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March 2013

Online at <https://mpra.ub.uni-muenchen.de/46578/>

MPRA Paper No. 46578, posted 28 Apr 2013 04:46 UTC

Financial Fragility and Macroeconomic Instability in a Heterogeneous Interacting Agents Framework

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Short paper prepared for the INET Conference 2013, Hong Kong

1. Introduction

The aim of this short paper is to stress the role that heterogeneity and interaction play in a complex macroeconomic system in which financial instability endogeneously arises. If we consider a system composed of many autonomous agents, which are characterised by heterogeneous financial conditions and are interconnected through credit/debt linkages, we can analyse how financial distress may spread across the credit network and how this may impact the business cycle. As we will discuss below, a central point is the interplay between real and financial factors, that is the relationship between financial instability and macroeconomic evolution.

On the one hand, a financial crisis can have important effects on the real economy. The global recession which followed the Lehman Brothers' bankruptcy is only a recent but very relevant example. Indeed, if one or more banks face financial distress so that they are no longer able to provide an adequate amount of liquidity to the credit market, then some firms and households may go bankrupt; this may, in turn, result in non-performing loans and in a further deterioration of banks' financial conditions. The more financially fragile are agents the more likely is the occurrence of a financial crisis. Moreover, financial contagion may have more or less severe consequences on the real economy, depending on the degree distribution of links and on whether a *hub* of the network is hit by a shock, so spreading financial distress to its many counterparts.

On the other hand, we should also consider that real causes may be at the basis of increasing financial instability. For instance, the deregulation of markets may create the conditions for an increase of inequality; a possible consequence is that rich people save a larger part of their income, while the poor are forced to reduce consumption, so causing a lack of aggregate demand; in this scenario, credit consumption or the making of financial profits can just postpone the inevitable crisis due to growing inequality and mounting financial instability.

The paper is organised as follows. Section 2 discusses the impact of financial factors on the real economy. In particular, the focus is on the "financial accelerator" as a shock-amplifying

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mechanisms proposed in the field of mainstream economics, as well as on its “network-based” version development in the Agent-Based Modelling field. Section 3 examines the role of real causes in determining financial crises, focussing on financialisation and growing inequality. These topics are analysed in an agent based macroeconomic framework and preliminary results are discussed. Finally, Section 4 provides some concluding remarks.

2. From financial factors to the real economy

According to Minsky (1982), the pro-cyclicality of credit supply is a mechanism at the root of financial instability and crisis episodes. In this perspective, the leverage increases during expansions while it decreases during recessions, that is agents are less risk-averse in “good times” while they are more risk-averse in “bad times”. As a consequence, a lower risk perception in expansions leads to debt accumulation and this may increase overall “financial fragility”. In this way, the system endogenously evolves towards a critical state of financial instability and, before or after, a crisis follows.

A formalization of some aspects which relates to the Minskian interpretation of financial instability is given by the “financial accelerator”, which is a mechanism that amplifies the shocks due to the anti-cyclicality of the risk (external-finance) premium (Bernanke et al, 1998). In this framework, financial factors can have a large impact on business cycle fluctuations and a “financial crisis” may lead to considerable effects on the “real economy” (production, employment, etc.).

Overall, New Keynesians’ contributions provide an interpretation of the real consequences following financial distress when, for instance, the credit market is characterised by informational asymmetries (see, for instance, Greenwald and Stiglitz, 1993). In this context, when a firm asks for credit from a bank, the latter requires a collateral, and if the business cycle is going towards recession, then also the value of firm’s assets is decreasing, so leading to an increase of the risk premium and/or credit rationing. As a consequence, the typical working of financial markets amplifies the business cycle.

The models of the financial accelerator available so far are based on the Representative Agent assumption. For instance, in the market for funds, a representative borrower interacts with a representative lender, and a change in the “representative” borrower’s net worth is a metaphor for a change in “aggregate” net worth. In the models, as well as in general in the real world, this aggregate variable is pro-cyclical. By definition, the “aggregate view” of the financial accelerator abstracts from the complex nexus of credit relationships among heterogeneous agents that characterises modern financially sophisticated economies.

