS

Dynamics are shaped by five parameters: nominal interest rate i, loan maturity m, securitization ρ, the economy's nominal growth rate y, and the nominal wealth growth rate w. While the values for economic growth and wealth growth evolve endogenously, parameters for securitization, maturity, and interest rate will be given constant values in the simulations below, so as to bring out that financial instability arises from the structure of financial capitalism, not from variations in its financial parameters. This is the key point made in Minsky's work: to have sophisticated financial markets (asset markets distinguished from money) is to have financial fragility and instability. In particular, it bears emphasizing that instability dynamics do not exist because of interest rate movements. They exist because of the structure of leverage, the key element of capitalist finance. Geanakoplos (2009: 9) calls for an end to "the obsession with interest rates" and asserts that "regulating leverage, not interest, is the solution for a troubled economy." Endogenizing interest rates and making them variable does of course bring in additional dynamics that occur in reality. But Geneakoplos' point is that these may be secondary phenomena. The simulations below indeed show that credit cycles and financial instability exist also without changes in interest rates.

The growth rules are the following. Per period total lending dL by the real sector is determined by its cost (interest i) and its expected benefits. We use simple backward-looking expectation formation. In case of lending for real-sector production and consumption leading to dD, the expected benefit is based on the GDP growth rate y = dY in the last period. In the case of lending for wealth investments (such as mortgages) leading to dW, the wealth formation preference is shaped by both past income growth y (more wealth titles are acquired when income is higher) and the wealth growth rate w = dW in the last period (higher returns on wealth investments attract more wealth investment). With scaling parameters q_D , q_W, simple growth rules capturing this are

[4] The fact that wealth cannot grow unless debt grows is an *aggregate* accounting identity, not an individual-level assumption on how wealth is financed. Over the course of a credit boom, successive owners of an asset may sell the asset at a profit, but their buyers will have to shoulder proportionally more debt (or divert more of their real-sector income) in order to acquire the asset, balanced (for the time being) by the asset's value. Asset trade may be individually profitable; it is a zero sum game for the economy (Bezemer 2009a, 2009b).

$$dD = q_D \cdot \frac{1}{i} \cdot (y)_{t-1} \tag{G.1}$$

$$dW = q_w \cdot \frac{1}{i} \cdot (y + w)_{t-1} \tag{G.2}$$

Since the deposit stock increases with the size of the economy (Y=D) there is no net repayment per period (i.e., lending is larger than repayment) if economic growth is positive. What does need to be repaid are loans to finance wealth transactions. In each period t, repayment of such loans (principal and interest) is from deposits, with the amount determined by interest and maturity parameters *i* and *m*, and some scaling parameter q_R.

Recall that repayment flows may be channeled into equity investment or into securitization, where the returns on loans are repackaged as new interest-bearing loans. Both types of securities constitute wealth (a claim on output). Therefore they are interchangeable with (other) wealth W held by the nonfinancial sector (such as property and currency). It follows that the rate of increase of securities will be viewed as a rate of return on wealth investment. Past rates of return on securities and wealth will be among the determinants of current wealth investments. This is the way we capture the link between nonbank financial sector growth with investment decisions in the real sector. Thus, rising loan repayment flows capitalized into equities do not, by themselves, increase leverage; they increase D *pari passu* with rising S, at constant ratio (W+S)/D. But the higher rate of return on holding wealth that this implies causes more future lending for wealth investment W rather than for investment in real-sector growth D. This does increase leverage. Having dS depend on past values of S reflects the securitization feedback loop that makes growth of securitization self-propelled. With a constant parameter ρ (0<ρ<1) denoting the share of cumulative repayment that is loan securitized in each period, we have

$$dS = q_S \cdot \left(i + \frac{1}{m} \right) \cdot (D + W + \rho \cdot S)_{t-1} \tag{G.3}$$

with scaling parameter q_S. This concludes the model. With four variables and five parameters, it is perhaps the simplest model that still has the following five features:

