Market Disequilibrium, Monetary Policy, and Financial Markets: insights from new tools

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ABSTRACT

We revisit the main building blocks of the theoretical models underlying the monetary policy consensus before the Great Recession. We highlight how the failure of these models to prevent the crisis and to provide guidance during the recession were due to the excessive confidence in the ability of markets to coordinate demand and supply, and to the neglect of the role of finance. Furthermore, we outline the main elements of an alternative approach to monetary policy that put emphasis on the processes driving coordination in markets, and on the externalities transmitted by financial inter-linkages. Many elements of this new approach are captured by new classes of models, namely, agent-based and financial network models. We discuss some insights from these models for the conduct of monetary policy, and for its interactions with fiscal and macro-prudential policies.

KEY WORDS

Output-inflation dynamics, new-keynesian models, disequilibrium analysis, agent-based models, fiscal-monetary policy interactions, quantitative easing policies.

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E31, E32, E5, E61, E62.

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1. Introduction

The financial crisis of 2008 and the following Great Recession have led to radical changes in the conduct of monetary policy. These events were marked by the resurgence of the zero-lower bound on interest rates and by the implementation of several "unconventional" monetary policy measures. This season is now probably close to the end, with the return to a regime of global growth (much more robust in the US than in Europe). In face of these events, it is worth to discuss the elements that a new standard framework of monetary policy should include in face of the lessons learned during the recession.

Indeed, none of the monetary policy responses during the crisis was inspired by the economic theories guiding the conduct of monetary policy before. These economic theories largely agreed on the idea that inflation-targeting monetary policy rules were key to stabilize inflation and output. They were not equipped at all to allow central bankers to prevent the crisis or to cope with it. This is because these models dealt neither with the effects of large recessions nor with the consequences of financial market strains on real activity. The crisis has thus led to a reconsideration of the above models and to the development of new ones that could provide insights to central bankers in the practice of monetary policy (Howitt, 2012).

In this paper we revisit the main tenets of the pre-crisis inflation-targeting consensus on monetary policy. In addition, we discuss three cornerstones of New-Keynesian DSGE models (see e.g. Woodford, 2003) underlying this consensus. We also highlight how these building blocks led inevitably to the failure of these models to provide guidance in face of large systemic crises, as they implied a strong belief in the ability of market forces to coordinate activities, and a neglect of the role of financial markets in the creation of money and in the determination of credit supply. In addition, they had no room for the analysis of the possible long-run effects of monetary policy, and a very little one for monetary-fiscal policy interactions.

We then advocate for a new approach to monetary policy that acknowledges the disequilibrium nature of markets, that puts at the center of the analysis the processes allowing good or bad coordination in markets and, finally, that accounts for the complexity of today's financial markets and for their pervasive externalities. We also discuss how such a view generates several opposite conclusions to NK-DSGE models about the role of price rigidity and the one of financial markets. We also highlight how such a view implies new perspectives for the interactions between monetary policy and other types of policies, and even for the role of quantitative easing policies in normal times.

Next, we discuss some recent advances of new modeling frameworks that have gained increasing attention in the aftermath of the crisis. We focus in particular on Agent-Based Models (see e.g. Tesfatsion and Judd, 2006) and on financial network models (see e.g. Battiston et al., 2016). These models allow one to study several important aspects of coordination processes in markets, including the transmission of externalities in financial markets (and its consequences). In addition, these models have been able to provide several implications about the conduct of monetary policy, as well as for its interactions with macro-prudential regulation and with fiscal policies. They can thus turn useful in the building up of an effective new framework of monetary policy in this post-crisis phase.

The paper is organized as follows. Section 2 presents the main elements of the inflation-targeting view of monetary policy. Section 3 discusses the main building blocks of the NK-DSGE models that provided support to inflation-targeting policies and their consequences. Section 4 discusses the disequilibrium approach to monetary policy. Sections 5 and 6 are devoted to discuss the advances in agent-based models and in financial network models, and their implications for monetary policy. Finally, Section 7 concludes.

2. The inflation-targeting consensus on monetary policy

Monetary policy before the crisis was guided by a consensus on inflation-targeting policies (see Howitt, 2012). In particular, several macroeconomists agreed about the idea that a monetary policy rule targeting an inflation objective was an efficient way of anchoring inflationary expectations and of minimizing the inter-temporal distortions resulting from price rigidities, the latter being the only obstacle to the efficient allocation and full utilization of resources in the short-run (see Bernanke et al., 2011).