Indeed, a major flaw of mainstream (macro)economic theory (based on neoclassical microfoundations) is due to the idea of reducing the complexity of aggregate phenomena to the behaviour of a single, representative agent. By contrast, an alternative view stresses the peculiarity of macroeconomics as the study of the system *as a whole*, as clearly emerges from Keynes' theory (De Cecco, 1990). For instance Keynes argued “that important mistakes have been made through extending to the system as a whole conclusions which have been correctly arrived at in respect of a part of it taken in isolation” (Keynes, 1936, xxxii).

Various contributions in the field of Agent-Based Computational Economics are moving in this direction, proposing a study of macroeconomic phenomena as emergent properties of a *complex system*. Going beyond the Representative Agent hypothesis, Delli Gatti et al. (2010) analyse financially-driven fluctuations in a “heterogeneous interacting agents” framework, in which agents are the “nodes” and debt contracts are the “links” of the credit network. In this setting, even a small shock can lead to large fluctuations, because financial contagion may cause bankruptcy avalanches. Indeed, the bankruptcy of a borrower affects the lender's balance sheet, which will record a non-performing loan; the response of the lender to “bad debt” will be an increase of the interest rate charged to all the other borrowers (or a reduction of credit availability). Some of the borrowers will switch to lenders who extend credit at more favourable conditions. This may further deteriorates lenders' financial conditions. Thus, financial fragility may spread to the neighbourhood and possibly to the economy overall. If some borrowers are already on the verge of bankruptcy they may reach a tipping point and default; then, an avalanche of bankruptcies may ensue. In other words, failure of fulfilling debt commitments on the part of borrowers makes worse lenders' financial conditions; hence, some agents may go bankrupt and a “snowball effect” can develop with significant consequences on the overall economy. This mechanism can be described as a “network-based financial accelerator” according to which the depth of a crisis depends on financial fragility as well as on the complexity of credit linkages.

Furthermore, in Riccetti et al. (2013) we extend the analysis of the “network-based financial accelerator” by assuming that firms' financial structure is based on the Dynamic Trade-Off theory (Flannery and Rangan, 2006), rather than on the Pecking Order theory, as in previous studies. Therefore, firms have a “target leverage”, that is a desired ratio between debt and net worth, and they try to reach it by following an adaptive rule governing credit demand. Moreover, we allow for multi-period debt structure and consider multiple bank-firm links on the basis of a myopic partner choice mechanism, obtaining the following results: (i) if leverage increases, the economy is riskier; (ii) a higher leverage procyclicality has a destabilizing effect; (iii) a pro-cyclical leverage weakens the monetary policy effect; (iv) a central bank that wants to increase the interest rate, should

previously check if the banking system is well capitalized; (v) an increase of the reserve coefficient has an impact similar to that produced by raising the policy rate, but for the enlargement of bank reserves that improves the resilience of the banking system to shocks.

3. The real causes of financial crises

The financial sector is an essential channel of instability in the post-Keynesian analysis of Minsky. Therefore, in order to reduce such instability a possible solution is a downsizing (or a more effective regulation) of the financial sector when its weight has become disproportionate with respect to the whole economy. Such an intervention should contrast the tendency of the system towards “the production of financial profits by means of financial profits” as an activity increasingly disconnected from the “real economy”. However, this could be not enough to solve the problem of financial instability, if other and more fundamental causes, as for instance huge inequality, undermine the sustainability of the economic system. According to Palley (2010), the Minsky’s theory of financial instability has certainly an important role in explaining the crisis if considered as a mechanism coupled with the other aspects of capitalist accumulation.

