Unconventional Monetary Policy from Conventional Models?
Changes in Risk Premia and the Reaction Function of the Central Banker

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Abstract (extended version)

In the last three decades, a new class of DSGE models has been developed in which some Keynesian insights are explicitly accounted for. Looking at the underling monetary theory, this type of models, usually labelled as 'New Keynesian' or 'Neo Wicksellian', represents a progress over the early class of DSGE models. For, in the purpose of reflecting real-world central-banking, the loanable fund approach is rejected in favour of a (weakly) endogenous theory of money. More precisely, in the wake of Wicksell's two-interest-rate theory, the central bank is assumed to target interest rate on unsecured money markets, whereas monetary aggregates are treated as residual variables. In spite of this remarkable theoretical advancement, however, banking sector and financial institutions are usually neglected. This feature, along with the systematically wrong predictions and the failure in providing a plausible explanation of recent economic and financial crises, has represented a serious blow for the reputation of DSGE models. After the outbreak of the US crisis, attempts to improve the benchmark model have, therefore, multiplied. Two are the main flaws of old models which New Keynesian DSGE modellers have focused on: 1. the presence of systematic errors in inflation forecasting; 2. bound to the former, the absence of an appropriate way of modelling financial markets and financial frictions. A standard way of tackle point 2 is to allow for volatile 'risk premia', whose fluctuations are regarded as the main shock driving the business cycle. This simple amendment is shown by many to enable DSGE models to *ex post* accurately 'predict' the behaviours of chief macroeconomic variables during recent crises, including output growth and inflation rates. However, seldom it is observed that such a very development in DSGE models is logically equivalent to the assumption of hysteresis of output. In addition, the inclusion of financial frictions entails a revision of the standard interest rate rule adopted by the central bank. For the stabilization of borrowers' balance-sheets should replace price stability as the main target. The aim of this paper is, therefore, two-fold: firstly, to argue that some interesting corollaries in policy-making logically follow once financial frictions are explicitly modelled; secondly, to compare the effect of a standard Taylor rule with a different interest rate rule under an otherwise standard New Keynesian 'toy model'.

Key Words

DSGE Models, Keynesian Economics, Financial Accelerator, Central Banking

JEL Classification Codes

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1. Introduction

In the early 1990s a wide convergence of views in macroeconomics and macroeconomic policy emerged (e.g. Woodford 2009, p. 2). Such a «new consensus» concerned both economic theory in academia, and policy-making in central banks and supranational institutions around the world (e.g. Taylor 2000, p. 90; also Tovar 2009). On the *methodological* side, it was a «new neoclassical synthesis» incorporating frictions and imperfections of the old neoclassical-Keynesian synthesis within the «dynamic stochastic general equilibrium model» (DSGE, hereafter) developed by the «real business cycle school» (RBC) (e.g. Goodfriend and King 1997, Clarida *et al.* 1999, Dixon 2008, Fontana 2009, McCombie and Pike 2013). In fact, authors of the «New Keynesian Economics» (NKE) could be regarded as the majority shareholders of the new consensus in macroeconomics and macroeconomic policy. On the *theoretical* side, in the NKE-DSGE benchmark model, as in the RBC-DSGE one, an expansionary fiscal policy leads to higher inflation and interest rates in the long run, with no real effects on output and unemployment. The neoclassical principle of the «neutrality of money» is, therefore, still confirmed in the medium to

long run. The main novelty of the NKE compared to the RBC and other "monetarist" approaches is the rejection of money supply targeting, in favour of money being a residual of inflating targeting policy (via short-term interest rate smoothing) by central banks (Fontana, 2007, 2011). The supply of money is considered to be an endogenous variable of the model.

However, both the money market and financial institutions are not mentioned, let alone modelled (Arestis 2009, p. 11). This may sound rather odd if one considers that NKE-DSGE models are one of the main analytical tools adopted by the most part of central banks around the world (e.g. Adolfson *et al*. 2007, Tovar 2009). For instance, the benchmark model for the Euro Area is that proposed in the path-breaking work of Smet and Wouters (2003). Yet, there is no scope for money and finance in that model. Actually, some pioneering attempts to account for financial asymmetries, regarded as possible triggers or amplifiers of the business cycle, were made between the early 1980s and the late 1990s. We refer, particularly, to the literature on the «financial accelerator mechanism» (FAM) pioneered by Ben Bernanke and other New Keynesian scholars (see, mainly, Bernanke 1981, 1983; Bernanke and Gertler 1989; Bernanke *et al.* 1996, 1998). After the collapse of *Lehman Brothers* and the subsequent crisis, Bernanke's seminal works have been rediscovered and further developed in order to account for the post-2008 deep recession (coupled with the protracted but modest decline in inflation) and to model additional monetary policy transmission mechanisms (see, among others, Tovar 2009, Christiano *et al.* 2013, and Del Negro *et al*. 2014). These brand-new contributions still rely on the benchmark DSGE model pioneered by the RBC and then amended by NKE authors.[1] Market economies are thus likened to non-monetary systems where the labour market always clears. However, several «frictions» and «imperfections» are added. It is such imperfections which enable households to supply the desired quantity of labour and set wages, whereas firms are enabled to supply goods and set prices. As the price-resetting process is not instantaneous, socially sub-optimal results are likely to occur, in the short run at least.

Against this background, the paper is organized as follows. In sections 2 and 3 an outline is provided of the NKE-DSGE benchmark (reduced-form) model. In section 4 we analyse the

monetary side of the NKE-DSGE model. We argue that, on the one hand, the adoption of a (weakly) endogenous theory of money represents an advance compared to the «monetarist» claim that the central bank should be targeting some monetary aggregate (Fontana and Palacio Vera, 2002). For, in line with current central-banking practice, money supply is now correctly seen as a residual of inflation targeting (IT).[2] On the other hand, banks and financial markets are not included in the benchmark model, which relies essentially on a non-monetary take (Tovar, 2009). This is considered by many to be one of the reasons why standard DSGE models systematically failed to forecast (and explain) economic and financial crises which hit advanced economies since the 2000s. In sections 5 and 6 an overview is provided of FAM literature. This is a somewhat «heretical» branch of modern macroeconomics, aiming to analyse the role of financial frictions in the business cycle. As we mentioned, FAM works have deeply influenced post-2008 developments in mainstream (i.e. DSGE-based) macroeconomics, a critical examination of which is provided in sections 7 and 8. More precisely, we show that a new class of NKE-DSGE models has been implemented, aiming to account for the pro-cyclical effect of financial frictions. Besides, we argue that the very inclusion of financial frictions in the model is like introducing a persistent effect of current demand on natural output (i.e. path-dependency of output). Consequently, we argue that some unconventional corollaries in policy-making logically follow once financial frictions are modelled. Finally, some further remarks are provided in section 9.

2. Macroeconomic physiology of the NKE-DSGE benchmark model

As pointed out by many authors, the macroeconomic dynamics of the NKE-DSGE model can be described through three reduced-form equations, namely, an aggregate demand equation, an inflation equation, and an interest rate rule. Each macroeconomic equation, in turn, is strictly «micro-founded», where that is taken to be optimising behaviour under constraints.[3] More precisely, every relationship between aggregate magnitudes is derived from the constrained inter-temporal optimization of an individual utility function. This function underpins the behaviour of a

single, sovereign, completely rational representative agent with perfect foresight, who maximises its utility over an infinite horizon by combining labour supply (or leisure time) and consumption (or saving) in each period. In simple algebraic terms, the reduced-form benchmark model is:[4]

(1) $$Y_t^g = a_0 + a_1 Y_{t-1}^g + a_2 E\left(Y_{t+1}^g\right) - a_3\left[r_t - E\left(\pi_{t+1}\right)\right] + \varepsilon_1$$

(2) $$\pi_t = b_1 Y_t^g + b_2 \pi_{t-1} + b_3 E\left(\pi_{t+1}\right) + \varepsilon_2$$