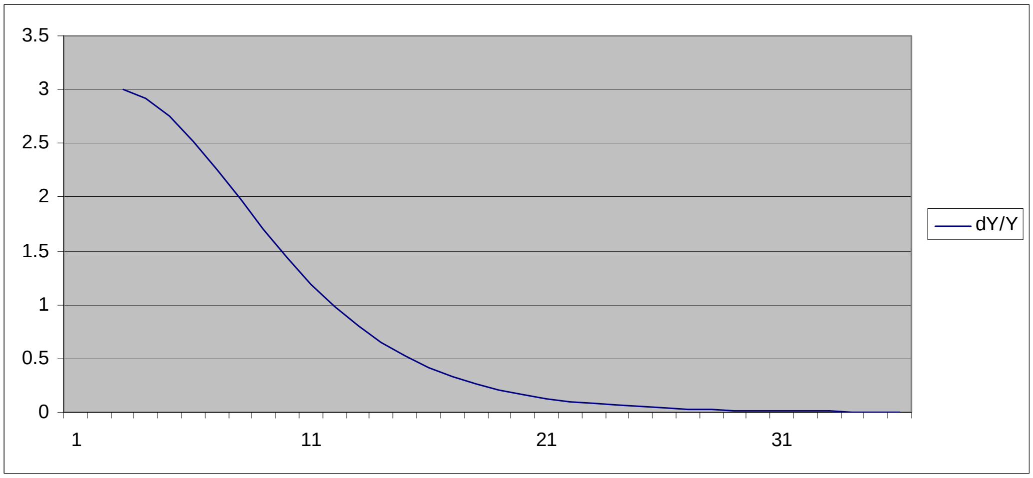
1. The economy is shaped by, not merely reflected in, balance sheets.
2. The real sector and the financial sector's flows are separate, because the real sector's money (deposits) and wealth are separate from the financial sector's assets (securities). But they do interact (point 4, below).
3. Within the financial sector, the function of banks and nonbanks is separated (loans making versus securities trading)—even though actual banks may mix them.
4. Securities trading effects the real sector's wealth and increased lending elicits return flows of interest and financial fees. These are the key mechanisms of real-sector effect of finance.

Following Godley's dictum (e.g., Godley and Lavoie 2007: xii), the model has so-called stock-flow consistency throughout. In model terms, this means that the identity L + S = D + W is always satisfied because in flow terms, in each period dL + dS = dD + dW holds. Everything is in nominal terms for, as Minsky (1986) emphasized, it is nominal values for assets and debt that are among the financial causes of cycles and crisis. Model properties suffice to generate endogenous cycles, and instability of cycles due to increasing leverage. But as we will see, the timing and severity of instability depend on the nature of securitization. We now turn to simulations.

7. SIMULATIONS

Without leverage, there are no finance-induced cycles. This is because finance *is* leverage. With W=S=0 the model reduces to L=D, as in DSGE models: all credit creation is for the real sector, which grows autoregressively according to growth rule G.1, with rules G.2 and G.3 irrelevant. Loan repayment is not invested in securities, but just creates the financial room for new bank lending to the real sector. In the present specification of G.1, growth tapers off. For instance, with starting values {Y=D=10,000, W=S=0} and parameters {i = 6 %, $w_0=y_0$= 3 %, m=10 years, q_D = 6} income Y converges in 30 periods to a level that is stable to 2 decimal points percentage growth, with income growth rate *y* converging to zero. Changes in parameter values change the pattern and the speed of convergence. For instance, with *i* = 4 %, growth first rises before falling, and the stable level is reached after 20 periods. This hypothetical simulation links in with the central role of finance for economic growth to occur at all in capitalists systems—or as Schumpeter, Keynes, and Minsky emphasized, capitalism is inherently *financial* capitalism.

