

# New directions in stabilisation policies\*

RALF FENDEL

## 1. Introduction

An understanding of business cycles and the optimal policy response to their presence still lies at the heart of macroeconomic research. Starting with the contributions of John Maynard Keynes, we have witnessed ongoing intellectual debate on these issues. Despite the knowledge macroeconomists have gained in both empirical and theoretical work, we still lack a clear understanding of the driving forces of business cycles, and thus continue the search for an appropriate policy response.

Recently a new class of models has suggested a fresh approach to business cycle theory. Goodfriend and King (1997) labelled this class of models the “new neoclassical synthesis” (NNS), whereas other authors prefer to call them “new Keynesian models” (Galí 2002). The first title may be an overstatement, and some economists dislike it for this reason (Blanchard 1997). Nevertheless, it indicates one crucial characteristic of the new class of models, which apparently merge two formerly opposed schools of thought. Historically, the first synthesis goes back to Paul A. Samuelson and John R. Hicks who, among other economists in the 1960s, developed and presented the (original) *Neoclassical Synthesis*.

The NNS combines crucial elements of the *New Classical Theory*, especially of the *Real Business Cycle Theory* (RBC-theory), with those of the *New Keynesian Macroeconomics* (NKM). On the one hand, the

---

□ WHU Koblenz - Otto Beisheim Graduate School of Management, Department of Economics, Vallendar (Germany); e-mail: Ralf.Fendel@whu.edu.

\* I am grateful to Matt Canzoneri, Michael Frenkel and two anonymous referees for helpful suggestions and comments, which contributed to improving the paper significantly. The usual disclaimer applies.

new models build on the principles of intertemporal optimisation and rational expectations taken up from the RBC-theory, while on the other hand they utilise the central elements of the NKM, namely imperfect competition, and the dynamic price and wage rigidities caused by costly price and wage adjustments. Arguing that the main merit of the new class of models lies in combining these two distinct types of models, which still seemed irreconcilable just a decade ago, I adopt the term ‘new neoclassical synthesis’ throughout this paper, but nevertheless present a critical discussion of its value added.

Opposing the ‘old synthesis’, the NNS contains elements that lead to very different policy implications, especially with respect to the conduct of monetary policy. However, this new line of research is still evolving, and final assessment of its value added remains arduous. Nevertheless, it has already found its way through the academics into the central banks, and is thus likely to influence the thinking of monetary authorities sooner or later.<sup>1</sup>

This paper aims at providing an introduction into the new class of models without elaborating on all their complexities.<sup>2</sup> To this end, the paper has the following structure: section 2 presents the main features of the new class of models, to some extent separated according to their respective schools of thought; section 3 highlights the transmission mechanisms at work in the new class of models; section 4 revisits the Phillips curve debate in the light of the new approach; section 5 discusses the policy implications; section 6 presents a small-scale model that has become the new ‘workhorse model’; and, finally, section 7 concludes by identifying the main issues for future research.

---

<sup>1</sup> In several central banks there is currently an ongoing effort to integrate crucial elements of the NNS into their macroeconomic models. See, for example, Smets and Wouters (2002) for the European Central Bank.

<sup>2</sup> An excellent reference for the formal and analytical aspects of the NNS models is Canzoneri, Cumby and Diba (2002a) and the derivations that accompany the paper which can be found on Matt Canzoneri’s web page (<http://www.georgetown.edu/faculty/canzonem/canzoneri.htm>). More technical details can also be found in Galí (2002). Woodford (2003) presents a comprehensive treatment of the ongoing research.

## 2. Foundations of the new neoclassical synthesis

In order to understand why the new class of models has been labelled ‘new neoclassical synthesis’ it is useful to review the two main classes of business cycle theories that preceded the new paradigm while at the same time displaying crucial ingredients for the NNS. These theories are the Real Business Cycle Theory and the New Keynesian Macroeconomics. For the sake of brevity I will refer only to their core elements, although behind them is an extensive literature contributing to both approaches.<sup>3</sup>

### 2.1. *The contribution of the Real Business Cycle Theory*

Consideration of the intertemporal optimisation of households and firms with respect to their decisions on consumption and labour supply, as also on investment and labour demand, can be seen as the most crucial and, indeed, innovative element of the RBC-theory. Actually, economists had long held that intertemporal substitution effects lay at the heart of macroeconomics, but had not integrated them into macroeconomic models. Together with (by then already standard) intra-temporal optimisation, the element of intertemporal optimisation was integrated into general equilibrium business cycle models with flexible prices and perfect competition determining market clearing prices and quantities.<sup>4</sup>

Generally speaking, all RBC models yield at least two intertemporal optimality conditions. The first is the well known Euler equation governing the intertemporal path of consumption,<sup>5</sup> the second a relation governing the allocation of labour, which depends on the expected time path of wages. Due to flexible prices and wages, business

---

<sup>3</sup> For a broader presentation of the main classes of business cycle theories see Arnold (2002).

<sup>4</sup> See, for example, Cooley (1995) for a representative sampling of the RBC literature.

<sup>5</sup> The consumption Euler equation represents the modern theory of consumption developed, among others, by Hall (1978 and 1988a), which implies that an intertemporally efficient consumption plan equates the cost of foregone consumption today and the benefits of increased consumption in the future. The Euler equation is derived from the household’s optimal saving decision.

cycles are interpreted as equilibrium phenomena with no involuntary unemployment.<sup>6</sup> Rather, households and firms respond optimally to shocks with voluntary variations in labour and, hence, production, their response being driven by substitution and wealth effects. This characteristic reflects the quest for a solid microfoundation of macroeconomic models expressed in the form of marginal conditions which govern the behaviour of agents.<sup>7</sup>

Shocks to productivity are regarded as the main driving force behind the substitution and wealth effects, and thus constitute the main reason for the cyclical behaviour of output and employment. This also means that the supply side is regarded as the crucial part of the economy when it comes to explaining business cycles. The approach takes into account that productivity shocks measured by the Solow residual exert two distinct effects. First, they change output given any amount of input, and secondly they may change the amount of inputs: in fact, bringing about changes in the intertemporal wage and interest rate structure, they work through the first order marginal conditions. On account, above all, of the latter, productivity shocks have to be distinguished according to their degree of persistence: while permanent productivity shocks do not cause any substitution effects, temporary shocks certainly do.