(3) $$r_t = \left(1 - c_3\right)\left[RR_t^* + E\left(\pi_{t+1}\right) + c_1 Y_{t-1}^g + c_2\left(\pi_{t-1} - \pi^T\right)\right] + c_3 r_{t-1} + \varepsilon_3$$

where: a_0, a_1, a_2, a_3, b_1, c_1, $c_2 > 0$; $(b_2 + b_3) = 1$; and $0 < c_3 < 1$.[5] Equation (1) roughly corresponds to the usual *IS* curve. It shows that the output gap – viz. the difference between (the logarithm of) actual current output and its «natural» (or potential or long-run) level – depends negatively on the expected real interest rate.[6] It depends also positively on the past and expected future output gaps.[7] Equation (2) corresponds to the «accelerationist» (or expectations-augmented or New Keynesian) Phillips curve, acting as the aggregate supply function. It shows that the inflation rate depends positively on the output gap (and also on the past inflation and the expected future inflation), signalling demand pressures.[8] For this reason, it is sometimes called the «inflation-adjustment (IA) line» (e.g. Romer 1999; and Taylor 2000). As the inflation rate accelerates whenever the actual (rate of growth of) demand and output exceeds the natural (rate of growth of) output, equation (2) can be considered as the equivalent of the NAIRU principle.[9] Equation (3) is the monetary policy rule or the reaction function of the central banker. It incorporates the well-known «Taylor rule» (e.g. Taylor 1993, 1999), according to which the *change* in nominal interest rate set by the central bank must be a positive function of the «natural» real interest rate, the expected future inflation rate, the past output gap, and the past inflation gap (that is, the deviation of the actual inflation in previous period from its target value).[10] In formal terms, it is usually drawn from the minimisation of the «loss function» of the central banker, where the losses for each period are a weighted average in quadratic terms of the deviation of inflation from its target rate and of current output relative to its potential level (Woodford 2003, p. 381). However obtained, since prices are supposed to be sticky

in the short-run and changes in expected inflation are taken into account, when steering the nominal rate, central banks are effectively setting the real interest rate (Romer 2000, p. 155). Two points are worthy to mention here. First, the interest rate policy rule replaces the traditional *LM* curve in the *IS-LM-AS* model, along with its assumption that the central bank targets the money supply. In the NKE-DSGE model the central bank is able to influence the short-run real interest rate and money is a residual. Second, the short-run stickiness of prices also explains the limited effectiveness of monetary policy. In the long run price are by definition flexible and hence central banks are unable to influence the real interest rate. Therefore, monetary policy is effective in the short run but neutral in the long run. Finally, notice that combining equation (1) with equation (3) gives a negative sloped relationships between inflation and output gap, acting as the aggregate demand function of the model (see, among others, Romer 2000; Taylor 2000; Fontana and Setterfield, 2009).[11]

Plainly, the closure of the model (1)-(2)-(3) requires the specification of the nature of expectations, that is, of the form of the set of functions $E(\cdot)$. In this regard, it is admitted that expected values of inflation and output may deviate from actual values in the short run. This discrepancy, in turn, may temporarily push the economic system out of its natural equilibrium state (or natural growth path).[12] Consequently, there is some room for public intervention in the short run, though mainly through the «scientific» steering of the target interest rate, and just in order to anchor agents' inflationary expectations. By contrast, agents' forecasts could not be *systematically* wrong over time. The assumption that agents know the right economic model and manage to use all information efficiently (i.e. the "rational expectations hypothesis") remains one of the theoretical pillars of the NKE model, as it was in the RBC one. Exogenous non-systematic shocks may affect the equilibrium in the long run. In equations (1)-(2)-(3) this random component is "captured" by ε_i (with $i = 1, 2, 3$). By contrast, every systematic economic policy is doomed to leave real magnitudes (notably, output and employment rate) unchanged. For instance, the only long-run effect of a long-lasting expansive fiscal stimulus would be an increase in inflation and (both nominal and real) interest rates. This result is the NKE equivalent of the neoclassical principle of the long-run

neutrality of aggregate demand-driven macroeconomic policies.

The trend (over 100 periods) in output gap, inflation rate and interest rates within the artificial discrete-time economy outlined by equations (1)-(2)-(3), call it «Model I», is portrayed in Figure 1. A glossary of variables and parameter values of the model is provided in the final Appendix. As we mentioned, inflation and output expectations are always fulfilled in the long run, but may be wrong in the short run. This is the reason why we assume that expected values equal actual current values in the simulation of Model I.[13] This clarified, a shock (+10%) to the autonomous demand – viz. a permanent increase in a_0 due to a fiscal stimulus, in our example – has been imposed in period 25. Because of *price stickiness*, a positive effect of the fiscal stimulus on the economy occurs.[14] However, such effect is absorbed after a certain number of periods, whereas the increase in both inflation and interest rates is of permanent nature.[15] An important corollary is that an expansive fiscal policy affects neither the long-run volume of output nor its long-run growth rate, but only its *composition*.[16] A «crowding-out» effect of government intervention on private spending is likely to occur, due to the increase in the real interest rate. In this regard, the main difference between NKE and monetarist approaches (including the RBC) turns out to be the different hypotheses about the *persistence* of frictions, imperfections and asymmetries of real-world economies, i.e. the *actual length* of the short run.[17]

3. Natural equilibrium, path-dependency, and the role of demand in the NKE

The mechanics of Model I is rather straightforward: a departure of output from its «natural» volume (or natural growth rate) causes inflation to change.[18] This, in turn, leads the central bank to change the short-run nominal interest rate, and given the stickiness of prices, the short-run real interest rate such that to bring current output back to its natural level.[19] The institutional structure of the economy, including prevailing conditions on the labour market, is sometimes considered,[20] but the natural (or potential) level of output is always independent of aggregate demand changes, including fiscal and monetary-policy-led changes. However, the concept of the natural equilibrium (of output

and unemployment) has been the subject of a long-lasting debate in economics since the mid-1970s. According to several dissenting economists, real world economies should be better regarded as *path-dependent* systems (see, among others, Hargreaves-Heap 1980, Cottrell 1984-85, Blanchard and Summers 1987, Flaschel 2000, León-Ledesma and Thirlwall 2002, Lavoie 2006, Fontana and Palacio Vera 2007, McCombie and Pike 2013, Sawyer 2013). For economic variables do not progress steadily toward an exogenously-given, unique and stable equilibrium. On the contrary, autoregressive effects and nonlinearities are rather strong. As a result, output and employment may reach many different equilibria. Each of the equilibrium achieved depends, partly to least, on the dynamic process of getting that position. Think, for instance, of the possible consequences of a lack of demand leading to a stop in the production process: once productive capacity has been wasted, workers have not been trained, and investments have not been undertaken, it is not possible to restore the previous potential output, as if nothing happened (Setterfield, 2002). This path-dependency affects also effectiveness of policy-making. For, in the absence of an exogenously-given natural equilibrium, there is no necessary «crowding-out» of government spending on private investment.[21]

In order to clarify this point, a simplified version of Model I, call it «Model II», is employed. The new system of equations is defined as follows:

(4) $$Y_t = \alpha_0 - \alpha_1 \left(r_{t-1} - \pi_{t-1} \right) + \varepsilon_1$$

(5) $$\pi_t = \pi_{t-1} + \beta_1 \left(Y_{t-1} - Y_{t-1}^n \right) + \varepsilon_2$$

(6) $$r_t = \pi_t + RR_t^* + \gamma_1 \left(\pi_{t-1} - \pi^T \right) + \gamma_2 \left[Y_t - E\left(Y_{t+1}^n \right) \right] + \varepsilon_3$$

where α_0, α_1, β_1, γ_1, $\gamma_2 > 0$. The main difference with the previous model is that equation (4) now determines the actual volume (or the actual growth rate) of output, instead of its gap with the natural volume (or the natural growth rate), Y^n.[22] In addition, for the sake of simplicity, equations (4) and (5) are assumed not to be forward-looking. As we have already mentioned, the variable RR^* in equation (6) is the real rate of interest assuring the (*ex ante*) matching of savings and investment at

the natural level of output. It corresponds to the Wicksellian «natural rate of interest» and can be derived by using equation (4) in equation (6).[23] Then, by imposing that the actual inflation rate equals the target rate and that the output gap is nil, we obtain:

$$RR_t^* = \left(\alpha_0 - Y_t^n\right) / \alpha_1 \tag{7}$$

If the central bank sets the value of RR_t^* in accordance with equation (7), then the economy adjusted at its natural equilibrium, and Model II (including equation (7)) can be shown to behave like Model I. Accordingly, the only long-run effect of a permanent increase in government expenditure would be an increase in nominal and real interest rates. This would end up crowding out the private sector's spending. Notice also that, if one assumes that there is no lag in the effect of the real interest rate on output, as reported in equation (4), then the actual inflation rate equals the target rate in the long run.