The above consensus was firmly rooted in the results obtained with New Keynesian Dynamic Stochastic General Equilibrium models (NK-DSGE henceforth, see e.g. Woodford, 2003). One typical mechanism at work in these models is the following one. Firms anticipating a positive productivity shock will not lower prices as much as they should because, for example, the existence of costs of changing prices. The general price level will be higher than it should be. As a result, consumption will not increase as much as it should. Production and employment will not increase as much as they could. There is an inflation gap, an output gap, and involuntary unemployment, which result from nominal price stickiness. Moreover, "*the assumed 'stickiness' of prices implies that when they are reconsidered, they are set in a forward looking manner, on the basis of expectations regarding future demand and cost conditions, and not simply in response to current conditions. As a result, expectations turn out to be a crucial factor in the equilibrium relation between inflation and real activity (as argued by Phelps and Friedman in the 1960's)* "(Woodford 2003, p. 7-8).

In these circumstances, the task of monetary policy is to correct distortions stemming from rational firm and consumer behavior in presence of price rigidities, and to keep the inflation rate constant. In particular, central banks must follow a rule implying that the interest rate is adjusted to cope both with the inflation gap and the output gap. For instance, in the above-mentioned case of an increase in productivity, the central bank must increase the interest rate, to restore the rationally chosen inter-temporal consumption path, i.e. the one that would have prevailed with perfectly flexible prices. In addition, the satisfaction of the inflation objective also guarantees as a "divine coincidence" (Blanchard and Galí, 2007) the achievement of the output gap objective. In other words, the same instrument achieves two objectives simultaneously: there is no need to arbitrate between price stability and growth.[1]

Furthermore, in the above framework the variability of the rate of inflation is detrimental to the allocation of resources, precisely because of the presence of rigidities or viscosities. It is the intermittent and spasmodic adjustments implied by nominal price rigidities that create gaps between the actual price level and the natural price level, and they are therefore the main obstacles to the well-functioning of markets. It follows that central banks should not care much

[1] Blanchard and Galí (2007) also make clear that, in presence of real wage rigidities instead, monetary policy faces again a trade-off between stabilizing inflation and stabilizing output. Rigidities (real rather than nominal) are still the source of the problem. For example, an increase in the price of oil requires a cut in real wages that workers may accept only if there is a large increase in unemployment (and a very low output). In this case, it may be better to allow for some inflation and a level of output above the level that would prevail in absence of rigidities (Blanchard 2008).

about markets where prices are extremely flexible, for example about financial markets. As eloquently explained by Woodford (2003) : "*The prices that monetary policy should aim to stabilize are the ones that are infrequently adjusted, and that consequently can be expected to become misaligned in an environment that requires these prices to move in either direction. Large movements in frequently adjusted prices – and stock prices are among the more flexible of prices – can instead be allowed without raising any concerns, and if allowing them to move makes possible greater stability of the sticky prices, such instability of the flexible prices is desirable*" (Woodford 2003 p. 16).

In this perspective, the effectiveness of monetary policy is not associated with the control of credit flows. On the contrary, such a control must even be discouraged, as it would result in detrimental distortions in resources' allocation.

Finally, in the framework of NK-DSGE models there is little room for monetary and fiscal policy interactions, except at the zero-lower bound (see Woodford, 2011). This is because if expected inflation exceeds the target, an inflation-targeting central bank should increase the interest rate and decrease aggregate demand to bring the inflation rate back to the required level. In such a world, the government should be reluctant to pursue an expansionary fiscal policy, as it will anticipate that any increase in aggregate demand driven by higher public spending will be offset by an equivalent reduction due to central bank monetary rule. Furthermore, the lack of monetary financing of public deficit will generate an increase in government debt, even larger if the monetary policy is restrictive. If – as a result of his dynamics - government debt solvency is questioned, then the only alternative become either a drastic reduction in the deficit, or debt monetization with the consequent high inflationary pressures. A fiscal rule constraining government deficit can be beneficial in escaping this unpleasant arithmetic (Sargent and Wallace 1981).