Fiscal shocks also play an important role in the RBC models. For example, variations in income taxes have effects on economic activity due to their influence on the first order marginal conditions which, in turn, trigger substitution effects. Imagine, for example, a tax  $\tau$  on labour income and the following production function in labour ( $n$ ) and capital ( $k$ ):  $y_t = a_t F(n_t, k_t)$ , with  $a_t$  being a technology parameter. Then, given a perfectly competitive labour market, the after-tax real wage rate at time  $t$  can be expressed as

---

<sup>6</sup> However, this is not the case in all RBC models: see, e.g., the search unemployment models by Andolfatto (1996) or Merz (1995).

<sup>7</sup> However, a note of caution should be added here. To be borne in mind is the criticism levelled at this approach emerging from the 1960s debate on capital theory underlying those models including questioning many elements: the inverse relationship between real wage and employment, the formulation of an aggregate production function and U-shaped cost curves (i.e., the convexity of production sets). This criticism would consider the microfoundation of the models under consideration as far from solid. According to this criticism, the microfoundation of the models under consideration is far from solid. For more explicit illustration see Sylos Labini (1988).

$$w_t = (1 - \tau)a_t \frac{\partial F(n_t, k_t)}{\partial n_t}. \quad (1)$$

Thus, from the point of view of the marginal return of labour, the tax resembles the productivity parameter. In RBC models, an increase in the tax rate has practically the same consequences as a negative technology shock (McGrattan 1994).<sup>8</sup>

Despite the integration of intertemporal aspects, the RBC models also introduced some 'technical advances' into macroeconomics. RBC researchers constructed models in which alternative policies can be compared on the basis of measures of utility benefits and costs rather than *ad hoc* objectives.<sup>9</sup> The models also allow for analysis of the effects of policy changes and other shocks in the dynamic stochastic context of a fully specified system as required by the logic of rational expectations. The theoretical RBC models also come closer into line with the current methodology of empirical research. In particular, the numerical solutions obtained with the RBC models are directly comparable to the impulse response functions derived from VAR analyses.

The marked monetary neutrality built into the RBC models precludes meaningful analysis of monetary policies, while the close correlation of money and output over the business cycle is mainly explained by endogenous variations in money supply. This leaves the RBC models somewhat incomplete for the purpose of analysing monetary policy and, therefore, rather less attractive in terms of policy support.

## 2.2. *The contribution of New Keynesian Macroeconomics*

The *New Keynesian Macroeconomics* provides a competing explanation for the existence of business cycles based on nominal rigidities and market imperfections compatible with rational expectations. While

---

<sup>8</sup> However, there remains a difference. While a negative technology shock results in a fall in both real wages and the real interest rate, an increase in the wage tax reduces labour supply, increases the capital intensity and, hence, results in a fall of real wages and an increase in the real interest rate.

<sup>9</sup> However, one could also argue that while this means some technical advances in the analysis, there is also a step backwards since it implies a mono-dimensional notion of the economic agent.

early contributions focused on the role of rigid wages, the more recent literature assumes price rigidities in the goods markets, the shift in emphasis also leading to increased interest in monopolistic price setting power in the goods markets.

In a prototype NKM model, monopolistic firms are specialised in the production of one particular differentiated consumption good,  $c(z)$ , all the differentiated goods combining to form a composite consumption good,  $C$ , according to the CES function

$$C_t = \left[ \int_0^1 c_t(z)^{\frac{\varepsilon-1}{\varepsilon}} dz \right]^{\frac{\varepsilon}{\varepsilon-1}}, \quad (2)$$

where  $\varepsilon > 1$  displays the constant elasticity of substitution among individual goods.<sup>10</sup> It also measures the degree of monopoly power of individual firms. Intra-temporal allocation of consumption by households leads to the demand function that each firm faces:

$$c_t(z) = \left( \frac{p_t(z)}{P_t} \right)^{-\varepsilon} \cdot C_t, \quad (3)$$

where  $p_t(z)$  is the price of an individual consumption good and  $P_t$  is the aggregate price level defined as the minimum expenditure for one unit of the composite consumption good given individual prices:

$$P_t = \left( \int_0^1 p_t(z)^{1-\varepsilon} dz \right)^{\frac{1}{1-\varepsilon}}. \quad (4)$$

Monopolistic firms set profit maximising prices with a constant mark-up over nominal marginal costs,  $\psi_t$ . The size of the mark-up is given by the conventional formula and depends on the degree of monopoly power a firm has:

$$p_t(z) = \frac{\varepsilon}{\varepsilon-1} \cdot \psi_t. \quad (5)$$

The most crucial assumption in the NKM is price stickiness, whose extent and precise form varies across models. In the simplest formulation, prices are fixed for just one period for all firms, which enables

---

<sup>10</sup> The number of firms (and, thus, goods) is normalized to one.

researchers to find a closed-form solution for the model. However, this formulation is empirically unsatisfactory since it leads to discrete jumps in the price level rather than observed gradual adjustment. The alternative is dynamic formulation, and the NKM literature shows two popular approaches.<sup>11</sup> The first – staggered price setting due to deterministic contracts (Taylor 1980) – was originally developed for labour contracts, and postulates that firms and workers set a fixed wage over a contract length of, say,  $J$  periods. Wage bargains are assumed to be staggered through time with  $1/J$  of the contracts set each period, which means that only a  $1/J$  fraction of all wage rates is considered flexible. Since rational agents know that they will lack the ability to adjust wages over the life of the contract, the contracts are forward-looking in the sense that expected price developments will be priced in. The same reasoning applies if price stickiness is modelled instead of wage rigidity. Expected changes in marginal costs are taken into account in the pricing decision.