As mentioned, the assumption that the level of potential output (or its growth rate) is an exogenous variable has been criticized by several authors. The point is that labour productivity (think of workers' learning by doing, technological innovations and investment in fixed capital) and even the availability of labour-force (think of migration flows) are seen as strictly linked to the current level of demand and output. To put it differently, current output may affect the future potential (or natural) output of the economy. As a result, Model II should be further amended – for instance, in the wake of Lavoie (2006) – by introducing an additional equations:

$$Y_t^n = Y_{t-1}^n + \phi_1\left(Y_{t-1} - Y_{t-1}^n\right) + \varepsilon_4 \tag{8}$$

with $\phi_1 > 0$. Equation (8) states that the short-run volume of effective demand affects the long-run level of output. This «introduces the possibility of multiple equilibria, that make long-run supply forces dependent on short-run disequilibrium adjustment paths induced by effective demand» (Lavoie 2006, p. 181). The provision of a (micro) foundation for equation (8) is beyond the scope of this paper. Notice, however, that equation (8) has been justified by many by recurring to the notion of the «hysteresis-augmented natural rate of unemployment» (e.g. Hargreaves-Heap 1980, Cottrell

1984-85, and Blanchard and Summers 1987, quoted in Lavoie 2006). A simulation of Model II (including equations (7) and (8)) is reported in Figure 2. As usual, parameter values of the model are provided in the final Appendix. This time, a positive shock on α_0 entails a permanent increase in the natural volume (or natural growth rate) of output.[24] Two obvious corollaries follow: i. to the extent that *hysteresis* of output is accounted for, discretional fiscal policy may be effective also in the long run;[25] ii. in the presence of a negative shock to the aggregate demand, a long-lasting effect might emerge on output and the natural unemployment level.[26]

4. Monetary policy and the nature of money in the NKE

As it has been mentioned, the consensus emerging in the late 1990s was not confined only to the methodology to be adopted in modelling. It concerned also the specific way in which a «scientific» monetary (and fiscal) policy should have been conducted in practice. In a sense, the very concern about real-world monetary policy seems to be one of the main features of NKE authors compared to other DSGE modellers.[27] According to Allsopp and Vines (2000, p. 2), there are five elements of NKE in the economic policy: 1. the main purpose of the intervention should be to provide a «nominal anchor» to inflation expectations; 2. this purpose is better pursued by an independent central bank; 3. the main instrument of monetary policy is the short-term interest rate in the unsecured money market; 4. the steering of the interest rate should also account for stabilization purposes; 5. fiscal policy is admitted, but its adoption affects the effectiveness of the monetary policy, so that it should be employed for short-run stabilization purposes only (and then through automatic stabilisers rather than discretionary fiscal policy). Plainly, points 1 and 2 can be regarded as a success of the old neoclassical economics pre-analytical view. The emphasis on both the credibility of announcements of monetary authorities and the benefits of a «conservative» central bank chair (in the wake of Rogoff 1985) is now shared by the vast majority of mainstream economists, be they either RBC or (new) Keynesians. Accordingly, the behaviour of monetary authorities must be expressed in the form of a «policy rule», viz. a predictable reaction function

depending on few economic variables. The rationale is to anchor agents' inflation expectations in the medium to long run (e.g. Taylor 1994; Allsopp and Vines 2000). If the central bank credibly signals its intent to maintain inflation low in the future – it is usually argued – then it is possible to reduce the current rate of inflation with less cost in terms of output reduction than might otherwise be required (Clarida *et al.* 1999, p. 1670). A noteworthy corollary is that it is desirable to shift monetary policy's decisions from national governments to politically-insulated bodies.[28]

By contrast, points 3 to 5 differentiate the NKE from RBC and other neoclassical approaches. In particular, point 3 entails the (partial) rejection of the exogenous money theory, and the replacement of a money growth rule with a real rate of interest targeting rule. Within the NKE, high-powered money «is not a variable the central bank is targeting, but rather one it is manipulating to make interest rates behave in the way it desires» (Romer 1999, p. 162). In this sense, the NKE proposition that central banks have the power to determine real interest rates is consistent with the argument, supported in the past by dissenting monetary economists only, that money supply is endogenous and demand-led. According to Woodford (2009, p. 13) monetary policy needs not be theoretically identified with the control of the money supply, mainly because «at most of the central banks with explicit commitments to an inflation target, monetary aggregates play little if any role in policy deliberations». The same position has been anticipated by Romer (2000), according to whom a number of developments in both economic theory and institutional environment challenged the traditional IS-LM-AS model over the 1980s-1990s. On the theoretical side, the main issue was that different interest rates were relevant to different parts of that model.[29] Furthermore, it was necessary to replace the price level with the inflation rate, and to shift the focus from monetary aggregates to the steering of the interest rate in conducting monetary policy. This, in turn, was seen as the consequence of a long-lasting change in the actual institutional environment: «the dominance of interest rates over monetary aggregates in the conduct of monetary policy – it was argued – is not a recent phenomenon. In the United States, for example, only in the 1979-1982 period did monetary aggregates play a significant role in policy» (Romer 2000, p. 155).

However, in the NKE benchmark model, like in the RBC one, the two principles of the ineffectiveness of the fiscal policy and of the neutrality of money remain confirmed in the long run. As it has been shown in section 2, an expansionary fiscal policy would eventually lead to an increase in inflation rate and an even higher increase in nominal interest rate. The final effect would be an increase in real interest rate, with no long-lasting impact on real output. Similarly, a restrictive monetary policy would eventually lead to a lower inflation rate, without any «negative» impact on real interest rate and real output.[30]

5. Financial instability in the NKE-DSGE model: the financial accelerator mechanism

Standard NCM-DSGE models employed by staff of central banks for forecasting purposes have shown a limited explanatory power about recent events (e.g. Foley and Farmer 2009; see also Krugman 2009, Buiter 2009, and Spaventa 2009). The main issue is the inability of the benchmark model to grab fundamental aspects of today's financially-sophisticated capitalist economies. The failure in providing a plausible explanation of the two economic and financial crises which hit the US economy in the decade 2000-2010 has represented a serious blow for the reputation of NKE-DSGE models. The point is that those models «by their very nature rule out crises of the type we are experiencing now» (Foley and Farmer 2009, p. 685).[31] More precisely, one of the main issues is that the DSGE benchmark model eventually relies on both the «efficient market hypothesis» (EMH hereafter) and the «Modigliani-Miller theorem» (M&MT hereafter), in the medium to long run at least.[32] As a result, given an *sufficiently long* period of time, money and finance would not affect output and employment, but only inflation and interest rates. This again is not surprising: as an autonomous investment function of firms is ruled out of the model, conditions of financing of investment (and current production) cannot, by definition, influence real variables.[33] However, this sounds rather counter-intuitive. In fact, is seems at odd with all of available empirical evidence.

The explicit analysis of the possible interaction between the real economy and the prevailing conditions in finance and credit-markets is the subject of a somewhat «heretical» sub-class of NKE

theories and models, mainly developed by Bernanke, Gertler and Gilchrist during the 1980s-1990s (e.g. Bernanke 1981, 1983; Bernanke and Gertler 1989; Bernanke *et al.* 1996, 1999). We refer to the literature on the so-called «financial accelerator mechanism» (FAM), in which the assumption of informational asymmetries between firms (or entrepreneurs) and financial intermediaries make both the EMH and the M&MT inapplicable. More precisely, the *two chief hypotheses* underpinning the FAM are: i. informational asymmetries entail higher costs of «external» finance, as compared to «internal» funds, in the form of agency costs (linked to the monitoring by the lender and bankruptcy risks);[34] ii. *ceteris paribus*, the higher the amount of «collateralizable» net worth of firms, the lower will be the (expected) agency costs. At the macroeconomic level, *two implications* follow: i. to the extent that net worth of firms moves pro-cyclically (in the wake of cash-flows and asset prices), the premium on external finance rises in recessions and reduces in booms, therefore increasing investment fluctuations and enforcing cyclical persistence; ii. not only demand shocks, but also shocks affecting net worth of firms (as occurs in a debt-deflation crisis) may trigger real fluctuations (e.g. Bernanke and Gertler 1989). Thus, during recessions (booms) the fall (rise) in firms' net worth increases (decreases) the premium on external funds, while increasing (decreasing) the need for finance, therefore reducing (boosting) investment and output. This is the core of the FAM: an initial shock to demand, however small, is likely to be amplified by the change in balance-sheets of firms and, more generally, by conditions in finance and credit markets. Plainly, such dynamics is «intrinsically nonlinear», since the final impact of the FAM on output depends on the current level of internal finance of firms. More precisely, the deeper the economy is in recession, the lower is the internal finance, and hence the stronger will be the «autoregressive movement» in output (e.g. Bernanke and Gertler 1989, pp. 14-15; Bernanke *et al.* 1996, pp. 3-4). This, in turn, will negatively affect demand for inputs of firms, which will be accumulating an excess of inventories, while reducing the employment level and/or real wages bargained with workers (e.g. Greenwald and Stiglitz 1993, p. 109).