3. The building blocks of the monetary policy consensus and their consequences

The NK-DSGE models underlying the inflation-targeting consensus built on some hypotheses about the ability of monetary policy to affect nominal and real variables, about the faith in the ability markets to promote coordination of agents' activities. Finally, these models also embed a very specific view of the money creation process in the economy. These critical assumptions have severely limited the analysis of the scope of monetary policy and it interactions with other types of policies. In addition, they mostly explain the inability of central banks to prevent the last financial crisis.

The first of the above axioms is the natural unemployment hypothesis (see Friedman, 1968) or, more precisely, the existence of a unique rate of unemployment that does not accelerate inflation. This hypothesis carries over, as a consequence, the classical dichotomy between nominal and real variables and, in its turn, the inability of monetary policy to affect real variables in the long run (*in primis* the unemployment rate). Several macroeconomic works have provided arguments for the non-uniqueness of the natural rate of unemployment rate and for its sensitivity to the aggregate demand level (e.g. Tobin, 1972, 1995, Diamond, 1982, see also Blanchard 2018 for a recent account). Nevertheless, most NK-DSGE models have mostly overlooked these results, thus assuming the presence of a unique natural unemployment rate, determined by supply factors or by labor market rigidities. This has also implied, as a consequence, a sharp separation between the analysis of business cycles and the one of long-run growth. The first may admit some coordination problems, created by price rigidity in the framework of NK-DSGE models, while the second is determined by supply factors, and in particular by those affecting the level of total factor productivity. Incidentally, the level of total factor productivity is assumed to be exogenous in NK-DSGE models, which has also implied a neat separation between the macroeconomic literature on monetary policy and business cycles and the one analyzing processes of endogenous technical change and growth (Nelson and Winter, 1982, Aghion and Howitt, 2008, Acemoglu, 2008).

The second hypothesis is what Clower and Howitt (1998) call "the classical stability hypothesis", namely the belief in the existence of some invisible hand able to coordinate all markets in the economy at all point in time. New Keynesian models mostly focus on the interaction among few aggregate variables, under the hypothesis that markets clear somehow and the expectations of agents are also model-consistent (see Kirman, 1992, Howitt, 2011). This implies removing from the analysis the very problem of functioning of markets and of how can actually reach good or bad coordination outcomes. However, as we shall argue more in depth below, accounting for the actual working of markets populated by heterogeneous agents and of how they can reach coordination in a state of disequilibrium, can have significant consequences for many key issues for monetary policy, including the uniqueness of the natural rate of unemployment, the interplays between the short- and long-run dynamics of an economy, the interactions of monetary policy with fiscal and macro-prudential policies.

The third hypothesis refers to the characteristics of the process of money creation and dates back even to Wicksell (1898, 2013). It consists in the assumption that money is endogenous in the sense that credits make deposits, and that commercial banks fully serve credit applications at the

interest rate set by the central bank (see Woodford, 2003). This modeling choice reflected the observation that, with the liberalization of financial markets, the traditional money multipliers become highly unstable. It was then meaningless to focus monetary policy on the control of monetary aggregates. At the same time, such an assumption has implied the removal of any explicit reference to the functioning of financial markets and to its consequences for the creation of money and for the supply of liquidity to firms and households. Thus, it is not surprising that the building-up of excessive debts, which was at the root of the financial crisis of 2008, was not perceived as a concern by central bankers (see Stiglitz, 2011, Howitt, 2012).

Although the hypothesis of endogenous money can hardly be questioned (see McLeay et al., 2014, Lavoie, 2003), the actual process of money creation is far from one where banks simply adapt to the interest rate set by central bank and fully serve credit applications of their clients. Money creation (or its destruction) in modern financial systems largely results from the expansion (or shrinkage) of banks' leverage, which is mostly driven by risk considerations (see Adrian and Shin, 2010, 2013). In addition, banks do not fully serve the demands of their clients. On the contrary credit rationing, based on counterparty risk evaluation and on the risk situation of the bank is more the rule than the exception (see Stiglitz and Greenwald, 2003). It follows that the distribution of the risk in the financial system (Stiglitz, 2011) is the fundamental determinant of the supply of money and of the supply of credit in the economy.