In contrast to the Taylor contracts, Calvo (1983) assumes that for each firm the possibility to adjust prices optimally arrives stochastically. Again, this leads to forward-looking pricing decisions on the part of firms, since they recognise that the chosen price will be constant for a stochastically determined period. Notwithstanding the stochastic nature of the pricing process, it leads to a very neat aggregate formulation of the overall price level which makes the Calvo mechanism somewhat superior to the Taylor-pricing mechanism from the purely modelling point of view. In the end, both mechanisms lead to a slow adjustment of the overall price level which is much more in line with the empirical evidence than the (synchronised) static formulation of one-period price stickiness for all firms. However, this comes at the price of rather complex model dynamics that can only be established by calibrated simulation exercises rather than closed form solutions.

The fact that prices in the NKM models exceed marginal costs helps to rationalise the assumption that at least in the short run (defined as the duration of complete wage and price adjustment) the aggregate output is determined by demand. Otherwise a firm would have no incentive to step up output at a given price when faced with

---

<sup>11</sup> See Taylor (1999a) for a comprehensive treatment of price and wage setting behaviour in macroeconomic models.

an expansion in demand.<sup>12</sup> This makes the demand side of the economy the crucial driving force for business cycle fluctuations. By the same token, monetary policy has real effects in the short run.

### 2.3. *The unifying characteristics of the new synthesis*

Intertemporal utility functions, originally introduced by RBC researchers, lie at the heart of the NNS models. By adopting them within a stochastic general equilibrium framework, explicit utility-based welfare analysis can be performed on the consequences of alternative policies.<sup>13</sup> Despite varying parameters in the presence of different models, the utility functions always have at least two standard arguments: consumption and leisure (or the disutility of work as its negative representation). Whether real money balances are also incorporated depends on how money is introduced into a particular model. If no cash in advance constraint is modelled, money is an additional argument in the utility function due to the transaction services it provides.<sup>14</sup>

Together with an intertemporal budget constraint and a solvency condition, the utility function establishes a well-defined optimisation problem for the individual household. She has to choose 1) the allocation of her consumption over time (i.e., bond holdings),<sup>15</sup> 2) her work effort,<sup>16</sup> 3) her real money balances and – depending on the formulation of the model – 4) investment in physical capital. These

---

<sup>12</sup> However, there is a limit up to which firms are willing to expand output, because marginal costs may not be constant. This limit, often ignored in the models, is known as ‘participation constraint’. If taken seriously, it would pose some technical difficulties since it leads to discontinuities that are hard to handle (Canzoneri, Cumby and Diba 2002a).

<sup>13</sup> In the following paragraphs, I focus on closed economy models, although one important area of research are open economy models. For these approaches see, for example, Gertler, Gilchrist and Natalucci (2001) and Clarida, Gali and Gertler (2001 and 2002).

<sup>14</sup> An alternative formulation would be a ‘shopping time technology’ or a ‘cash-in-advance constraint’. See, for example, King and Wolman (1996) and Cooley and Hansen (1989) for such formulations.

<sup>15</sup> It is to be borne in mind that the intratemporal allocation of the consumption expenditure among the differentiated consumption goods resulting from the static optimization problem is already given by equation 3.

<sup>16</sup> In some simple formulations consumers and producers are merged to a ‘yeoman farmer’. Such models, without the explicit modelling of firms, limit the analysis and are not the main scope of this paper.



choices constitute four optimality conditions. The allocation of consumption is governed by the Euler consumption equation, while the work effort and, hence, production is determined by a marginal condition that equates the marginal disutility of work to marginal utility of the extra revenue available for consumption. Real money balances are pinned down by the third marginal condition, which leaves the household indifferent between consuming a unit of the composite consumption good in the current period and holding the equivalent amount of money in order to raise utility-providing cash balances and use the funds for consumption in the future. The fourth marginal condition leads to a no-arbitrage-condition.

Firms produce the differentiated goods by employing labour and capital. The technology is described by a production function whose productivity parameter is subject to stochastic shocks. As described before, firms possess monopolistic power and set prices above marginal costs. Let  $\mu [= \varepsilon/(\varepsilon - 1)]$  denote the mark-up; then, the first-order condition leads to optimal labour demand (i.e., the value marginal product of labour is equated to the nominal wage rate,  $W$ ) as<sup>17</sup>

$$W_t = \frac{P_t}{\mu_t} a_t \frac{\partial F(n_t, k_t)}{\partial n_t}, \quad (6)$$

And, after dividing both sides of equation 6 by the price level, the real wage can be expressed as

$$w_t = \frac{1}{\mu_t} a_t \frac{\partial F(n_t, k_t)}{\partial n_t}. \quad (7)$$

The market clearing condition ensures that production equals demand in each period. While in the short run prices are fixed and production is driven by demand following the New Keynesian avenues, the long-run equilibrium is characterised by optimal prices and the corresponding natural level of economic activity.<sup>18</sup>

If price stickiness takes the form of staggered price setting, the economy described above is generally characterised by 4 distortions

---

<sup>17</sup> Note that the monopolist has to lower prices in order to increase its sales due to the negatively sloped aggregate demand function 3. This makes the marginal revenue less than the current price by an amount driven by the monopoly power (which determines the size of  $\mu$ ).