Significantly enough, references to an exogenously-given natural volume (or rate of growth) of

output are rather rare in FAM literature. On the one hand, it is clearly stated that the methodological starting point of the FAM model is the benchmark NKE-DSGE model. This, *inter alia*, may produce a possible «short circuit» in the theory of money adopted. The point is that it is sometimes assumed that the role of banks is just to «collect deposits from households and lend to entrepreneurs» (Del Negro *et al*. 2014, p. 9). But this hypothesis, recalling the old «loanable funds» theory of money, is clearly at odd with the assumption that money supply and credit are residually-determined and demand-driven (as implicitly stated by the Taylor rule). Thus, the introduction of frictions in the money market can be here regarded as a way to reconcile two otherwise very different monetary takes. On the other hand, FAM authors openly «abstract [...] from long-term financial relationships» (Bernanke and Gertler 1989, p. 15) in their works. This is remarkable for it that price flexibility is no longer regarded as the natural or long-run condition of the system, but just as the «limiting case» – as Bernanke *et al.* (1999, p. 6) call it – analysed in RBC-DSGE models. In other words, the long run is implicitly regarded as an ideal path, rather than as an actual historical tendency of market economies. But if the relationship between price stickiness and price flexibility is to be reversed, short-run sub-optimal equilibria become the rule, and so does public intervention. This hint of heterodoxy is strengthened by the repeated reference of FAM authors to Fisher (1933)'s debt-deflation theory, and also by some veiled reference to Minsky's theory of the increasing risk on investment activity.[35] The heterogeneity of agents is another unorthodox feature of FAM models. More precisely, they «step outside the convenient representative-agent paradigm [since] the distribution of wealth affects the dynamics of the economy in a nontrivial way» (Bernanke *et al.* 1996, p. 3-4). The reason is that a reallocation of lending in recession from firms whose net worth is decreasing to a safer alternative is likely to occur, thereby triggering a «flight-to-quality» (or «flight-to safety») process. This, in turn, increases the financial fragility of economic units. Against this background, it is argued that large corporations are likely to be less hit by the greater cost (or difficulty) in obtaining credit in downturns compared to small firms. An important corollary is that «recessions that follow a tightening of monetary policy are perhaps most likely to involve a flight to

quality, because of the adverse effect of increased interest rates on balance sheets and because of monetary tightening may reduce flows of credit through the banking system» (Bernanke *et al.* 1996, p. 6; see also Bernanke and Blinder 1988). To put it differently, monetary policy affects output and other real magnitudes not as much because prices are sticky (as is assumed in the benchmark NCM model) as because *the access to external finance has a crucial impact on investment demand (and production plans) of firms*.

6. Financial accelerator mechanism and the hysteresis of output

In the wake of the standard DSGE methodology, FAM models are obtained through a process of micro-foundation of the macroeconomic dynamics.[36] This is usually put in practice by considering a production (or investment) technology that involves asymmetric information between entrepreneurs (who have direct access to the technology) and lenders (who have not). In addition, it is assumed that lenders incur agency costs in order to observe returns on firms' investment. Such costs, in turn, are assumed to be a decreasing function of net wealth of firms. In other words, agency costs depend on the perceived soundness of borrower's balance-sheet. Finally, since net worth is likely to move pro-cyclically, agency costs will behave counter-cyclically, therefore improving lending conditions in booms and worsening them in recessions. Thus, the macroeconomic «accelerator effect of income on investment» (Bernanke *et al.* 1996, p. 27) is brought back to a simple microeconomic *principal-agent* scheme. A formal treatment of micro-foundations of the FAM model has been initially proposed by Bernanke and Gertler (1989), and has been later developed by other New Keynesians (e.g. Christiano *et al*. 2013). Consequently, such treatment is not provided in this article. Rather, the focus is maintained on the macroeconomic dynamics, namely, on the behaviour of the reduced-form model. In this regard, the simplest way to frame the benchmark DSGE model (i.e. Model I) with the FAM is to replace equation (1) with the following:[37]

$$Y_t^g = a_0 + a_1 Y_{t-1}^g + a_2 E\left(Y_{t+1}^g\right) - a_3\left[r_t - E\left(\pi_{t+1}\right)\right] + a_4 h_{t-1} + \varepsilon_1 \tag{9}$$

in which:

(10) $$h_t = h_{t-1} + \omega Y_t^g + \varepsilon_4$$

where $h > 0$ is the net worth of investing firms, $\omega \geq 0$ is the share of aggregate (retained) profits and capital gains in total output (gap), and α_4 is the sensitivity of total output (gap) to change in credit-worthiness of firms, through a change in investment financing. The basic idea underpinning equations (9) and (10) is that investment activity, and hence current output, are crucially affected by the financial soundness of the (consolidated) balance-sheet of firms. More precisely, the lower (higher) the amount of internal funds accumulated by firms over the previous periods, the lower (higher) will be current investment and output. Notice that changes in internal funds can affect production decisions both through the self-financing of investment (direct channel) and through the degree of credit-worthiness of firms (indirect channel). Whatever the prevalent channel, the result is a strengthening and extension of the (however temporary) effect of current demand on output and employment levels. Such effect is portrayed in Figure 3.

Table 1. Four different DSGE models.

	No role of finance	*Role of finance (accelerator)*
Short-run effect of shocks	(I) Benchmark NKE	(III) Benchmark FAM
Long-run effect of shocks	(II) Emended NKE	(IV) New FAM?

In Table 1 all of the four DSGE models mentioned in this paper are reported, notably, the benchmark NKE model (or Model I), the emended NKE model (or Model II), and the benchmark FAM model (call it «Model III»). A fourth model is considered, which is commented in next sections. In Model I a positive shock on, say, government spending affects real output and employment levels (or their rates of growth) only in the short run. By contrast, Model II is marked by a higher and persistent effect of the shock on real variables, due to the hysteresis of output. Finally, Model III looks like a sort of middle ground, as the initial effect of the shock on demand and output is augmented and prolonged because of financial frictions (compared to Model I), though such effect is not of permanent nature (as in Model II). In fact, on a closer inspection, the

use of the financial accelerator may be regarded as a way to introduce a temporary (though not ever-lasting) hysteresis of output in the benchmark DSGE model. This is recognized by the very proponents of the FAM. In the absence of information asymmetries – they argue – investment demand can be safely assumed to be fixed over time, in the first approximation at least. By contrast, «when information asymmetries are present, investment demand will vary and be history-dependent» (Bernanke and Gertler 1989, p. 20). As it is argued in next section, this has noteworthy consequences on the role of central bank.

7. The current state of macro: New FAM-DSGE models

The repeatedly wrong predictions, and especially the failure in providing a plausible explanation of the US crisis and the subsequent global financial instability and economic recession, represented a serious blow for the reputation of DSGE models, including their NKE declensions. In a sense, the proclaimed consensus around the benchmark NKE-DSGE model (often called the «new consensus model») was rather short-lived. This notwithstanding, the analytical core of that model is still «seen by many to be relatively unscathed (but with the imperative to build in assumptions that allow for debt default and bankruptcy)» (McCombie and Pike 2013, p. 521). To be fair, attempts to make the benchmark model more realistic were made far before the onset of the subprime crisis. The most popular way is to modify the benchmark DSGE model in order to allow for a fraction of households or consumers who cannot access financial markets. As these «non-Ricardian» consumers cannot borrow or save in order to smooth their consumption, they follow a simple «rule of thumb», namely, they always spends all current labour income on current consumption. It turns out that

> if the weight of such rule-of-thumb consumers is large enough, a Taylor-type rule must imply a (permanent) change in the nominal interest rate in response to a (permanent) change in inflation that is significantly above unity, in order to guarantee the uniqueness of equilibrium. Hence, the Taylor principle becomes too weak a criterion for stability when the share of rule-of-thumb consumers is large. (Galì *et al*. 2004, p. 740)

Furthermore, the presence of non-Ricardian consumers is shown to affect significantly the reaction of economy to fiscal policy shocks. For instance, an increase (decrease) in government spending

entails now a remarkable increase (decrease) in output, in the short to medium run at least (e.g. Galì *et al*. 2007). Notice that such conclusion has been further strengthened by post-crisis findings about the actual size of the government-spending multiplier. This latter turned out to be much larger than one when the zero lower bound on the nominal interest rate binds or, anyway, when the nominal interest rate is constant (e.g. Christiano *et al.* 2009). In short, the introduction of financial constraints makes DSGE models produce old-fashioned «Keynesian» results. Here is the essence of NKE-DSGE modelling.

In the aftermath of the crisis, the attempts to improve or update the benchmark model have multiplied. More precisely, two are the main flaws of the benchmark DSGE model that New Keynesians have focused on: i. the presence of systematic errors in inflation forecasting; ii. bound to the former, «the absence of an appropriate way of modelling financial markets […] or financial frictions» (Tovar 2009, p. 6). Starting from point (i), the overestimating of deflationary effects of the crisis produced by the benchmark model has been usually regarded as the consequence of the underestimating of price stickiness. This latter is captured by the so-called «Calvo parameter» in the New Keynesian Phillips curve.[38] The underrating of the degree of price rigidity, in turn, would be the consequence of the lack of financial frictions in the benchmark model. By contrast, once these frictions are introduced in the model, this latter is shown to *ex post* accurately «predict» the behaviour of the US economy since 2008, including the weak drop in inflation rate. Intuitively, the rationale is that financial frictions make the Phillips curve «flatter» (i.e. such frictions reduce b_1 in equation 2, or β_1 in equation 5, in our simplified reduced-form model). The US crisis could be, therefore, interpreted and modelled as the result of aggregate demand shocks in the presence of a flat aggregate supply (e.g. Del Negro *et al*. 2014, p. 19-21).