Nevertheless, distributional considerations were simply ruled out in the NK-DSGE models that were at the basis of the inflation-targeting consensus before the crisis. Since then, several works in the NK-DSGE literature have partially acknowledged the above problems, and they have developed models with financial frictions, wherein credit conditions depend on the balance sheet conditions of financial intermediaries (see e.g. Gertler et Kiyotaki 2010, Gertler and Kharadi 2011). Nevertheless, these models still overlook some key factors of instability at the root of the last financial crisis. One of them is the increased disintermediation of lending activities, which has moreover been associated with an increase in the degree of complexity of products and relations among actors in financial systems (see Stiglitz, 2011). As we discuss more at length below, this high complexity is an important source of pervasive negative externalities that are not accounted for by the above-mentioned wave of models with financial frictions.

4. The case for a disequilibrium approach to monetary policy

An alternative route in face of the problems exposed in the previous section is to develop an analytical framework that explicitly studies coordination processes on markets that are heterogeneous and not in equilibrium at all times. In addition, such a framework should account for the fact that heterogeneity in markets may persist as a result of innovation and diffusion of new technologies, changes in consumers' habits, and in agents' expectations.

Embracing the above disequilibrium perspective, which has strong Keynesian roots (see e.g. Clower, 1965, Hicks, 1974, Tobin, 1972, 1995), has several consequences for the conduct of monetary policy. It also leads to several opposite conclusions with respect to NK-DSGE models. First, one needs to consider the sluggish nature of market adjustment processes, e.g. because of the time agents need to acquire the necessary information and to process it. Accordingly, wages do not fall immediately in the face of an excess of labor supply unless a high unemployment rate persists.[2] In that, price rigidity may favor the coordination of market activities, instead of being an obstacle to it. Indeed, when markets are in disequilibrium, inflation is inevitably associated with changes in relative prices. One problem that economic agents then face is that they might be unable to correctly interpret the signals that result from relative price changes associated to the inflationary process. Some rigidity in price formation processes may thus allow agents to anchor their expectations and to allow them to correctly interpret market signals (see Amendola and Gaffard, 2006, 2010). In contrast, excessively flexible prices may produce erratic changes in relative prices and thus blur the agents' response to market signals. In turn, this may amplify the effects of relative price changes and, paradoxically, it may also set the conditions for high inflation (see Heymann and Leijonhufvud 1995).

Second, a disequilibrium perspective also implies discarding the idea that inflation is always a pure monetary phenomenon, and that central banks can control it via inter-temporal substitution effects produced by changes in interest rates. One needs instead to pay attention to how imbalances across markets evolve, and how they result from different demand as well as supply conditions. The latter are affected by structural change processes induced by the innovation and diffusion of new technologies, but also from the process of readjustment of productive capacities and of exit of firms following a recession (see Amendola and Gaffard, 1998). In addition, both demand and supply on good markets are shaped by the supply of credit as resulting from the banks' leveraging or deleveraging processes, and affected by the distribution of

[2] In addition, if one further assumes that wages and prices are more flexible upwards than downwards then an increased dispersion in market excess demands can also explain stagflation (see Tobin 1995).

risk. It is also important to stress that credit may not only allow agents to finance their investment, production and consumption plans, thus removing the gaps between notional and effective demands (Clower, 1965). It may also help to keep in existence costly trade relationships that are at core of the orderly functioning of markets (see Howitt and Clower, 2000). Again, all this may lead to quite different conclusions with respect to the inflation-targeting consensus, as it implies for instance the absence of any automatism between persistent low interest rates (or excessive government deficits) and inflation.

Third, considering that markets are persistently in disequilibrium implies abandoning the idea of the existence of a unique equilibrium growth path towards which the economy converges in the long run. In contrast, the long-run evolution of the economy is the result of a sequence of short-run states characterized by discrepancies between supply and demand, which reveal co-ordination failures (see Gaffard, 2017). This also implies breaking down the classical dichotomy and allowing for the possibility that the effects of monetary policy decisions have also long-run real effects.