Figure 2: Capitalism without Leverage Stagnates



Starting values: D=Y=10,000
W=S=0
$y_o = 3$ %

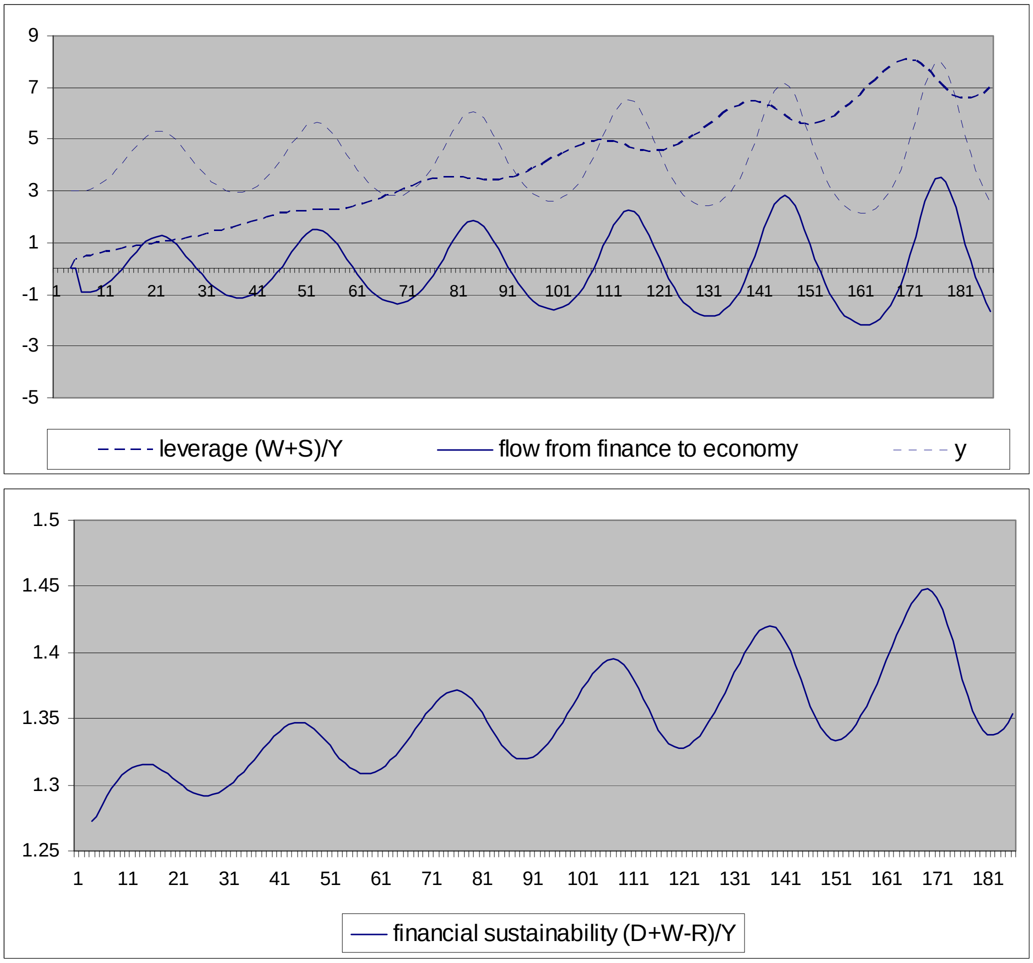
Parameters: i = 6 %, $q_D = 6$, m=10, ρ= 0

In the second simulation we introduce leverage without securitization by setting starting values W_o=S_o=10 and ρ=0 so that growth rules G.2 and G.3 come into play, and all else equal. Again, we normalize interest to 1% by setting $q_D = 1/i = 6$. Figure 3 below shows three variables: income growth dY/Y, leverage (W+S)/Y, and net flows from finance to the economy, which is (dD+dW-dS)/Y, all multiplied by 100 to yield percentages of Y. The simulations over the short run (200 periods) show cyclicality of income and of financial flows, with increasing levels of leverage. As was the case with postwar US growth, each business cycle starts at a higher level of leverage. Leverage itself is also cyclical.

The bottom panel in figure 3 shows that the model is financially sustainable in the short run, in the sense that all financial obligations can be met. This is indicated by a "financial sustainability" measure, which subtracts the flow of net payments from the real to the financial sector (dS) from the stock of financial means to service this payment (D+W), all scaled by Y. Since D=Y, this measure (D+W-dS)/Y is equivalent to (1 + (W-dS)/Y), or one plus the excess of wealth over repayment obligations. Situations with (W-dS)<0 are clearly financially unsustainable in this model.[5] However, in the equity scenario in the short run, financial sustainability is on an increasing trend, as figure 3b shows.