<sup>18</sup> I will only deal with staggered price setting in this paragraph and introduce sticky wages at a later stage. As can be shown, the coexistence of staggered price and wage setting has crucial implications for monetary policy.

that justify economic policy interventions (Galí 2002). The first distortion results from money holding. Private agents allocate part of their wealth to non-interest rate bearing monetary assets, which means that private opportunity costs of holding money coexist with zero social costs of producing money. This generates a *monetary distortion*, which could be eliminated by a zero nominal interest rate. This recommendation is the well-known Friedman rule.

The second distortion is reflected in the first-order condition 7 and results from the existence of monopolistic power. Prices are, on average, above marginal costs so that the marginal rate of substitution between consumption and leisure (i.e., the real wage) differs from the corresponding marginal rate of transformation (i.e., the marginal product of labour). With this *average mark-up* distortion output is seen to come short of the social optimum (Blanchard and Kiyotaki 1987). Note that the two distortions described so far are also at work in the case of full price flexibility: they are not related to the presence of nominal rigidities. Consequently, in order to work out the crucial new elements, we follow the NKM literature and assume that a comprehensive government subsidy financed in a non-distorting way takes care of both, so that we can ignore them.<sup>19</sup>

This leaves us with two remaining distortions that are directly related to the price stickiness and the staggered nature of price adjustment. The third distortion, called *dynamic mark-up distortion*, is caused by the inability of a fraction of firms to adjust prices instantly, which leads to persistent deviations of the mark-ups from their frictionless (constant) level given in equation 5. Variations in marginal costs in the presence of sticky prices will lead to an endogenous fluctuation in the mark-ups and, thus, let the static mark-up distortion discussed above switch to dynamic. From equation 7 we see that variations in  $\mu$ , in principle, have the same consequence for the first order principles as variations in tax rates in equation 1.

The fourth distortion stems from the lack of synchronisation in price adjustment after a shock (i.e., the staggered price setting) and the implied coexistence of different prices until the very last firm has the opportunity to adjust prices. This means that different quantities are produced (and consumed) for goods that enter the consumer preferences symmetrically and have a marginal rate of transformation of

---

<sup>19</sup> See Canzoneri, Cumby and Diba (2002a) for its implementation.

one-to-one. This relative price distortion gives rise to inefficiency in the allocation of resources within the economy. The latter two distortions have their origin in the presence of sticky prices and present a source of the non-neutrality of money within the NNS framework (Goodfriend and King 1997).

If the assumption of sticky prices is replaced by flexible prices, all firms are able to adjust prices optimally each period, taking the path of aggregate variables as given. The assumption of an isoelastic demand implies that they choose a mark-up given in equation 5. The mark-up will be the same across firms and constant over time. This implies that the real marginal costs ( $\psi/P$ ), i.e., the inverse of the mark-up, are also constant. All other variables (i.e., consumption, production, work effort and the real interest rate) are then also at their natural level. This equilibrium allocation under flexible prices coincides with the efficient allocation, i.e., the one that would be obtained under flexible prices, with no distortionary taxes and perfect labour competition. Under flexible prices, the equilibrium values of all real variables are independent of monetary policy, so that the classical dichotomy holds. This model version resembles the various versions of a pure, albeit non-competitive, RBC model (Goodfriend and King 1997, p. 279).

Under fixed prices, firms do not adjust their prices optimally each period and, thus, real marginal costs and mark-up are no longer constant. After a shock, there is a gap between the actual and desired (equilibrium) mark-up. Consequently, real marginal costs also deviate from their steady state level. Equation 7 already shows that variation in the mark-up influences economic activity through the first-order condition. Let us imagine a monetary expansion which translates into higher demand and rising nominal marginal costs. Now, the inability of some firms to increase their output prices leads to an increase in the average real marginal costs and, thus, to a decline in the average mark-up.<sup>20</sup> Through the first-order condition 7, this leads to higher production. Production deviates from its (natural) flexible price level, i.e., an

---

<sup>20</sup> To be more precise, two measures of the mark-up have to be distinguished: the *average mark-up* and the *marginal mark-up*. As suggested above, the average mark-up plays a prominent role in the transmission of monetary policy. At any point in time, though, a subset of firms have the possibility to adjust their prices and set a new mark-up level, which is the marginal mark-up. For detailed analysis of the cyclical behaviour of marginal costs see Rotemberg and Woodford (1999).

output gap opens.<sup>21</sup> Hence, monetary policy does have real effects. But, in sharp contrast to the traditional Keynesian view, it works through the channels of RBC models. Thus, Keynesian-style fluctuations originating in nominal rigidities are explained within the RBC logic.

However, it is not only the dynamic mark-up distortion that leads to the real effects of monetary policy that can be explained within the RBC logic since the relative price distortion also does. In order to explain this in a relatively heuristic way, I first express potential output  $Y_t^*$ , neglecting any demand restrictions, as the aggregate over the production of differentiated goods  $y(z)$  (see Yun 1996, p. 355):

$$Y_t^* = \int_0^1 y_t(z) dz. \quad (8)$$

This coincides with the flexible price (natural) level of output. However, we know that, under fixed prices, production is determined by demand according to expression 3. Market clearing also implies  $C_t = Y_t$ , so that equation 3 becomes

$$y_t(z) = \left( \frac{p_t(z)}{P_t} \right)^{-\varepsilon} \cdot Y_t. \quad (9)$$

Substitution equation 9 into equation 8 yields, after rearranging:

$$Y_t = \frac{1}{\int_0^1 \left( \frac{p_t(z)}{P_t} \right)^{-\varepsilon} dz} \cdot Y_t^*. \quad (10)$$

Expression 10 highlights the fact that the relative price distortion works like the variation in total factor productivity within RBC models (Goodfriend and King 1997, p. 259). Unless the relative price is equal to one, which is the flexible price equilibrium level due to the high degree of symmetry within the model, actual output deviates

---

<sup>21</sup> Since the models present transitory departures of output from its potential level and, subsequently, give attention to the adjustment of prices and inflation expectations as the process through which actual output adjusts toward potential, some authors describe the new style of models as 'neomonetarist' (see Kimball 1995). This, again, seems to justify the use of the term 'new neoclassical synthesis' since both schools of thought seem to identify with the new class of models.

from its natural level and an output gap is produced. Again, money is not neutral.