Finally, considering the dynamics of an economy as a sequence of short-run states has also implications for the interactions between monetary and fiscal policy. In particular, the fiscal rules that avoid explosive government debt dynamics according to NK-DSGE models may instead have very asymmetric effects and plunge the economy into a highly unpleasant dynamics in a disequilibrium framework. For instance, a restrictive monetary policy constraining investment (as it was the case in Europe in the 1990s and in the first decade of this century) may change the whole pattern of economic fluctuations. This is because such a policy may generate a persistent shortfall in investment. Accordingly, it may lower the output growth consistent with price stability and higher the rate of unemployment that does not accelerate inflation. In such a context, the introduction of a fiscal rule may aggravate fluctuations. This is because such a rule leads to a fall in public spending during a recession, accentuating the short- and medium-term recessionary effects of the restrictive monetary policy and by delaying the recovery. In contrast, during an expansionary phase, such a rule allows governments to lower taxes without a corresponding decline in public spending, thus contributing to foster inflationary pressures that can in turn lead to a tightening of monetary policy and to premature recessions. In conclusion, the effects of a fiscal rule can be very asymmetric in a disequilibrium context. No effective constraint is introduced in the expansionary phases of the cycle. In contrast, recessions are amplified, where the latter are

not interpretable as deviations from a predetermined exogenous trend, but as phases of an endogenous disequilibrium process that both monetary and fiscal policy contribute to determine.

These conundrums call for a monetary-fiscal policy mix able to cope with a wrong temporal distribution of excess-demand and excess-supply. For instance, when a budget deficit responds to a decrease in aggregate demand and to a decline in economic activity, the real question is how long to accept a budget deficit and what should be its amount before public spending can be relayed by the recovery of private expenditure. In addition, inflationary pressures and budget deficits should not always be considered as pathological, but rather temporarily accepted when they are obvious outcomes of the coordination process of economies that are naturally out of equilibrium.

5. Agent-based models and their implication for monetary policy

The approach to monetary policy advocated in the previous section calls for models able to study coordination processes *out of equilibrium* and to understand their consequences. Agent-Based Models (ABMs henceforth, see Tesfatsion and Judd, 2006) are good candidates in this respect. This is because ABMs represent an economy as a dynamical system of heterogeneous interacting agents. Heterogeneity may involve agent's characteristics (e.g. their net worth) and/or their behavior of agents (e.g. their expectation rules). Furthermore, agents in ABMs can interact globally via prices (as they typically do in traditional macro models) but also locally via non-price variables (e.g. the imitation of a technology or the adoption of an expectation rule adopted by another firm in the economy). Another important ingredient of these models is their non-exclusive focus on equilibrium states. On the contrary, these models explicitly allow for states of the economy where some markets do not clear and/or where agents are not optimizing their behavior and thus have incentives to change it. Abandoning the exclusive focus on equilibrium also implies dispensing with the assumption of rational expectations. ABMs rather assume bounded rationality, i.e. agents have very simple rules of behavior for coping with an environment that is too complex for anyone fully to understand (Leijonhufvud, 1993). These ingredients altogether make ABMs very different from NK-DSGE models. The latter follows a top-down philosophy, wherein agents behavior obeys to conditions compatible with an inter-temporal optimal equilibrium path. In contrast, ABMs have a bottom-up approach. Agents are endowed with simple heuristics not obeying any particular inter-temporal (or model-consistent) constraint. The

macroeconomic dynamics then emerges as a result of the (disequilibrium) interactions among those agents.

The literature on macroeconomic ABMs is rapidly growing. We refer to the recent survey in Fagiolo and Roventini (2017) for a rather complete survey of the different contributions and to Napoletano (2018) for a discussion of the implications of ABMs for macroeconomic analysis as well as of their limitations (and of how they are currently addressed in the literature). Here we shall briefly mention few examples that show the ability of ABMs to develop analyses that deal with the monetary policy in a market disequilibrium perspective as discussed in the previous section. These works shed lights on mechanisms of transmission of monetary policy (and on their effects) beyond the inter-temporal substitution effects that are studied by NK-DSGE models.[3] Ashraf and Howitt (2011), Ashraf et al. (2017) and Popoyan et al. (2017) all share the same agent-based framework (originally developed by Howitt and Clower, 2003) consisting in an economy where the local interactions of heterogeneous agents following simple heuristic give rise to stable trade organizations and relationships. In this economy, exchange activities are facilitated and coordinated by a self-organizing network of entrepreneurial trading firms. The ordered functioning of markets and the steady growth of the economy depend on keeping such structures into existence. Recessions in these models arise from disruption to trade and they are costly because they result in the disappearance of trade organizations and in the breaking down of trade relationship, which are then costly (also in terms of time) to restore. In this framework, an increase in the trend rate of inflation leads to an increase in the long-term unemployment rate (Ashraf and Howitt 2011). This is because higher inflation is associated with higher price volatility. In turn the high price volatility exacerbates market selection and generates higher exit rates of trading firms and more instability in trade relationships.