[5] This should be viewed as a minimum value for financial unsustainability. In the real world, even dipping below some positive lower threshold value for (W-dS) will be financially unsustainable. Reasons include that at this point financial market participants can foresee the W<dS point approaching and that fire sales of assets depress asset prices and reduce repayment capacity.

Figure 3: The Equity Scenario in the Short Run: Financially Sustainable Credit Cycles



Starting values: $D_0=Y_0=10{,}000$

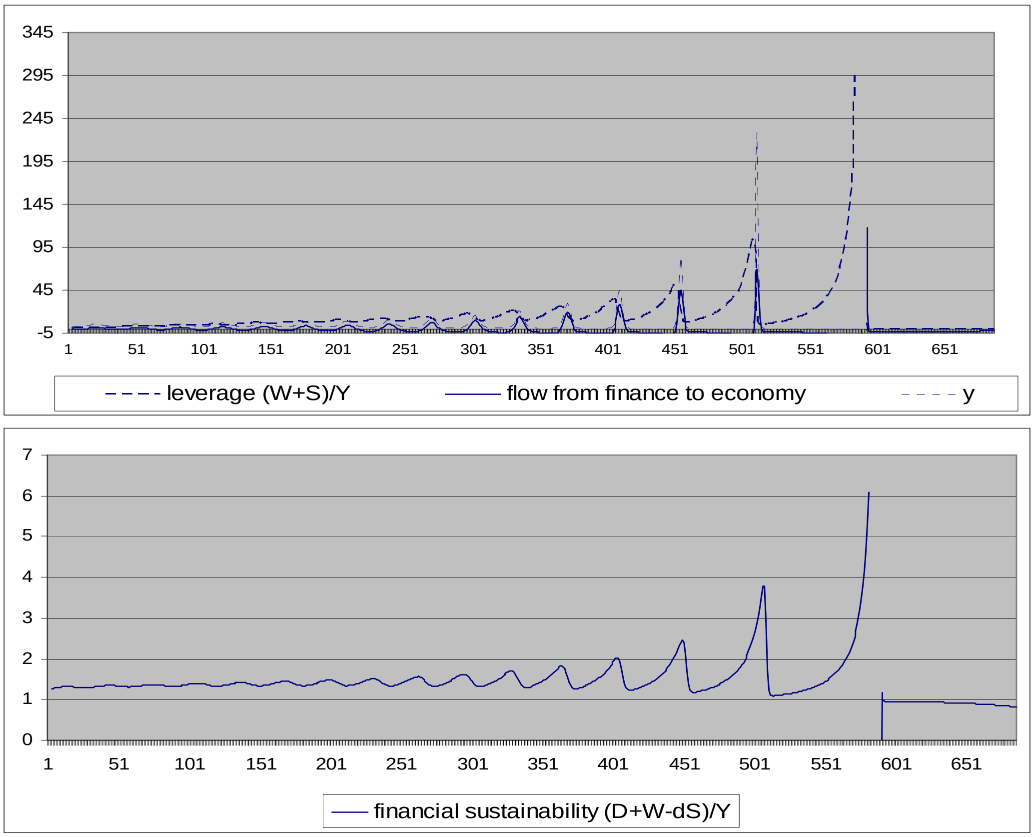
$W_0=S_0=10$

$y_0 = w_0= 3\ \%$

Parameters: $i = 6\ \%$, $q_D=q_w=6$, $m=10$, $\rho= 0$

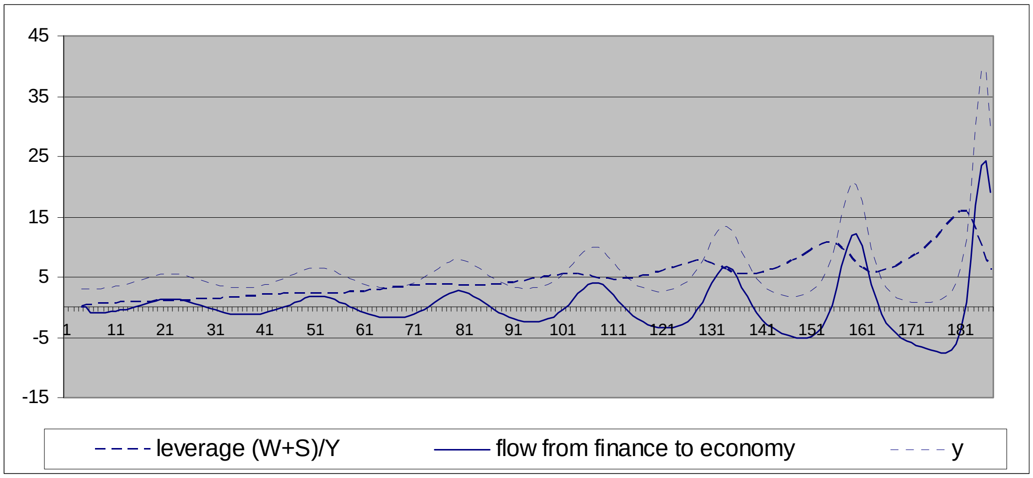
That instability is nevertheless built into the fabric of financial capitalism, as Minsky (1986) explained, becomes clear only in the medium run (700 periods). Figure 4 (bottom panel) shows for the same settings that the cyclical minimum value for financial sustainability peaks