In the NNS models, monetary policy is often modelled in terms of rules, taking the form of instrument rules – either money growth rules or interest rates rules. Taylor-type rules modelling the interest rate reaction of the central bank according to the development of inflation (relative to its target level) and the output gap often prove particularly popular. In simulation exercises the relative performance of alternative rules can readily be evaluated in terms of output and inflation dynamics, as also in terms of utility.<sup>22</sup>

### 3. The transmission of shocks

The presence of sticky prices has additional implications for the economy's response to non-monetary shocks, over and above that of being the source of the non-neutrality of money. The exact dynamics following a specific shock depend on the parameterisation of the NNS models. As mentioned above, once a dynamic price and wage setting behaviour is taken into account, no closed-form solutions can be obtained. Rather, the models have to be calibrated and choices made for the elasticities of intra- and intertemporal substitution, as also of labour supply, money demand, and so on. Instead of presenting one specific calibration, I prefer to highlight the 'core dynamics' that seem to be present across a wide range of parameter sets. I will first focus on a money shock, and subsequently on a technology shock.

As pointed out above, money is not neutral and works through the mark-up mechanism in the NNS framework. Standard calibrations lead to surprisingly large values of output fluctuations that can even surpass observed US postwar experience. Additionally, the effects are fairly persistent, especially if the Calvo mechanism of stochastic price adjustment is modelled. For example, Galí (2002) reports a half life of the output response to a one-standard deviation money supply shock of 3.2 quarters with a Calvo mechanism that implies an average price duration of only 4 quarters. With a deterministic adjustment in prices

---

<sup>22</sup> See section 5 for more extensively elaborated discussion on these issues.

it is more difficult to generate significant effects of money on output beyond the duration of prices (Chari, Kehoe and McGrattan 2000).

An interesting feature that points to the difference between the NNS and former models of non-neutral money is the presence of a liquidity effect, i.e., a declining nominal interest rate after an increase in money. Across some calibration ranges (but not all) in the NNS models, a monetary expansion raises the nominal interest rate. Thus, some of the NNS models fail to predict the existence of a liquidity effect (for example, Galí 2002), but this does not prevent monetary policy from transmitting its effects through an interest rate channel. In this case monetary policy works through a decline in the *ex ante* real interest rate and, thus, through the intertemporal allocation of consumption via the Euler condition.<sup>23</sup> Actually, the absence of a liquidity effect is at odds with the empirical evidence but, on the other hand, it does bring out in all evidence the fact that the transmission channels at work in the NNS are very different from those of the traditional Keynesian models.

Exogenous variations in technology have been claimed to be the main source of the observed cyclical behaviour of output by the proponents of RBC models. According to the traditional, flexible price, perfectly competitive RBC models, positive technology shocks lead to positive output and employment effects, so the question that naturally arises at this point is what the consequences of technology shocks are within the NNS models. Recently, some authors have mentioned a surprising aspect of the interaction between sticky prices and technology shocks within the NNS framework (e.g., Galí 1999). A favourable technology shock is likely to induce a short-run decline in employment, as long as the response of monetary policy falls short of full accommodation. Again, this result is not necessarily the outcome of the technology shock in this model but holds for a large subset of parameter values.

In order to see the intuition behind this result, let us take the case of a positive technology shock and assume that monetary policy does not react. All firms experience a decline in their marginal costs, but only a fraction are able to react with lower prices. Accordingly, the aggregate price level will fall and demand will rise, but less than

---

<sup>23</sup> See Christiano, Eichenbaum and Evans (1997) for more probing discussion of the lack of the liquidity effect and alternative mechanisms to restore it.

proportionally to the increase in productivity due to the staggered price adjustment. Depending on the relative size of the partial effects this may bring about a decline in employment, since more output can be produced with less input after the productivity increase. This is clearly at odds with the implications of the standard RBC model, which predicts a strong co-movement in productivity, output and employment.

The contrast in the model's prediction for the relation between employment and technology shocks has clear, testable implications, and it leads to the question as to what the empirical evidence tells us about the correlation between productivity and employment. However, an empirical examination of the correlation between productivity shocks and employment is no easy task. The Solow residual used by RBC researchers is not a good measure of productivity changes since it is biased in several dimensions. Hall (1988b), for example, starts from a production technology with fixed costs that is consistent with monopolistic competition and demonstrates that a Solow decomposition leads to the consequence that the Solow residual varies with the business cycle even if there is no productivity shock. Measurement errors and labour hoarding are other reasons that disprove the Solow residual as a reliable indicator for technology shocks.

Basu, Fernald and Kimball (1998), therefore, construct a measure of aggregate technology by controlling for possible non-technological effects in the aggregate Solow residual: increasing returns, imperfect competition, varying utilisation of capital and labour, and aggregation effects. Their corrected technology residual shows a variability over time that is only about one-third of the Solow residual variability. In addition, although the Solow residual is strongly procyclical, technology fluctuations tend to be countercyclical contemporaneously; they have a significantly negative correlation with inputs and a near-zero correlation with output. According to the authors' analysis, technology improvements lead to a reduction in employment within the year, but eventually to an increase, with a lag of up to two years.