In supporting the above-described mechanisms of exchange, banks can play a "financial stabilizer" counter-cyclical role, especially during deep recessions, characterized by high rate of bankruptcy of trading firms (Ashraf et al. 2017). This is because the provision of credit helps incumbents to remain in business thus and keeps the remaining trading relationships into existence. In addition, credit favors the growth of entrant firms and thus contributes to restore trading relationships that were dismantled by the wave of firm bankruptcies. In contrast, banks

[3] Agent-based models have also been used to analyze other aspects of monetary policy like the role of central bank learning for time-consistency problems, as well as the impact of heterogeneous agents' learning and expectations on inflation targeting policies. We do not discuss these research strands here, and we refer the interested reader to the contributions of Arifovic et al. (2010), of Salle et al. (2013) and of Salle (2015).

rationing their clients have a pro-cyclical effect and exacerbate recessions. Moreover, monetary policy and macro-prudential regulation and monetary policy can affect the ability of the credit sector to dampen or to amplify bankruptcy shocks (see Popoyan et al. 2017 who extend the Ashraf et al. model 2017). In particular, the combination of a triple-mandate Taylor rule (focusing on output gap, inflation and credit growth) with a Basel III prudential regulation improves the stability of the banking sector and smooth out output fluctuations. And the beneficial effects of Basell III are mostly due to dynamic capital requirements, whereas other measures (like liquidity requirements) have a negative impact. These results are explained by the fact that a leaning-against-the-wind policy together with dynamical requirements strengthens the counter-cyclical credit channel we outlined above. In particular, during recessions they favor the supply of credit to firms, thus helping to restore trading relationships. In contrast, during expansions they avoid excessive credit growth and thus reduce the likelihood of a wave of firm bankruptcy and, accordingly, of a deep recession.

Otherwise, the distribution of financial risk in the economy shapes credit supply and also firm levels of production and investment (Delli Gatti et al. 2003), and Giri et al. 2018).[4] In particular, sudden and sharp increases of the policy rate can generate recessions (see Giri et al. 2018, who analyze the impact of monetary policy during large crises like the Great Recession). In addition, after a crisis, returning too soon and too quickly to a normal monetary policy regime can generate a "double dip" recession. Such a double-dip recession can instead be avoided by anchoring the interest rate at a zero-lower bound for a prolonged period. These results thus find support for the monetary policy moves of central banks during the Great Recession. This is interesting because, as Howitt (2011) also points out, none of these policy responses were indeed guided by NK-DSGE theory.

Finally, ABM models allow dealing with the issue of the short- and long-run effects of combinations of fiscal and monetary policy (Dosi et al. 2013, 2015). In these works, firm investment determines the rate of innovation and diffusion of new technologies and, accordingly, the long-term productivity growth rate. Moreover, the level of investment is determined by firms' expectations about future demand, and it can be constrained by the credit supplied by banks.

[4] These works belong to a stream of works in the macro ABM literature focusing on the consequences of the distribution of financial risk in the economy. See Delli Gatti et al. (2008) and Gallegati et al. (2017) for good collections of works belonging to such a research strand.

Monetary policy works via the debt channel by affecting firms' ability to finance their investments via internal vs. external debt, and by affecting banks' propensity to supply credit to firms.