at value 3.36 for t=244, and sinks to just above value one (1.08) at it last realization (at t=516) before the system implodes around point 590. (Recall that value one for financial sustainability means that that period's repayment obligations can just be met out of total wealth W). However, since peak values for financial sustainability rise much more than trough values fall, average values continue to increases right until the crash. These peaks reflect the skyrocketing asset values typical of the last phase of a credit boom, aptly labeled the “winner’s curse” phase by Harrison (2008). Leverage and financial flows to the economy also peak before they turn negative and the system collapses.

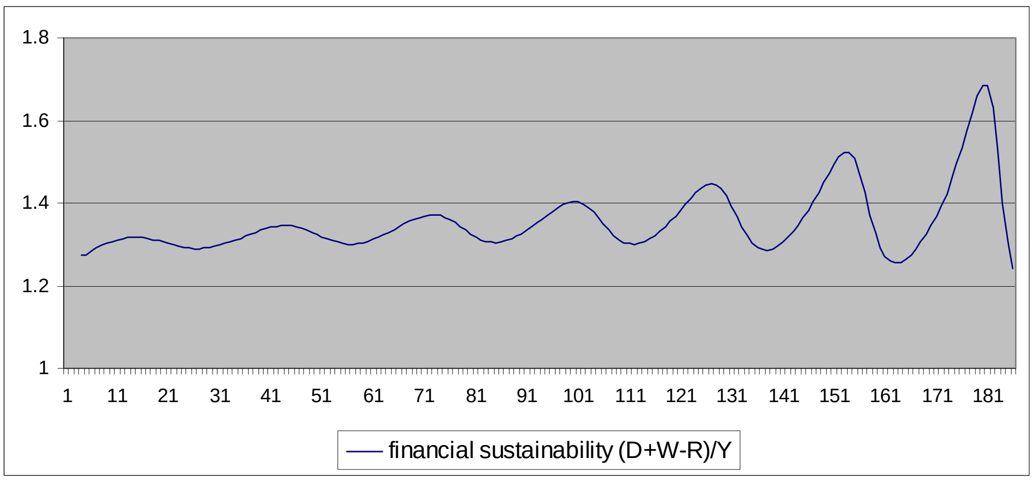
Figure 4: The Equity Scenario in the Medium Run: Increasing Cycles Followed by Breakdown



We now introduce securitization by setting ρ = 0.1 and everything else equal. Figure 5 shows the short-run 200-period scenario.