Recently, researchers have tried to identify technology shocks within structural vector auto-regression (VAR) analyses. In these studies the main challenge is that of formulating identifying assumptions that rely on relatively few *a priori* restrictions. One approach, for example, is to assume that technology shocks are the only source of disturbances that affect the level of labour productivity in the long

run (Galí 1999; Altig *et al.* 2002). The existing VAR literature on the influence of technology shocks on employment is somewhat mixed, and the issue remains open. Galí (1999) claims that in response to a positive technology shock labour productivity rises by more than output, while employment shows a persistent decline.<sup>24</sup>

By contrast, Altig *et al.* (2002), who in principle use the same methodology as Galí (1999), find that a positive technology shock drives up hours worked, investment and output. According to their analysis, the difference to the literature asserting the negative correlation between productivity and employment comes from an omitted variable bias and an overdifferencing of employment data, constituting a flaw in this literature.<sup>25</sup> However, both studies derive the same result, namely that technology shocks account for only a small fraction of business cycle fluctuations (so that technological shocks cannot have been the major source of business cycle fluctuations as claimed by RBC proponents).<sup>26</sup>

#### 4. Revisiting the Phillips curve

The Phillips curve debate has always been at the heart of discussion on business cycle theories, competing theories being reduced to their Phillips curve implications. Not surprisingly, the NNS also has some crucial implications for the Phillips curve that differ from those of former theories. They can be derived in an intuitive way within the model framework set out above.<sup>27</sup> To begin with the similarities, the ‘new’ Phillips curve consists of the two elementary terms that are also present in the traditional Phillips curve. The first is an inflation term,

---

<sup>24</sup> See Francis and Ramey (2001) who support Galí’s analysis. However, Shea (1998) finds a decline in labour as a long run response, while it rises in the short run. It should also be mentioned here that Shapiro and Watson (1988) uncovered this result a decade before, but it went unnoticed (see Figures 2 and 5 in their paper).

<sup>25</sup> The possibility of overdifferencing the employment data arises from the stationarity issue in time series econometrics. While Galí (1999) works with first differences due to non-stationarity in levels, Altig *et al.* (2002) use levels in hours worked. The latter authors also include more explanatory variables in their analysis.

<sup>26</sup> However, the debate still seems unresolved. See also Galí (2004), Uhlig (2004) and Christiano, Vigfusson and Eichenbaum (2004).

<sup>27</sup> For its analytical derivation see, for example, Woodford (2003, chapter 3.2).



the second a measure of economic activity, but their precise functional form and their meaning differ.

The inflation term of the new Phillips curve is forward looking. This forward-looking nature of inflation is inherent in the NNS models. Prices are set by firms under constraint in the frequency with which they can re-set the prices of their goods. Today all firms able to re-set their prices recognise this constraint, and it is optimal for them to take into account their expectations regarding future costs and demand conditions. Since the change in the aggregate price level results from individual pricing decisions, inflation must have a forward-looking component.

As mentioned above, the average mark-up is of crucial importance for the cyclical behaviour of the economy. Variations in the average mark-up also imply variations in real marginal costs and, given equation 5, the desired equilibrium mark-up is accompanied by an equilibrium level of the real marginal costs ( $mc^*$ ). Once the firm has the opportunity to re-set prices, it will apply the desired mark-up. Price changes are therefore a function of the gap between the actual mark-up and the desired equilibrium mark-up. Thus, they are also a function of the gap between existing real marginal costs ( $mc_t$ ) and the equilibrium level of real marginal costs defined as  $\Delta mc_t = mc_t - mc^*$ .

In sum, the inflation dynamic can be expressed as

$$\pi_t = \beta E_t \{ \pi_{t+1} \} + \lambda \Delta mc_t, \quad (11)$$

where  $E_t$  is the expectation operator,  $\beta$  is a discount factor and the parameter  $\lambda > 0$  is a function of the probability of a price change within the Calvo mechanism described. Additionally, it is possible to derive a stable relationship between the deviation of real marginal costs from its equilibrium level and the output gap  $\hat{y}_t$ , defined as the log deviation of output from its equilibrium level:<sup>28</sup>

$$\Delta mc_t = \theta \cdot \hat{y}_t, \quad (12)$$

where the parameter  $\theta > 0$  is a function of the model's parameter, e.g. the intertemporal elasticity of substitution. Combining equations 11 and 12, the new Phillips curve is conventionally expressed as

---

<sup>28</sup> Formally, the Phillips curve is simply a log-linear approximation about the steady state of the aggregation of the individual firm pricing decisions. See Galí (2002) for the derivation.

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \kappa \hat{y}_t + u_t, \quad (13)$$

with  $\kappa = \lambda\theta$ , and the shock term  $u_t$  is referred to as a ‘cost push’, capturing deviations from the relation 12.<sup>29</sup> By contrast, the traditional expectation-augmented Phillips curve has the following functional form:<sup>30</sup>

$$\pi_t = E_{t-1} \{\pi_t\} + \chi \hat{y}_t + v_t, \quad (14)$$

where often static expectations of the form  $E_{t-1} \{\pi_t\} = \pi_{t-1}$  are imposed. Disregarding the differences in the parameters  $\chi > 0$  and  $\kappa$  in equations 13 and 14, the crucial difference between the two Phillips curves is the degree of their forward-looking nature.<sup>31</sup>

In the traditional Phillips curve, past inflation counts in determination of current inflation and current inflation is positively related to current output. In other words, output leads inflation. This property stands in sharp contrast to the implication of the new Phillips curve. In order to illustrate this, equation 13 is iterated forward to get:

$$\pi_t = E_t \left\{ \sum_{k=0}^{\infty} \beta^k (\kappa \hat{y}_{t+k} + u_{t+k}) \right\}. \quad (15)$$

Expression 15 indicates that past inflation is not a relevant factor for current inflation. Furthermore, inflation is positively correlated with

<sup>29</sup> A note on parameter  $\beta$  is called for. This parameter stems from the fact that price setters discount the future in their forward-looking pricing decision from which the new Phillips curve is derived. However, this discounting of the future introduces a long-run trade-off between inflation and output. In order to avoid this undesirable feature, the parameter is often fixed to unity, which is identical to the assumption that price-setters do not discount the future.