According to our interpretation (Russo, 2012), the *deregulation cycle* which started around the 1980s has led to a renewed process of capital accumulation based on labour flexibility, production decentralisation, privatisation, globalisation, financialisation, and so on. These elements have allowed for a recovery of capitalist accumulation by counteracting the post-WWII decline of the profit rate culminated in the stagflation of the 1970s. But, due to the typical working of capitalist development, the same elements at the basis of capital accumulation have given rise to a *crescendo* of crises, until the current one (and maybe beyond). Indeed, before or after, the contradiction between the individual goal of maximizing profits (“micro”) and the collective one (“macro”), consisting in the valorisation of capital, gives rise to an inevitable crisis. In the last years this was due to huge inequality, financial instability and global imbalances. In this perspective, the financial collapse is the most apparent symptom of a more general crisis whose realisation has been postponed and amplified by financial factors.

In order to give an interpretation of (at least some aspects of) this complex picture, in what follows we briefly discuss some preliminary results obtained by simulating an agent based macroeconomic model. Firstly, we provide a sketch of the modelling framework, then we will focus on “financialisation”, by analysing the impact on the real economy of different firms’ policies regarding the distribution of profits through dividends, and on growing inequality, which can lead to a lack of aggregate demand thus increasing the likelihood of observing a large and extended crisis.

3.1. An agent based macroeconomic framework

Consider a macroeconomic microfounded framework with heterogeneous agents in which households, firms, and banks interact according to a decentralized matching process presenting common features across four markets: goods, labour, credit and deposits. Overall, the idea is to start from simple (adaptive) rules of individual behaviour and interaction mechanisms in order to reproduce the emergence of aggregate regularities from the “bottom up”. The modelling details are presented in Riccetti et al. (2012).

In this setting, agents are boundedly rational and follow (relatively) simple rules of behaviour in an incomplete and asymmetric information context: households try to buy consumption goods from the cheapest supplier, they also try to work in the firm offering the highest wage; firms try to accumulate profits by selling their products to households (they set the price according to their individual excess demand) and hiring cheapest workers; workers update the asked wage according to their occupational status (upward if employed, downward if unemployed); households' saving goes into bank deposits; given the Basilea-like regulatory constraints, banks extend credit to finance firms' production; firms choose the banks offering lowest interest rates, while households deposit money in the banks offering the highest interest rates.

Following Riccetti et al. (2013), we assume that firms' financial structure is derived from the Dynamic Trade-Off theory (Flannery and Rangan, 2006). This capital structure has a relevant role in influencing the leverage cycle, with important consequences on macroeconomic dynamics. In this macroeconomic setting, we also consider the action of two policy makers: the government and the central bank. The government hires a fraction of the population as public workers, so providing an additional component of the aggregate demand. Moreover, the public sector taxes private agents and issues public debt. The central bank sets the policy rate and manages the quantity of money in the system. Furthermore, in our framework the central bank is committed to buy outstanding government securities.

Model dynamics are studied by means of computer simulations. Some macroeconomic properties endogenously emerge such as business cycle fluctuations, nominal GDP growth, the Phillips curve, leverage cycles and credit constraints, bank defaults and financial instability, and the importance of government as an acyclical sector which stabilises the economy. In particular, the endogenous business cycle emerging from model simulation has the following characteristics: when firms' profits are improving, they try to expand the production and, if banks extend the required credit, this results in more employment; the decrease of the unemployment rate leads to the rise of

wages that, on the one hand, increases the aggregate demand, while on the other hand reduces firms' profits, and this may cause the inversion of the business cycle.

Model simulations show that credit is pro-cyclical. In particular, there is a negative but modest correlation between firms' leverage and the unemployment rate, while a more significant negative correlation between banks' exposure and unemployment emerges. Simulation results are consistent with the empirical evidence on the topic (Kalemli-Ozcan et al, 2011). Accordingly, banks' capitalization plays a relevant role in determining credit conditions, so influencing firms' leverage and, in general, the macroeconomic evolution. Another interesting feature of the model is that credit mismatch (that is the difference between banks' credit supply and firms' credit demand) tends to follow the cycle of banks' net worth: when banks are poorly capitalised this results in credit rationing for firms; in this case, the central bank intervenes by providing credit to banks; on the contrary, when banks are well capitalised they are able to fulfil all credit demand. Accordingly, firms' mean leverage is influenced by credit availability.