This brings us to point (ii), namely, to the debate about the proper way of accounting for financial markets and financial frictions. We have mentioned that one of the standard ways of modelling the impact of the financial structure on the economy (within a DSGE model) is to introduce non-Ricardian agents who can neither borrow nor save. Another increasingly-popular

escamotage is to allow for volatile «risk premia», whose fluctuations are indeed regarded as the most important shocks driving the business cycle. Actually, the implementation of this insight closely follows the work of Bernanke and Gertler (1989) and Bernanke *et al*. (1999). It admittedly represents an attempt of developing the original FAM approach. This is the reason why we propose to dub this new class of models as the «New FAM» approach to DSGE modelling. In fact, FAM and New FAM models share the same principles, the major difference being the highest accuracy of modelling and econometric techniques of the New FAMs. In this regard, a recent but already-fundamental contribution has been provided by Christiano *et al*. (2013). It is assumed that firms (or entrepreneurs) combine internal funds with bank loans to acquire raw (physical) capital. The production process is likened to a process in which entrepreneurs convert the *raw* capital into *effective* capital under «idiosyncratic uncertainty» or «risk». For whether the raw capital turns into highly effective capital or becomes worthless, is assumed to be mostly up to chance. Finally, it is argued that a jump in risk triggers responses in the New FAM model which (*ex post*) resemble actual (recent) recessions. The underlying rationale is the interest rate on loans includes a «premium» covering the costs of default by the entrepreneurs who are unsuccessful. When the risk is high, the premium charged by banks is high and credit extended to entrepreneurs is low. The rest is a well-known story.

> With fewer financial resources, entrepreneurs acquire less physical capital. Because investment is a key input in the production of capital, it follows that investment falls. With this decline in the purchase of goods, output, consumption and employment fall. For the reasons stressed in [Bernanke *et al*. 1999], the net worth of entrepreneurs – an object that we identify with the stock market – falls too. This occurs because the rental income of entrepreneurs falls with the decline in economic activity and because they suffer capital losses as the price of capital drops. Finally, the overall decline in economic activity results in a decline in the marginal cost of production and thus a decline in inflation. So, according to the model the risk shock implies a countercyclical credit spread and procyclical investment, consumption, employment, inflation, stock market and credit. These implications of the model correspond well to the analogous features of US business cycle data. (Christiano *et al*. 2013. p. 2)

In short, fluctuations in risk premia over the risk-free interest rate should be regarded as the main trigger (or amplifier) of the business cycle. In formal macroeconomic terms, it is sufficient to replace equation (1) with the following:

(14) $$Y_t^g = a_0 + a_1 Y_{t-1}^g + a_2 E\left(Y_{t+1}^g\right) - a_3 \left[\underbrace{r_t + \rho_t}_{\text{actual nominal interest rate}} - E\left(\pi_{t+1}\right) \right] + \varepsilon_1$$

with:

(15) $$\rho_t = \eta_0 - \eta_1 h_{t-1}$$

and

(16) $$h_t = \omega_0 + \omega_1 h_{t-1} + \omega_2 Y_t$$

where ρ is the risk premium on the nominal interest rate targeted by central bank, and η_0, η_1, ω_0, ω_1, $\omega_2 \geq 0$. A simulation of system of equations (14)-(2)-(3)-(15)-(16), call it «Model IV», is shown in Figure 5. As one would expect, Model IV behaves like Model III in Figure 3. A positive shock to autonomous demand inflates net wealth of borrowers, thereby leading to an increase in bank lending which further supports investment and output. Similarly, an autoregressive downturn occurs when a negative shocks hits the demand. Once this simple mechanism is introduced in the benchmark NKE-DSGE model, this is shown to accurately reproduce US cyclical fluctuations since the mid-1970s (e.g. Gilchrist *et al*. 2009; also Merola 2013).

Notice that a similar way of introducing pro-cyclical effects of finance is to link it to the «inappropriate responses by financial market participants to changes in the time dimension of risk, especially in its systematic component. These responses primarily reflect the mismeasurement of changes in the absolute level of risk over time, but also the incentives that are faced by individuals and institutions» (Borio *et al*. 2001, p. 49). As a result, there is an underestimation of risks in booms and an overestimation in recessions, so that bank provisions and capital ratios fail to increase in economic booms and to reduce in recessions. This, in turn, strengthens the pro-cyclicality of bank profits, thereby pushing banks to increase lending in booms and reduce it in recessions (on this point, see also Borio 2006). Finally, it has also been shown that NKE-DSGE models can be further emended to account for Fisher's debt deflation and Minsky's deleveraging crises. On this basis, it has been argued that «countries can have sound domestic fiscal and monetary policies and

competitive, open markets and still reach a point of high leverage at which a financial crisis occurs» (Mendoza 2010, p. 1965). This potentially provides support to a broad scope for government and central bank interventions (e.g. Eggertsson and Krugman 2012).

8. Unexplored consequences in central-banking of New FAM-DSGE models

A weakness of FAM and New FAM models is that they only address «one aspect of many possible financial frictions» (Tovar 2009, p. 7). As a result, alternative ways of modelling the impact of financial factors (within a benchmark DSGE model) have been developed in the last few years, including the introduction of collateral constraints, currency risk premia in open economies, «Minsky-Fisher» devices, and other financial imperfections (for a survey, see Brunnermeier *et al*. 2012, and Roger and Vlcek 2012). In addition, other augmented FAM models have been obtained through the explicit inclusion of a heterogeneous, monopolistically competitive banking sector (e.g. Hafstead and Smith 2012). However, the vast majority of these approaches share the main weakness of the old benchmark NKE-DSGE model. We refer to the claim that it would be possible to regard both financial instability and long-lasting slumps as simple outcomes of market frictions (i.e. imperfections, asymmetries or rigidities in labour, goods and financial markets), rather than as endogenous by-products of the dynamics of market economies. The point here is not as much the need to model an «artificial» economy by defining an equilibrium state and then assessing its reaction to exogenous shocks, as the assumption that, in the medium to long run, free market forces would drive the economy towards a *unique exogenously-given and socially-optimal equilibrium*. It is this very feature, coupled with the assumption of perfect rationality of agents, that has led to the introduction of several «ad-hoc assumptions about why agents do not adjust their plans instantaneously and why prices are rigid» (De Grauwe 2010, p. 416). However, the use of lags in price-setting is rather controversial, as

> the inconsistency was brushed under the carpet. Why is it that in a world where everybody understands the model and each other's rationality, agents would not want to go immediately to the optimal plan using the

> optimal price? […] Calvo pricing is an ad hoc assumption forced unto the model to create enough inertia so that it would fit the data better. (De Grauwe 2010, p. 417)

Similar considerations hold for the other limitations to optimizing behaviour introduced in NKE-DSGE models, such as the presence of rule-of-thumb consumers or other financial constraints. Both relevance' and consistency's sakes would require either the introduction of different micro-foundations (for instance, the explicit acknowledgement that agents' behaviour is guided by heuristics) or the outright abandoning of the search for «deep parameters» of a representative agent. The former is the way proposed by behavioural economists (e.g. De Grauwe 2010) and agent-based modellers (e.g. Dosi *et al*. 2013; Delli Gatti *et al*. 2005). The latter is the way followed by those macroeconomists who adopt unconventional methods of modelling based on national account matrixes and stock-flow relations (e.g. Godley and Lavoie 2007).

Ironically enough, old and new FAM models are usually criticized both because they are based on the standard technique of modelling developed by the RBC (viz. because they rely on the concept of the natural equilibrium), and because of the *ad hoc* assumptions which lead to Keynesian results (viz. because of the methodological weakness of the related micro-foundations). By contrast, seldom is stressed that such class of models potentially lead to a different rule of central banking. The point is that, once it is admitted that lending is driven by creditworthiness of borrowers, it turns out that market value of financial assets becomes the priority target of the central bank. To put it differently, in the presence of financial frictions, the main task of the central bank is not as much the stabilization of inflation expectations, through the steering of the target interest rate, as the *strengthening of agents' balance-sheets, through the stabilization of values in financial asset (viz. collateral) markets*. While steering the target interest rate on money market, the central bank is, in fact, settling the solvability threshold of firms and banks interacting in the system (e.g. Brancaccio and Fontana 2013). In this regard, Figure 5 shows what happens if the standard Taylor rule is augmented in order to explicitly take into account the impact of changes in net wealth on risk premium and, hence, on output. In simplified but formal terms, it is obtained by replacing equation

(3) in Model III (or also in Model IV) with the following:

$$(17) \qquad r_t = (1-c_3)\left[RR_t^* + E(\pi_{t+1}) + c_1 Y_{t-1}^g + c_2 \left(\pi_{t-1} - \pi^T \right) \right] + c_3 r_{t-1} + c_4 (h_{t-1} - h_t) + \varepsilon_3$$

where $c_4 < 0$ is a parameter measuring the reaction of the central bank to a change in net wealth of economic agents (i.e. in the retained profit of firms, in this simplified toy model). This simple amendment enables the central bank to improve financial stability, thereby smoothing the business cycle. More precisely, the new rule for central-banking, while sharply reducing the peak of a demand shock, makes such effect more smooth and distributed over time.