In this framework, the combination of a single mandate inflation-targeting monetary rule and of a fiscal compact rule constraining government debt and deficit levels, does not only lead to higher output growth volatility and unemployment in the short-run (Dosi et al., 2015). It also reduces the long-term growth rate of the economy. In contrast, a double-mandate monetary rule (including both an unemployment as well as an inflation target) is able to alleviate the negative effects of fiscal rules constraining government's budget. The foregoing results thus confirm the insights we discussed in the previous section about the negative effects of fiscal rule in a disequilibrium framework, especially when this fiscal rule is coupled with a strict inflation-targeting monetary rule. Finally, these works show that the effects of monetary policy are highly dependent on the characteristics of income distribution, as approximated by the functional distribution between profits and wages (Dosi et al. 2013). In particular, when such a distribution is too much biased in favor of profits, the economy get stuck in a liquidity trap when firms pile-up profits that are not used to invest as their demand expectations are low (due to the low wage level in the economy). In this situation, the ability of monetary policy to stimulate the economy via the debt channel is totally ineffective.

6. Endogenous money, financial networks and monetary policy

As we explained in the section 3 above, the process of money creation and of the determination of credit supply to non-financial firms and households largely results from the leveraging and deleveraging of banks and other financial intermediaries, which in turn follows risk evaluation by those actors. Such a consideration has important consequences for the conduct of monetary policy (see Adrian and Shin, 2009). First, it implies that monetary policy should pay attention at how changes in short term interest rates and, relatedly, in the whole yield curve, affect the capacity of financial intermediaries to borrow short and lend long. Second, it paves the way to another important "risk-taking channel" for the transmission of monetary policy (see Borio and Zhou, 2012, Stiglitz, 2011), which operates via the effect that open market operations have on the liquidity of different financial securities and thus their ability to be used for collateralized borrowing by financial intermediaries. The financial crisis of 2008 has shown that a huge deleveraging of the financial sector can have significant adverse effects on the real economy. Such

a deleveraging was mainly driven by the abrupt increase in haircut rates and credit spreads on assets used for collateralized borrowing (Adrian and Shin, 2009, Gorton and Metrick, 2012). The various interventions denominated as "quantitative easing policies" were all aimed at softening the strains imposed by the above deleveraging process and to improve the market liquidity of the financial assets used as a collateral. The main rationale for these policies was given by the "unconventional" occurrence of the zero-lower bound constraint that limited the ability of monetary policy to affect credit supply via the usual interest-rate channel. Nevertheless, the presence of the above risk-taking channel implies that the use of these policies should not be restricted to unconventional situations. They should rather be part of the standard toolkit of central bankers also in normal times.

However, monetary policies targeting interest rates or liquidity conditions and leverage need to pay attention of one fundamental feature of financial systems: its interconnectedness. Today the financial system is structured as a complex web of financial relationships of very different nature (e.g. unsecured lending, repurchasing agreements, derivatives) and among different types of actors (e.g. banks, hedge funds, money market, and pension funds). Financial inter-linkages can generate important trade-offs. On the one hand, they increase individual liquidity because, for instance, they can allow one financial institution to expand leverage by re-hypothecating the collateral obtained via reverse repos rather than its proprietary collateral (see Luu et al., 2018, for analysis of this channel). In addition, they can reduce individual risk via diversification (see Allen and Gale, 2000, and Battiston et al., 2012). On the other hand, they may generate important external effects (e.g. my insolvency can become yours if it causes a significant drop in the value of your assets), thus increasing systemic risk and generating financial crises (see e.g. Leijonhufvud 2009, Battiston et al., 2012, Acemoglu et al., 2015). A good deal of literature in the last years has developed financial network models to study the consequences of the structure of the networks of financial inter-linkages for financial stability (see also Chinazzi and Fagiolo, 2015, for a survey). This literature has highlighted two main "transmission channels". First, shocks move from a bank to another via the direct interlocks between balance sheets. That is, since the liabilities of one bank are the assets of some other banks, the default of the debtor may be better implies a loss for the creditors (see e.g. Eisenberg and Noe, 2011). Likewise, in case creditors decide to hoard liquidity, this has negative external effects on the liquidity accruals of their borrowers. This, in turn, leads the latter to further hoard liquidity from their borrowers. A liquidity-hoarding cascade may thus start, with the result of reducing the overall liquidity in financial markets (see Gai,

Haldane and Kapadia, 2011, and Luu et al., 2018). Second, there are indirect connections among banks due to the fact that they invest in common assets (see e.g. Battiston et al., 2012, Cont et al., 2013). This implies that, for instance, if as a result of a shock on the price of an asset, a bank sells a quantity of that asset sufficient to move down the price, the other banks holding the same asset will experience both the initial price shock as well the secondary one. They may then start to sell the asset themselves, thus triggering a devaluation spiral.