In a small number of cases, the macroeconomic system evolves towards an "extended crisis" scenario. In this case, differently from the usual business cycle mechanism, the decrease of wages due to growing unemployment does not reverse the cycle, but rather amplifies the recession due to the lack of aggregate demand. In other words, the self-adjustment mechanism which spontaneously reverses the business cycle (e.g., the rise of the unemployment rate reduces the real wage and then the resulting increase of profits makes room for an expansionary production phase) does not work. Indeed, real wage lowers excessively, thus boosting a vicious circle for which the fall of purchasing power prevents firms to sell commodities, then firms reduce production, unemployment continues to rise, and the system moves towards a devastating crisis. If the production system completely crashes, it cannot escape this trap without an exogenous intervention. Instead, if the production system does not completely disrupt, then we cannot exclude a recovery in the very long run. But, accordingly to Keynes, "in the long run we are all dead".

In next subsections we briefly discuss two relevant topics as financialisation and inequality that we try to analyse by simulating our agent based macroeconomic model. Then some preliminary results are discussed.

3.2. Financialisation

The entire working of financial markets changed in recent decades. The post-1970s deregulation wave has increased inequality and indebtedness (both for households and firms), promoting a broader role for finance in the working of the economy.

According to Lazonick and O'Sullivan (2000), the financialisation of nonfinancial corporations has been characterized by a shift from a “retain and reinvest” strategy to a “downsize and distribute” strategy; that is, management strategies have changed focusing more on the maximization of shareholder value and less on long-term growth. In fact, the profit share increase of recent decades has been accompanied by the stagnation of real investment and a sharply increase of interest payments, dividend payments and stock buybacks (also mergers and acquisitions may be considered).

Stockhammer (2004) confirms that over the past decades the financial investment of nonfinancial corporations has been rising and the accumulation of capital goods has been declining. According to this author, the 'shareholder revolution' and the development of a market for corporate control have shifted power to shareholders changing management priorities, with a reduction of growth rates. From the analysis of the time series of aggregate investment for the USA, the UK, France and Germany, it results that financialisation has been responsible for a slowdown of accumulation (in particular, for the first three countries).

Similar results have been reached by Dumenil and Levy (2005) according to which the growth rate of real capital accumulation depends on that of retained profits, that is profit after interest and dividend payments, which is diminished in recent decades.

Preliminary results based on model simulations show that when firms and banks decide to increase the fraction of profits to be distributed as dividends, the rate of unemployment tends to rise. Higher unemployment results in lower wages that, in turn, may have two different effects: on the one hand, it reduces workers' consumption; on the other hand, it reduces firms' production costs and, if a part of dividends finances consumption, then the firms' profit rate may rise. This implies a decline of the wage share (because wages decrease at a faster rate than price inflation). So, this type of “financialisation” of the macroeconomic system may work based on the substitution of a part of wages with a fraction of dividends in the financing of consumption. This is, however, a temporary solution, given that the reduced fraction of retained profits results in a decrease of firms' and banks' net worth. In this scenario, firms need more credit (due to a lower level of internal funds) while banks are characterised by a reduced amount of credit supply. In this situation firms may face credit rationing and they may be forced to reduce their leverage. As a consequence, firms cannot hire the desired number of workers and the unemployment rate goes up, while the volatility of the financial and of the macroeconomic system increases. Moreover, the rise of unemployment further deteriorates the problem of aggregate demand insufficiency and this may result in an extended crisis. All in all, we observe a negative impact of increasing dividend yields, although the relationship is highly non linear: the system does not exhibit huge problems below a certain

threshold, while above that it is quite likely to observe large crises and even a complete crash of the economy.