As mentioned, this approach requires the outright abandoning of the Ricardian equivalence. Notice also that some attempts have been made to extend NKE-DSGE models in order to consider balance-sheet effects in the banking sector. For instance, Choi and Cook (2004, p. 21) show that, under certain circumstances, «a monetary policy that targets inflation can ameliorate the destabilizing effects of sticky prices».[39] By contrast, a different policy rule, aiming to stabilize the balance-sheet of the banking system, may lead to greater economic stability (as also point out by Argitis 2013). The importance of collateral constraints for borrowing has been also remarked (e.g. Iacovello 2005, and Gerali *et al*. 2010; Gerlter and Karadi 2011), though it is still a largely unexplored line of research (e.g. Tovar 2009). Yet, seldom it is recalled that the vast majority of refinancing operations in the inter-banking market are conducted through REPOs, with government bonds acting as the main collaterals. But, if this is the case, then the support of (market values of) government bonds, and not price stability in final good markets, should be regarded as the overriding concern of central banks during recessions. Notice that the replacing of risky private assets with low-risk government bonds (guaranteed by central banks) would further strengthen the soundness of firms' balance-sheets (this is the "portfolio effect" pointed out by Minsky 1986), thereby contributing to smooth the business cycle. To put it differently, «deficit-financed government spending can, at least in principle, allow the economy to avoid unemployment and deflation while highly indebted private sector agents repair their balance sheets» (Eggertsson and Krugman 2012, p. 1471). It remains to be understood whether, in order to account for the role of

"collaterals" in today's financially sophisticated market economies, more accurate DSGE models would be either a useful instruments for policy-making or just a further «privately and socially waste of time», as Buiter (2009) defined them. Today, more than ever, the debate is open.

9. Final remarks

In the mid-2000s, a convergence of views in mainstream macroeconomics was emerged. Such a pervasive consensus concerned both the state of the discipline (theory, methodology and modelling) and central-banking around the world. Unsurprisingly, the chain of events which followed the bankruptcy of *Lehman Brothers* in September 2008 revealed the inadequacy of the benchmark model, viz. the standard NKE-DSGE model, to forecast prolonged economic slumps and financial crises. After 2008, a new class of DSGE models has been provided, aiming to make the basic model account for financial imperfections of real-word economies. In fact, such class of models represents a return to a somewhat dissenter branch of mainstream macroeconomics, based on the financial accelerator mechanism (FAM), which have been pioneered by Bernanke and other NKE scholars in the early 1980s. Unlike the benchmark DSGE model, FAM models explicitly incorporate the impact of financial variables on real magnitudes. More precisely, financial frictions, measured by volatility in risk premia, are regarded as the main trigger of the business cycle. On a closer inspection, the consideration of the impact of changes in risk premia on borrowing, investment and output, is none other than a way to account for the hysteresis of output. While the possibility of permanent effects of changes in current demand on natural output is still not recognized explicitly in the vast majority of DSGE models, the inclusion of financial frictions looks like a way of introducing path-dependency effects implicitly. In addition, some interesting consequences in central banking follow once financial frictions are modelled, supporting the adoption of «unconventional» policies aiming to stabilize market values of financial assets.

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Appendix - Glossary of variables and parameter values

Model I

Symbol	Description	Type	Value
Y^g	Output gap (level)	**Endog.**	0.00*
π	Inflation rate	**Endog.**	-
r	Nominal rate of interest	**Endog.**	-
RR^*	Equilibrium (or natural) real rate of interest	**Endog.**	-
π^T	Inflation rate targeted by the central bank	**Exog.**	2.00
ε_i	Stochastic components (with i = 1, 2, 3)	**Exog.**	0.00
a_0	Parameter of output gap function reflecting (also) the fiscal policy stance	**Param.**	200.00
a_1	Sensitivity of current output gap to past output gap	**Param.**	0.10
a_2	Sensitivity of current output gap to expected future output gap	**Param.**	0.10
a_3	Sensitivity of current output gap to (expected) real interest rate	**Param.**	–500.00
b_1	Sensitivity of current inflation rate to current output gap	**Param.**	0.001
b_2	Sensitivity of current inflation rate to past inflation rate	**Param.**	0.50
b_3	Sensitivity of current inflation rate to expected inflation rate	**Param.**	0.50
c_1	× $(1 - c_3)$ Sensitivity of nominal interest rate to past output gap	**Param.**	0.001
c_2	× $(1 - c_3)$ Sensitivity of nominal interest rate to inflation gap	**Param.**	0.10
c_3	Sensitivity of current interest rate to past interest rate (degree of 'smoothing')	**Param.**	0.50
$E(\cdot)$	Expected value at time t	**Funct.**	-

*Note: * steady state and initial value.*

Model II

Symbol	Description	Type	Value
Y	Current output growth rate	**Endog.**	-
Y^n	Natural output growth rate	**Endog.**	≈ 0.01*
π	Inflation rate	**Endog.**	-
r	Nominal rate of interest	**Endog.**	-
RR^*	Equilibrium (or natural) real rate of interest	**Endog.**	-
π^T	Inflation rate targeted by the central bank	**Exog.**	0.02
ε_i	Stochastic components (with i = 1, 2, 3, 4)	**Exog.**	0.00
α_0	Parameter of output function reflecting (also) the fiscal policy stance	**Param.**	0.01
α_1	Sensitivity of current output gap to (past) real interest rate	**Param.**	0.50
β_1	Sensitivity of current inflation rate to (past) output gap	**Param.**	0.01
γ_1	Sensitivity of nominal interest rate to past inflation gap	**Param.**	0.01
γ_2	Sensitivity of nominal interest rate to expected output gap	**Param.**	0.01

ϕ	Hysteresis effect	**Param.**	0.10
$E(\cdot)$	Expected value at time t	**Funct.**	-

Note: * *steady state and initial value.*

Model III

Symbol	Description	Type	Value
h	Neat wealth of firms (value of collaterals)	**Endog.**	-
α_4	Sensitivity of investment to net wealth of firms	**Param.**	0.15
ω	Share of retained profits and capital gains in total output	**Param.**	0.50

Note: Descriptions and values of other values and parameters are those of Model I.

Model IV

Symbol	Description	Type	Value
h	Net wealth of firms (value of collaterals)	**Endog.**	-
ρ	Risk premium on nominal interest rate targeted by central bank	**Endog.**	-
η_0	Risk premium in normal times	**Param.**	0.00
η_1	Sensitivity of risk premium to net wealth of firms	**Param.**	0.0003
ω_0	Autonomous component of net wealth of firms	**Param.**	0.00
ω_1	Share of past net wealth available in current period	**Param.**	1.00
ω_2	Share of retained profits and capital gains in total output	**Param.**	0.50

Note: Descriptions and values of other values and parameters are those of Model I.

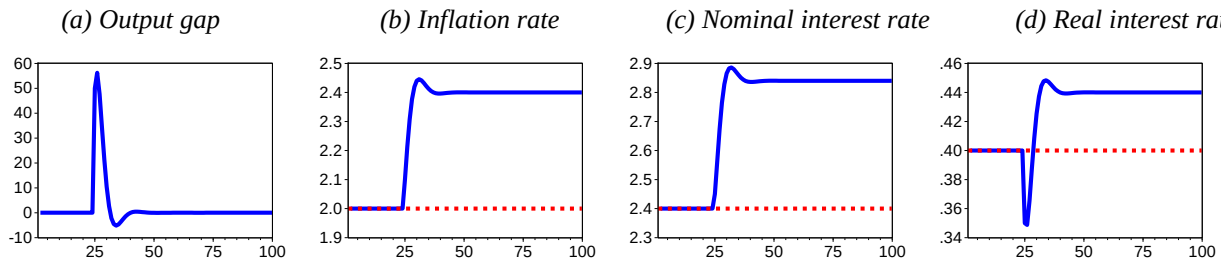
Model III augmented with alternative banking rule

Symbol	Description	Type	Value
c_4	Sensitivity of nominal interest rate to changes in net wealth	**Param.**	–0.001

Note: Descriptions and values of other values and parameters are those of Models I and III.