Financial network models constitute an important methodological leap forward in the analysis of the transmission of externalities, and their results are typically not reproducible by NK-DSGE models. Furthermore, the results of these models have important consequences not only for financial regulation (see e.g. Napoletano and Battiston, 2014, Battiston et al., 2016, and Haldane, 2013), but for the conduct of monetary policy as well. First, policies changing the short-term interest rate may trigger different responses of the financial system, not only as a consequence of the average leverage situation of the financial system, but also as a consequence of the different structure of the network of financial inter-linkages, as the latter may indeed work as a multiplier of the initial monetary policy shock (see Visentin et al., 2016, for a detailed analysis of the conditions under which an interconnected financial system amplifies or not external shocks). Second, financial networks have also consequences for policies directly affecting banks' balance sheets and liquidity. For instance, network structures concentrating collateral flows among few market players generate high market liquidity in presence of re-hypothecation (Luu et al., 2018). It is therefore those central nodes of the network that must be targeted by quantitative easing policies to quickly restore liquidity following a market strain. Furthermore, one key consequence of interconnectedness is that the value of assets and liabilities of one institution cannot be evaluated independently from the value of assets and liabilities of other institutions that are directly or indirectly connected to it (see Eisenberg and Noe, 2001, and Visentin et al., 2016). This is not just because of the above-mentioned practice of re-using other parties' collateral to expand leverage. It is also because the securitization process has implied that several securities may consist of debt obligations of third parties, such bonds, securities of other banks in the same financial system but also mortgage-backed securities and other asset-backed securities. It follows that monetary policies improving the solvency or liquidity situation of specific banks, or the liquidity of specific class of securities, may have a beneficial impact on the value of assets' portfolio of other banks and, in this way, improve their solvency, ultimately having a positive impact on the ability of the whole financial sector to expand leverage and to supply credit.

7. Concluding remarks

We revisited the main tenets of the inflation-targeting consensus about monetary policy before the Great Recession and the building blocks of the NK-DSGE models supporting it. We discussed how the failure of these models to provide guidance during the crisis were largely due to assumptions that implied excessive confidence in the ability of markets to coordinate supply and demand and in the neglect of the impact of finance on real activities, due to a particular view of the role of price flexibility and of the characteristics of the money creation process. In addition, these models left little room for the analysis of the possible long-run effects of monetary policy and had a very specific view of the interactions between monetary policy and other policies. We then argued that a new framework for monetary policy needs to go beyond the limitations of NK-DSGE models and in particular it needs to put emphasis on the role of processes guiding coordination in markets, and on the structure of financial relations guiding the diffusion externalities in financial markets. Finally, we discussed how these two important aspects are captured by new classes of models, namely agent-based and financial network models, that have been able to provide useful insights for the conduct of monetary policy, and to its interactions with other types of policies (fiscal policy, macro-prudential policy). These models may thus have a room in the future toolbox of central bankers.

As a final remark, one must stress the strong links existing between banks' leverage and, more generally, the organization of the financial system, and disequilibria in real markets, like the market for goods or the market for labor. On the one hand, disequilibria in real markets determine the demand for credit, which is a factor shaping the asset side of banks and their leverage.[5] On the other hand, the supply of credit determines the ability of firms and households to finance their consumption and investment plans, and accordingly aggregate demand and supply. Financial leverage, though, is not the only factor significantly impacting disequilibria in real markets. Another important one, is the time horizon of banks and financial institutions in their provision of credit. In particular, excessive short-termism may not only be a source of bubbles and excess volatility in financial markets. It may also reduce the amount of financing available for long-term real investments. i.e. the ones associated with higher uncertainty but also with higher productivity gains (see Haldane, 2015). The time horizon of financial actors cannot simply be affected by the

[5] Following the argument of Hicks, we can also argue that, 'the market makes its money' (Hicks 1989).

level of central bank interest rates or by macro-prudential measures. In involves restructuring the functions of banks (e.g. separating between commercial and investment banking activities) and the governance of firms. These crucial issues have probably received less attention that what they deserve for the moment, and they need to be on the research of theoretical models dealing with financial-real interactions, especially the ones dealing with market disequilibria.

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