<sup>30</sup> However, Mankiw and Reis (2002) recently showed how the traditional Phillips curve can be derived under totally different assumptions. The authors assume sticky information instead of sticky prices, and the essence of their model is that information about macroeconomic conditions diffuses slowly through the economy. The model combines elements of Calvo’s (1983) model of random price adjustment with elements of the Lucas (1973) model of imperfect information. In some ways, the dynamic response in the sticky information model resembles Phillips curves with backward-looking expectations.

<sup>31</sup> Here we must point out that this form of the new Phillips curve can only be derived with the Calvo pricing mechanism. Using the Taylor pricing mechanism instead would yield additional lagged inflation terms, which then would lead to a hybrid form of the Phillips curve with forward- and backward-looking inflation terms present at the same time.

future output and expected cost pushes.<sup>32</sup> What this boils down to is that inflation leads output. The reason for this forward-looking nature of inflation is quite intuitive. With staggered price setting, the pricing decisions that generate the behaviour of the aggregate price level are based on current and anticipated developments of marginal costs, which are in principle unrelated to past inflation (Galí 2002).

Currently the empirical validity of the new Phillips curve is being debated in the literature. A number of authors argue that the new Phillips curve may theoretically be very appealing, but it cannot account for some features in the data that are well explained by the traditional Phillips curve. For example, the cross-correlation between inflation and de-trended output suggests that output leads inflation (Fuhrer and Moore 1995). Not surprisingly, estimations of hybrid Phillips curves that contain lagged and leading inflation terms generally find a (sometimes totally) dominant influence of lagged inflation on current inflation (e.g., Fuhrer 1997), which again argues in favour of the traditional Phillips curve.

More recently a number of authors have challenged this view (Galí and Gertler 1999; Galí, Gertler and López-Salido 2001), arguing that such results cannot be taken as evidence against the new Phillips curve, because de-trended output, no matter which method for de-trending is applied, is not a correct proxy for the output gap in the NNS models. This, according to the authors, is a potential source of misleading results. In the NNS, the output gap has a very precise meaning, being the deviation of output from its equilibrium level in the absence of nominal rigidities. Traditional output gap measures based on de-trended output might prove poor proxies in this respect.<sup>33</sup>

To overcome this problem, the above-mentioned authors estimate equation 11 as a test for the validity of the forward-looking nature of inflation instead, which means that condition 12 is no longer required to hold. The difficulty is to find a proxy for real marginal costs. Here, it proves favourable that, under certain assumptions about technology and price setting behaviour, real marginal costs are pro-

---

<sup>32</sup> The cost-push term vanishes if we assume a zero mean. However, some authors introduce a serial correlation of this disturbances term (e.g., Clarida, Galí and Gertler 1999).

<sup>33</sup> There are several alternatives to measure the trend. Among them are 1) linear or quadratic time trends, 2) a Hodrick-Presscott filtering and 3) estimates of potential output.

portional to labour income shares. The findings of such alternative tests – based on data for the US and the euro area – have so far been interpreted as reasonably encouraging for the new Phillips curve (Galí 2002). In particular, parameter estimates imply an average price duration of one year for a firm, which is consistent with survey data (Taylor 1999a). However, future empirical work will have to clarify the issue.

## 5. Monetary policy implications

The NNS models have crucial implications for the conduct of stabilisation policies. Because nearly all models are based on Ricardian equivalence, the emphasis clearly lies on issues of monetary policy.<sup>34</sup> Optimal monetary policy in the NNS framework requires stabilisation of production at the natural level that would emerge for it under full price flexibility. Interestingly, for a range of NNS models no trade-off between output and price stabilisation appears. Full stabilisation of output is exactly guaranteed when the price level is fully stabilised, i.e., in the presence of zero inflation. In contrast to conventional wisdom, this may be seen as a somewhat provocative finding.

The exact nature of monetary policy is defined by the presence of the (dynamic) distortions described above. The underlying logic is quite simple: since prices cannot react flexibly enough to restore the optimal allocation immediately following a shock, monetary policy should instead react in such a way as to discourage firms from resetting their prices at all. This policy requires to counteract demand disturbances fully and accommodate technology shocks perfectly (see Clarida, Galí and Gertler 1999, pp. 1674 ff.).

As already mentioned, in these models monetary policy is often expressed in terms of monetary policy rules. These rules can either be exogenous or endogenous (optimal). Optimal rules are based on the minimisation of a quadratic loss function expressed as the weighted

---

<sup>34</sup> Research on fiscal policy in the context of the NNS models has only recently received more attention. See, for example, Linnemann und Schabert (2003) for the analysis of fiscal policy within the new neoclassical synthesis as well as Beetsma and Jensen (2002) for the interaction of fiscal and monetary policy within a monetary union.

sum of the variance of inflation and the output gap (and possibly additional arguments).<sup>35</sup> Such a loss function represents the quadratic (second-order Taylor series) approximation to the level of (expected) utility of the representative household in the rational expectation equilibrium associated with a given policy. Thus, there is a direct relation between the goals of monetary policy and the utility function of a representative household that lies at the heart of NNS model, which makes the households' utility a natural normative measure of monetary policy. In this respect, the approach to optimal monetary policy recalls the models in public finance literature. Reformulation of the utility function in a quadratic loss function is convenient for two reasons above all: first, the nature of optimal monetary policy can be addressed in terms of a linear-quadratic optimal control problem that has been extensively studied, and secondly the results are comparable with those of the traditional literature on monetary policy evaluation, which almost always assumes such linear-quadratic loss functions.<sup>36</sup>

Subsequently, the specific example of a technology shock should illustrate the design of the optimal monetary policy. Following a technological improvement, all firms face a decline in their marginal costs, but only a fraction are able to adjust prices and set the optimal mark-up instantly. We have already seen that this can lead to a decline in production and employment. A demand expansion caused by an accommodating monetary policy can offset this effect, stabilising the price level and the level of output at the same time.