Figure 5: The Securitization Scenario in the Short Run: Higher Growth but Declining Financial Sustainability Troughs





Starting values: $D_0=Y_0=10{,}000$
$W_0=S_0=10$
$y_0 = w_0= 3\ \%$

Parameters: $i = 6\ \%$, $q_D=q_w=6$, $m=10$, $\rho= 0.1$

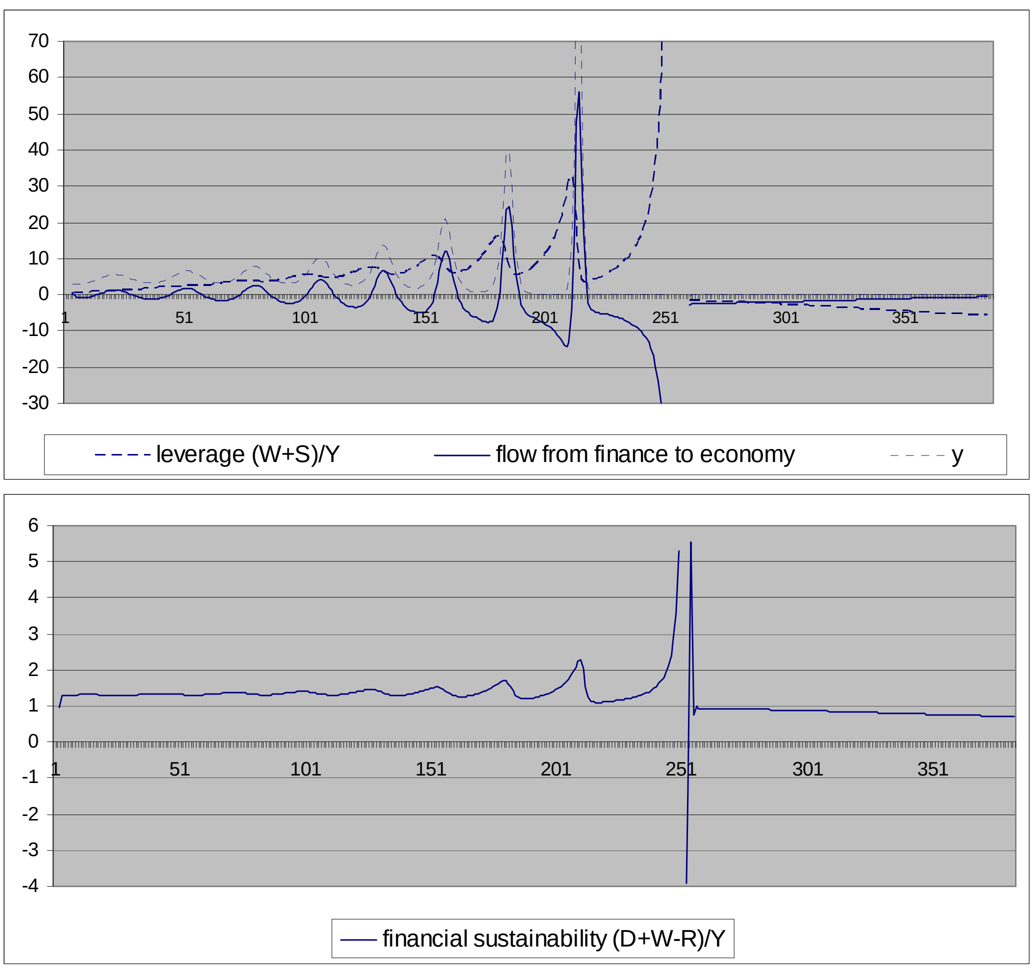
The differences with the equity regime are noteworthy (note the different scale):

1) Securitization is good for growth, in the short and medium run. The upward trend in income growth is now much stronger.
2) Securitization amplifies and intensifies the business cycle. The demeaned normalized standard deviation of growth increases. Within the first 200 periods, securitized growth goes through 7 cycles, equity growth through 6.

3) Leverage increases exponentially. After 100 periods it is at about the same level (peaking at about 5) as in the equity scenario but at t = 200 it peaks at double the level attained in the equity regime. It also exhibits stronger increasing cyclicality.
4) Over time, booms become shorter and troughs longer than in the equity scenario.
5) While the peak values for financial sustainability continue to increase, its trough values start declining already after t=85.