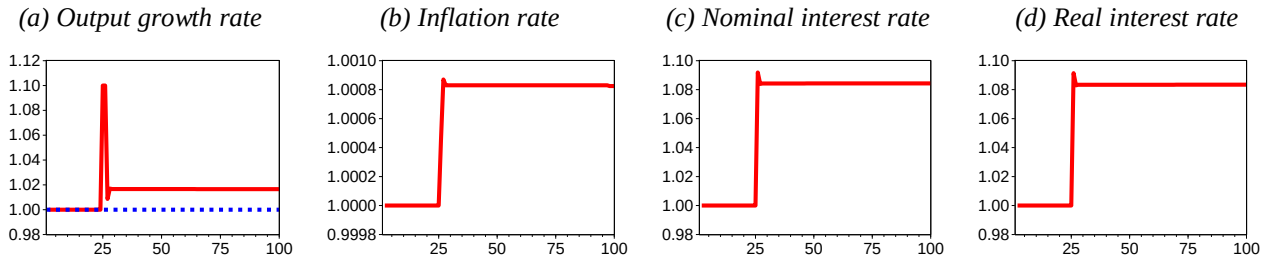
Figures - Simulations of four reduced-form DSGE models

Figure 1 Response of Model I to a permanent increase in government spending



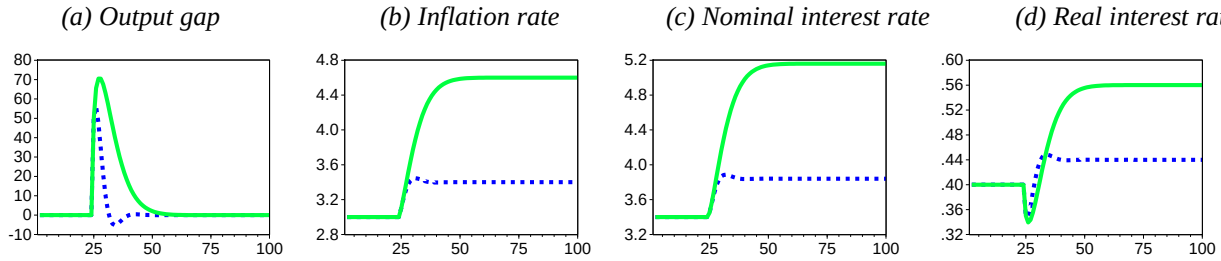
Notes: red dotted line = baseline; blue line = reaction to shock. Output gap is measured in conventionally-taken monetary units, whereas the other variables are expressed in percentage points.

Figure 2 Response of the DSGE model with hysteresis (Model II)



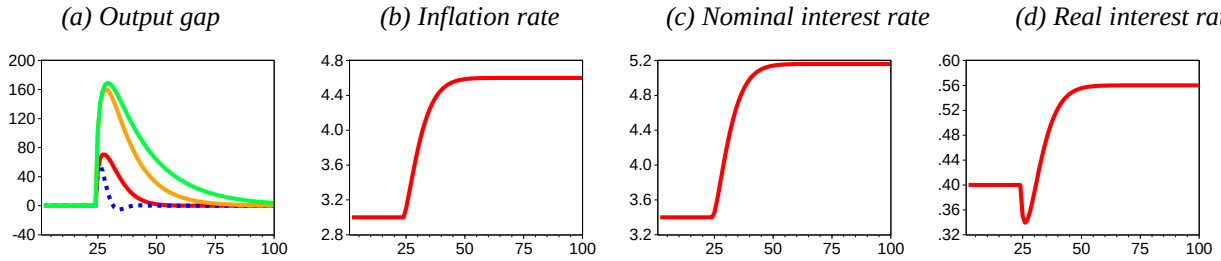
Notes: all values are compared to baseline.

Figure 3 A comparison between the FAM model (Model III) and Model I



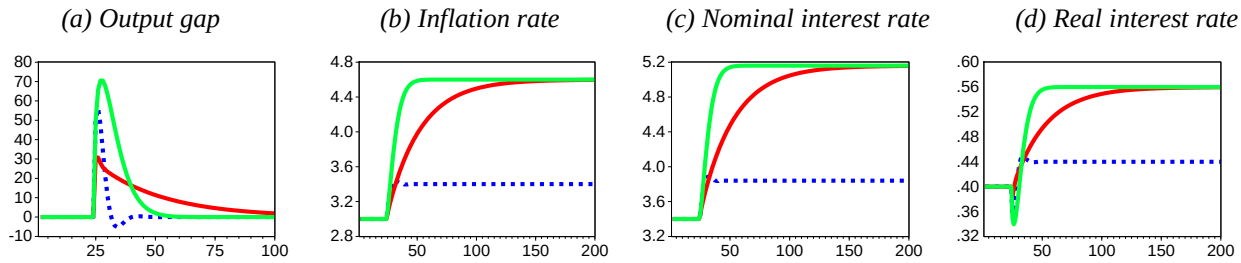
Notes: blue dotted line = benchmark NKE-DSGE model; green line = FAM model. Output gap is measured in conventionally-taken monetary units, whereas the other variables are expressed in percentage points.

Figure 4 Response of New FAM model (Model IV) to a perm. increase in government spending



Notes: blue dotted line = benchmark NKE-DSGE model; red line = New FAM model; other coloured lines = New FAM with higher sensitivities of risk premium to net wealth of firms. Output gap is measured in conventionally-taken monetary units, whereas the other variables are expressed in percentage points.

Figure 5 A new rule for the central bank: targeting the soundness of borrowers' balance-sheets



Notes: blue dotted line = benchmark NKE-DSGE model; green line = FAM model; red line = FAM model with alternative banking rule. Output gap is measured in conventionally-taken monetary units, whereas the other variables are expressed in percentage points.

[1] The standard version of the RBC-DSGE model has been provided by Prescott (1986).

[2] [Note on hard endogeneity of other dissenting approaches (post-k, circuit, Krugman and Eggertsson]

[3] According to McCombie and Pike (2013) these are indeed the «paradigmatic heuristics» (or «pseudo-assumptions») of DSGE models. For a criticism, we refer the reader to Da Silva (2009) and Dullien (2009).

[4] We resume the formulation proposed by Clarida *et al.* (1999). For the sake of simplicity, we neglect the foreign sector. More recently, the reduced-form model has been recovered and amended by De Grauwe (2010). Finally, a critical review is provided, among others, by Arestis and Sawyer (2008).

[5] Notice that values of «deep parameters» of DSGE models (i.e. parameters which are supposed not to be affected by government policy) are usually obtained through either «calibration» methods or Bayesian estimation econometric techniques. For a thorough analysis of this important but controversial issue, we refer the reader to Tovar (2009).

[6] As has been observed, here clearly emerges the separation between demand and supply, with the (growth of) natural output being supply-determined and independent from the (change of) aggregate demand (Fontana, 2010).

[7] Equation (1) is derived by households' consumption equation that arises, in turn, from the single agent's optimal saving allocation. More precisely, it is assumed that agents prefer to smooth consumption over time. Consequently, expectations of higher output next period lead to higher consumption and output today. Similarly, the (real) interest rate level affects the inter-temporal substitution of current vs. future consumption. This, in turn, affects the real unit wage (via the change in the demand of goods and labour services) and, therefore, the supply of labour and output. Consequently, in this model fluctuations in employment and output are «always an *optimal reaction* of households to changes in labour market conditions» (Dullien 2009, p. 13). By contrast, an autonomous investment function of firms is not included in the model, though this is said «not [to] affect any qualitative conclusions» (Clarida *et al*. 1999, pp. 1665-1666).

[8] As has been observed, «[t]here are two assumptions here. The first is that the immediate impact of an increase in aggregate demand falls entirely on output. […] The second assumption is that when output equals it natural rate and there are no inflation shocks, inflation is steady. This assumption fits the evidence that there is inflation inertia» (Romer 2000, p. 158-59). As in the old IS-LM-AS model, output's impact on inflation «can operate directly through firms' price-setting decision, or indirectly through wages. The lack of complete nominal flexibility […] can be justified on the basis of adjustment costs, imperfect competition, or contracts» (Romer 2000, p. 152). Coherently, equation (2) is usually derived «in terms of staggered price-setting by firms with some degree of market power» (Taylor 2000, p. 92). In other words, it is obtained from an explicit optimization problem: that of maximizing profits under a constraint on the frequency of future price adjustments (e.g. Clarida *et al*. 1999, p. 1666).

[9] See Arestis and Sawyer 2002, p. 536; Lavoie, 2006, p. 169. See also Ascari 2009 and DEF 2014.

[10] The natural interest rate is sometimes labelled as the «neutral» interest rate, «since fiscal policy can influence this neutral real rate of interest and so it is not very 'natural'» (Allsopp and Vines 2000, p. 9). Notice that the Taylor rule has been initially obtained as the result of an empirical search (e.g. Taylor 1993, 1994), and not as a normative device. A usual numerical specification of the rule for the US is: $r = 4 + 1.5(\pi - \pi^T) + 0.5Y^g$. Notice also that if the target (real) interest rate did not depend on inflation, its (exogenous) setting would produce explosive inflation or deflation (e.g. Romer 2000). More precisely, without a policy rule, there would be no «nominal anchor», and the inflation rate would be increasing, or decreasing, without limit (Allsopp and Vines 2000, p. 11), except for the equilibrium level of output. Furthermore, a policy rule which just relies on current inflation is not sufficient to (rapidly) remove the effects of a demand shock. The output-gap, and hence the expected inflation, must be explicitly included in the reaction function of the central bank to assure the stability of the economic system.