3.3. Inequality

In last decades, a decline of the labour share has occurred in advanced economies (about 10% in Europe and Japan and 3-4% in Anglo-Saxon countries since 1980), especially in unskilled sectors (IMF, 2007, chap. 5). Moreover, income inequality was relatively low and roughly stable before the 1980s, while it has dramatically increased (to levels comparable to the 1920s) in successive decades (von Treeck, 2009). Economists proposed alternative interpretations of such a phenomenon, from high vs. low skilled workers (and then the economic impact of technological progress on labour market dynamics), to the role of labour flexibility and globalisation, and so on. Here we focus on the macroeconomic consequences of raising inequality, and in particular on the possible lack of aggregate demand due to an “excessive” saving of rich and a “too-low” consumption of poor. In a monetary production economy, such as the capitalist system, this situation may lead to a fall of the profit rate that, in turn, may result in lower production. The consequent rise of unemployment further deteriorates macroeconomic conditions, possibly leading to a large and extended crisis.

A possible (and temporary) solution to the problem of insufficient aggregate demand is the availability of credit (coming from rich’s saving) to finance the consumption of poor households. Hence, credit consumption can counteract the fall of the profit rate, at least for a certain period of time. However, in a context of low interest rates (due to the large saving of rich agents), the rise of indebtedness of poor agents may amplify the financial fragility of the economic system. For instance, an interest rate spike due to a change of the rate set by the central bank may lead to an increase of the delinquency rate. Such a problem has an impact on banks’ capital: if one or more banks are not able to absorb the rise of non-performing loans then some agent can fail with negative repercussions on the productive sector. Indeed, the decrease of banks’ net worth may lead to credit rationing, so that firms cannot assume all the workers they need to produce the desired level of commodities. Moreover, rising unemployment results in a reduction of demand for goods, further deteriorating the financial conditions of firms. Some firms may go bankrupt, causing a further increase of non-performing loans and possibly leading to other bank defaults. In the worst scenario, a financial collapse happens. All in all, a “real cause”, that is the increase of inequality, may result in a “financial crisis”. In other words, the expansion of finance (through credit consumption) may only postpone the occurrence of the crisis.

We can test different behavioural hypotheses and alternative policies in our agent based macroeconomic framework. Here we focus on the macroeconomic effects of inequality by considering heterogeneous consumption behaviours. As a matter of fact, rich people may accumulate higher wealth while poor people may suffer from low consumption, so creating negative consequences at the macroeconomic level, as a lack of aggregate demand, so increasing the likelihood of observing a crisis with large unemployment.

Preliminary results show that increasing inequality may result in lower aggregate demand which, in turn, causes a fall of the profit rate and then an increase of unemployment, amplifying the recession. As previously mentioned, a possible countertendency we may consider is the introduction of credit consumption through which the saving of rich can finance the consumption of poor. However, in a context of growing inequality, debt accumulation may increase financial fragility, spreading in the system through credit linkages, eventually leading to a financial collapse. So finance may postpone the crisis due to the lack of aggregate demand, but it also creates the basis for a later financial crisis.

4. Concluding remarks

Financial instability can be the consequence of both firms' financial fragility and banks' excessive leverage. Depending on the heterogeneity of agents' financial variables and on the degree distribution of financial linkages, systemic risk may arise and then it is more likely that the failure of one or more agents can lead to bankruptcy avalanches due to financial contagion. Furthermore, a financial crisis may negatively impact the real economy. But financial instability can be also the consequence of underlying real causes such as financialisation and growing inequality which create the conditions for a subsequent financial crisis.

Our research project is aimed at developing a "complete" agent based macroeconomic framework to be used as a computational laboratory in which several behavioural hypotheses and alternative policies can be tested. Some preliminary results regarding financial instability show that (i) the financialisation of the economy through increasing dividend yields (and then decreasing firms' internal funds and banks' credit supply) results in higher profits and a decline of the wage share, thus implying that the increase of financial fragility and the lack of aggregate demand may eventually lead to a crisis; (ii) growing inequality results in a "saving glut" for rich and insufficient resources for the poor, so that a crisis due to the lack of aggregate demand is more likely, then, even if the saving of rich is used to finance the consumption of poor, through credit consumption, the subsequent increase of financial fragility leads to more macroeconomic instability and the system may eventually collapse.

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