Thus, already in the short run it is clear that securitization-led growth is financially unsustainable, although very profitable. A 400-period simulation shows that the system implodes at about t=250 (figure 6).

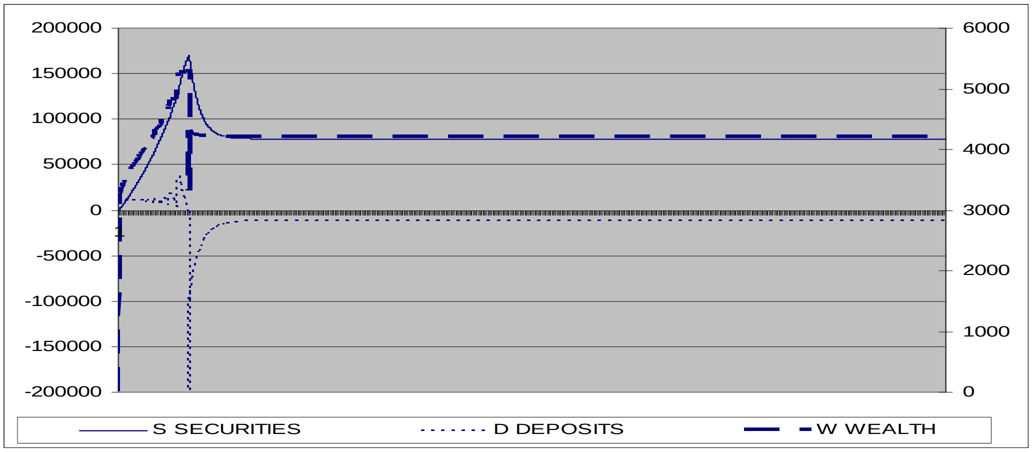
Figure 6: The Securitization Scenario in the Long Run: Growth and Volatility are Higher and the End Comes Sooner

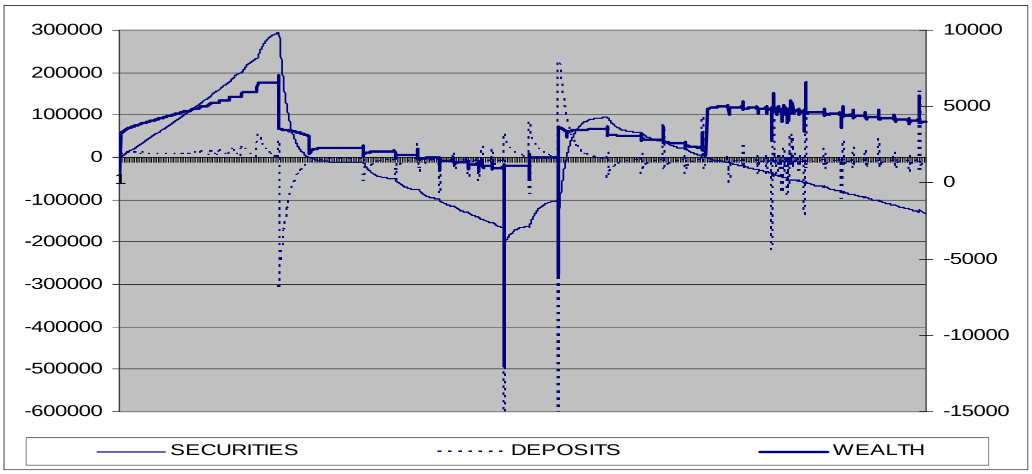


Finally, there is another noteworthy difference between the equity and securitization scenarios. Minsky (1978, 1986) in his early work analyzed that in postwar financial capitalism, financial fragility builds in the good times and periodically morphs into financial instability. These crises are then managed by massive government deficit spending and central bank lending, stabilizing the system at increasingly higher levels of leverage, and setting the scene for the next boom. In later work, however, Minsky noted the increasing influence of securitization in achieving those higher levels of leverage (e.g., Minsky 2008 [1987]). Minsky worried that what he called the "money manager capitalism" that he saw emerging in the 1980s and 1990s undermined capitalism's viability by redirecting investment to financial, not real, investments and capital formation (Wray 2009).