[11] In algebraic terms: $Y_t^g = a_0 + [a_1 - a_3(1-c_3)c_1]Y_{t-1}^g + a_2 E(Y_{t+1}^g) - a_3\{(1-c_3)[RR^* + c_2(\pi_{t-1} - \pi^T)] + c_3 r_{t-1}\} + \varepsilon_1$. Notice that «[m]ovements along this curve occur when inflation [...] changes and the central bank changes the real interest rate, causing real GDP [...] to change». Notice also that this curve is «the relationship between the *inflation rate* and the real GDP, rather than between the price level and real GDP» (Taylor 2000, p. 92).

[12] Actually, the natural level (or growth rate) of output is not necessarily the one at which all markets clear at a competitive equilibrium, assuring the full employment of labour-force. Rather, it is sometimes described as «that level of output at which 'competing claims' are reconciled'» (Allsopp and Vines 2000, p. 5). The former definition corresponds to the Friedman's one, whereas the latter entails the different concept of the «non-accelerating rate of unemployment» (NAIRU).

[13] Since inflation and output (gap) do not vary in the long-run steady state, the assumption that expected future values equal actual current values is fully rational. To put it differently, agents' expectations are here always correct, except when an exogenous shock occurs. Notice that the assumption of adaptive expectations would not *qualitatively* change the results of the simulation. By contrast, the assumption that expected values to be equal to actual future values would be make the model unstable. A critical analysis of rational expectations in DSGE modelling, along with the proposal of replacing fully rationality with «trial and error» learning of agents, is provided by De Grauwe (2010).

[14] As has been argued, the «reason for fluctuations in output and employment in DSGE models is hence not that wages are sticky and therefore an adjustment of real wages to shocks cannot take place (as it has been in the fixed-wage version of the old neo-classical synthesis) nor is it that aggregate demand can just fall short of supply because of a lack of an inherent tendency to full-employment output (as claimed by the Post-Keynesians). Instead, the reason for fluctuations is that nominal wages are flexible, but prices are not and hence demand shocks change nominal and real wages more quickly than prices which leads to high-frequency changes in the labour supply. The DSGE model is a model in which nominal wages and quantities adjust instantaneously while nominal prices can only adjust with a lag» (Dullien 2009, p. 14).

[15] Similarly, it is possible to show that a negative shock entails a temporary reduction in output (compared to its natural level) coupled with a permanent reduction in inflation and interest rates.

[16] In fact, DSGE modellers «have paid little attention to the role of fiscal policy […]. This has been partly because of the assumption of Ricardian equivalence. As a result, the distribution of taxes across time become irrelevant and aggregate financial wealth does not matter for the behaviour of agents or for the dynamics of the economy because bonds do not represent net real wealth for households» (Tovar 2009, p. 9).

[17] Fiscal policy also affects the effectiveness of the monetary policy. However, NKE authors usually stress that this «certainly does not mean that fiscal policy should not be used». This, rather, means that it should be used as «a policy tool in controlling inflation and in the stabilization of the economy» (Allsopp and Vines 2000, p. 19), and that monetary policy needs to take into account fiscal policy's effects.

[18] As is well known, the natural (or long-run or trend) equilibrium is defined as the state towards which a fully competitive economy would tend in the long run, namely, the state in which inflation expectations of agents are utterly fulfilled. In the natural equilibrium state, output volume and employment rate are determined by three fundamentals: i. the quantity of labour-force and capital (i.e. the stock of resources); ii. the system of preferences of individual agents (i.e. the utility function of consumers or households); iii. the available technology (i.e. the production function of firms).

[19] The raise (reduction) in the interest rate when the inflation rate is above (below) target is called the «nominal-anchor function» of monetary policy; the raise (reduction) in the interest rate in response to a positive (negative) shock affecting the demand is called the «stabilizing function» of monetary policy (e.g. Allsopp and Vines 2000, p. 11).

[20] More precisely, institutions are introduced as *constraints* ruling economic interactions among agents (such as budget constraints, price-setting rules and policy rules).

[21] According to Eggertsson and Krugman (2012, p. 1506), «a temporary rise in government spending will not crowd out private spending, it will lead to increased spending on the part of liquidity-constrained debtors».

[22] Obviously, the following holds: $Y_t = Y_t^n + Y_t^g$.

[23] The revival of the category of the «natural rate of interest», developed in the 1920s by the Swedish economist Knut Wicksell, is the reason why NKE authors are sometimes labelled «Neo Wicksellian» (e.g. Woodford 2003; also Fontana, 2007, 2011).

[24] Similarly, a negative shock would entail a permanent reduction in the natural level of output. Notice that, in simulation of Figure 2, a one-period lag has been introduced in equation (4). The higher this lag, the higher is the hysteresis of output. More in general, lags in equations (1) and (4), including fiscal policy parameter (i.e. α_0), are fundamental, as they rule the reaction of the central bank to inflation and output gaps (e.g. Taylor 2000, p. 92; see also Allsopp and Vines 2000, pp. 9-10).

[25] For an accurate definition of «path dependency» and «hysteresis» in macroeconomics, see Setterfield (2008).

[26] Plainly, if equation (8) were dropped, Model II would behave «normally», that is, after the shock the economy would return to its long-run equilibrium (with the permanent effect being just on inflation and interest rates).

[27] Sociologically, New Keynesians are often policy-concerned men, who are mainly interested in practical implications of the theory. Think of the assumption of price stickiness: although it is regarded by NKE authors as not completely satisfactory in theory (because of the lack of rigorous micro-foundations), it has become the cornerstone of NKE-DSGE models, because it «works beautifully in practice» (Krugman 2000). On the epistemological plan, the very concern for practical policy implications of the models (rather than for their theoretical pureness and logical

consistency) might be regarded as the main Keynesian attribute of NKE. For instance, Bernanke *et al.* (1999, p. 6) argue that they take the NKE-DSGE model as the starting point of their analysis because «it is possible to study monetary policy with this framework».

[28] For a thorough analysis of this aspect, we refer the reader to Major (2012).

[29] More precisely, in the traditional IS-LM-AS model, the real rate of interest affects the IS curve, whereas the nominal rate is relevant to the LM curve.

[30] It is explicitly recognized that «many empirical DSGE models, such as the Smets-Wouters model, make no reference to money, though they include an equation describing monetary policy, and imply that the specification of that equation matters a great deal for the dynamics of both nominal and real variables» (Woodford 2009, p. 13; who refers to Smet and Wouters 2003, 2007). Notice also that, differently from demand shocks, monetary shocks do not entail significant aggregate real effects, because (if money is internal) prices endogenously vary in response to changes in the amount of money. However, this point seems to be understated by many NKE authors.

[31] Notice that Foley and Former (2009, p. 685) explicitly propose to replace DSGE models with agent-based models (ABMs hereafter) which «potentially present a way to model the financial economy as a complex system, as Keynes attempted to do, while taking human adaptation and learning into account, as Lucas advocated». However, it is too early to say whether ABMs could be a helpful alternative to both DSGE models and old-fashioned Keynesian econometric models. A thorough analysis of the current state of formal modelling in economics is beyond the scope of this paper.

[32] According to the EMH, prices of traded assets always reflect all available information. According to the M&MT, under a number of restrictive assumptions, the value of a firm is unaffected by *how* that firm is financed.

[33] As mentioned, in the benchmark NKE-DSGE model (here Model I) investment merely adjusts to fit household inter-temporal preferences.

[34] This cost is also defined as «the inevitable deadweight loss that arises because of asymmetric information» (Bernanke *et al.* 1996, p. 2).

[35] Agency costs incurred by the lender (within FAM models) can be easily compared to the Minskian «objectivation» of the lender's risk into interest rates, fees and commissions, that firms have to pay on external funds (Minsky 1986). However, explicit cites to Minsky's works are very rare. Among the few exceptions, see Bernanke *et al.* (1999), who refer generically to Minsky's theory, and Bernanke (1983) who quotes Minsky (1977). Most recently, Eggertsson and Krugman (2012) explicitly recovered Minsky's theory of financial instability.

[36] The declared reason is that «[f]inancial contracts and institutions are endogenous, so that results that hinge on arbitrary restriction on financial structure are suspect» (Bernanke *et al.* 1996, p. 4).

[37] Notice that we do not introduce any heterogeneity between firms (say, between large corporations and small firms), but only between borrowing firms and lending banks.

[38] According to Calvo (1983)'s approach, «in each period, a firm is only allowed with the probability of $(1 - \theta)$ to reset its price. Thus, θ can be interpreted as a measure of price stickiness» (Dullien 2009, p. 7). Notice that this is none other than a way to make the model reproduce the inertia observed in the empirical data on prices. The rationale is that firms would be constrained in adjusting prices instantaneously.

[39] Choi and Cook (2004) analyse the case of those developing economies which face a mismatch in the currency denomination of their liabilities (denominated in foreign currency) and assets (denominated in domestic currency), coupled with sticky prices.