Figure 7 illustrates this difference in postcrisis viability of the two systems. It plots the stocks of securities, deposits, and wealth. In the equity scenario, recurrent growth and instability characterizes the system also in the very long run (3,000 periods). In the securitization scenario, the initial crash occurs at much higher levels of leverage and is final. Only a change in the system itself that reduces leverage (a change represented by ρ) could revive it. Geneakoplos (2009) likewise comments that "reduction of leverage, not interest, is the solution for a troubled economy."

Figure 7: Securitization (top) and Equity (bottom) Scenarios, Very Long Run: A System Change is Needed for Revival





Note: Wealth is on the right-hand scale

8. SUMMARY, REFLECTIONS, AND CONCLUSIONS

This paper explored the methodological shift in macroeconomics towards agent-based models, widely considered to be a promising alternative to current macroeconomic practice dominated by DGSE models. It explains that complex behavior and sudden transitions also arise from the economy's financial structure as reflected in its balance sheets, not just from heterogeneous interacting agents. It introduces "flow-of-funds" or "accounting" models, which were preeminent in successful anticipations of the recent crisis.

In illustration, a simple balance-sheet model of the economy is developed to demonstrate that nonlinear behavior and sudden transition may arise from the economy's balance-sheet structure, even without any microfoundations. Finance implies leverage, which implies cycles of increasing amplitude in real and financial variables. Because financially sustainable growth requires minimum values for the means to meet financial obligations, increasing cycle amplitude with higher peaks and lower troughs leads to a situation of crisis, which implodes the system.

The paper explores two types of leverage, under the headings of “equity” and “securitization” scenarios. It is demonstrated that securitization leads to higher growth, more cycles, and higher peaks for all variables but also longer trough periods and deeper troughs values. The model mimics postwar developments with increasing levels of leverage over business cycles and suggest that the system survives crises in the equity scenario but not in the securitization scenario.

It is not difficult to think of further analyses and extensions to this model, which the scope of the present paper prohibits. Robustness should be evaluated more extensively by studying the effects of changes in starting and parameter values. Inflation could be included, studying real as well as nominal dynamics. Different classes of assets (bond, stocks, and real estate) and players (central and commercial banks) could be introduced, as well as a trade and capital flows with a foreign sector and more detail in the real sector with regard to consumption patterns, savings behavior, production technologies, labor use, wages and prices, inventories, and industry disaggregation. It should be noted, however, that detailed flow of fund models (often with tens or hundreds of equations) exist, both theoretical and for specific economies. Even a “synthetic” model such as van Treek (2009) has 27 equations and the “Simplified, Benchmark Stock-flow Consistent Post-Keynesian Growth Model” by Dos Santos and Zezza (2007) has 66 equations. In a sense, extensions that make it more realistic would undermine the purpose of this stylized model, which was to demonstrate that complex behavior results from a complete but highly stylized balance-sheet model of the economy, even without all those extensions. A more complex model could easily obscure that financial instability resides (in part, at least) in the economy’s structure and not only in its policies or in the behavior of its agents. To demonstrate that was the aim of this paper.

In conclusion, we return to the motivation for this exercise, set out in the opening sections. This was to argue that the failure of DSGE-style macroeconomics was a failure to meaningfully include finance in its models. Apart from that, there also is a failure to model complex systems arising from heterogeneous interacting agents. The present model deliberately left out microfoundations in order to focus on structures rather than behavior within those structures. A next step would be to add microfoundations to a financially credible agent-based model. To the best of this author’s knowledge, the only attempt to date at doing this is reported in Cincotti, Raberto, and Teglis (2010). Based on the EURACE simulator environment, they develop a model linking the balance sheets of firms by double-entry accounting, and applying overarching accounting constraints. Cincotti, Raberto, and Teglis (2010) simulate the effects of specific fiscal and monetary policies, depending on firm's dividend payout policies. This research demonstrates, among other things, how a financially realistic representation and, especially, accounting constraints, modify the outcomes. To combine agent-based modeling with the economy's core financial structure (its "balance-sheet dimension") is a promising avenue for future research.

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