The general logic of the monetary policy response can be understood in the light of the RBC tradition. If a technology shocks hits the economy, it is optimal to redirect production to the present. In a standard RBC model, flexible prices would automatically create this effect, but here, given the rigidities, this is not possible. This is where monetary policy comes in. However, the ideal result of full stabilisation can only hold if technology shocks are not sector specific. If, on the other hand, the monetary authorities face sector specific technology shocks, even in the theoretical framework full stabilisation is no longer possible (Canzoneri, Cumby and Diba 2002a). Moreover, once we allow for the coexistence of staggered prices and wages, monetary policy is also no longer able to achieve the optimal allocation that

---

<sup>35</sup> An alternative approach would be the modeling of so-called Ramsey policies.

<sup>36</sup> See Woodford (2003, chapter 6) for an extended presentation and discussion.

would occur under completely flexible prices and wages. Instead, the model exhibits a trade-off in stabilising the output gap, price inflation and wage inflation (Erceg, Henderson and Levin 2000). The optimal policy has to strike a balance between the stabilisation of these three variables.

In order to be able to replicate the flexible price solution in response to a technology shock, the monetary authorities need to know the degree of persistence of a particular shock. This puts high informational requirements on monetary policy such as are hardly satisfied in reality. Researchers have consequently asked whether the sheer volume of informational requirements for design of an optimal policy response makes practical use of response functions irrelevant. In addition to the problem of observing and responding (contemporaneously) to different shocks, the theoretical literature identifies a second problem in terms of optimal policy rules, known as the 'robustness of monetary policy rules'. It has been shown by simulation exercises that specific forms of optimal rules are not robust to changes in some of the models' characteristics. If the monetary policy authorities work with a specific model and an optimal response function based on this model, the outcome might well prove poor if reality is better described by an alternative model. Thus, given model uncertainty, dependence on optimal response functions could well turn out to be truly hazardous.

Research on monetary policy rules has reacted to these problems. It has been shown that so-called simple interest rate rules (such as the well-known Taylor rule) that suggest that the central bank adjusts the interest rate in response to variations in inflation and the output gap generally provide a good approximation for the optimal rule, in terms of relatively small welfare losses compared to the optimal loss over a wide range of structural models. This explains the present attractiveness of the Taylor rule and other relatively simple monetary policy rules.<sup>37</sup>

Proponents of the NNS favour a monetary policy strategy of inflation targeting at a rate near zero (King and Wolman 1996), which follows from the forward-looking nature of the price setting behaviour. If agents expect stable prices in the future, mark-ups and, hence,

---

<sup>37</sup> Recent research on the performance of monetary policy rules is summarized in Taylor (1999b).

production are also stabilised. However, strict inflation targeting in the sense that monetary policy should adjust immediately to reach the inflation target is often found not to be the optimal strategy, flexible inflation targeting with smooth adjustment over a longer time horizon often being preferred instead.<sup>38</sup>

The major challenge to monetary policy comes with the occurrence of cost-push shocks as defined previously in the context of the new Phillips curve. To the extent that such cost-push inflation is present, a short-run trade-off between inflation and output comes into being (Clarida, Galí and Gertler 1999). Stabilising inflation by contracting demand would lead to a fall in output, while stabilising output would mean leaving aggregate demand unchanged, but would lead to inflation. Here it is the preferences of the central bank, i.e. its inflation aversion, that determine the outcome within this trade-off.

## 6. The “new consensus model”

In order to achieve status as the new paradigm, the NNS framework needed to be unified in a workhorse model proving easier to communicate than the rather complex models discussed above. This section outlines the so-called “new consensus model” (Meyer 2001), which has become the widely accepted workhorse for macroeconomic policy analysis. The new consensus model can be interpreted as the successor of the traditional IS-LM framework, and in fact is often labelled “optimising IS-LM model” since it is built up from a microfoundation or, alternatively, “expectational IS-LM model”, because the new framework is modified to include expectational terms in the behavioural equations and because it is analysed using rational expectations (see McCallum and Nelson 1999a and 1999b).

The new consensus model can be summarised in three equations: an aggregate demand equation, the forward-looking Phillips curve and an equation determining monetary policy.<sup>39</sup> The aggregate demand equation is a forward-looking IS equation where current real spending

---

<sup>38</sup> See Clarida, Galí and Gertler (1999) and Goodfriend (2002) for an in-depth analysis of the conduct of monetary policy in the presence of the NNS.

<sup>39</sup> An excellent introduction is King (2000).

$y_t$  depends on its expected future level, the real interest  $r_t$  and a shock term  $x_t$ :

$$y_t = E_t \{y_{t+1}\} - s[r_t - r] + x_t, \quad (16)$$

where  $r > 0$  represents the real interest rate which prevails in the absence of output growth and aggregate demand shocks.<sup>40</sup> Equation 16 is obtained by log-linearising the consumption Euler equation after imposing the restriction that consumption equals output minus government spending (see Clarida, Galí and Gertler 1999, p. 1665).

The expectational Phillips curve which relates current inflation to expected future inflation, the output gap and a supply shock has already been discussed in section 4. For convenience equation 13 is restated here:

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \kappa \hat{y}_t + u_t. \quad (17)$$

To close the model, it is necessary to specify the monetary equilibrium condition. As already mentioned, it has become very popular to define an interest rate rule which specifies the nominal interest rate as the instrument of monetary policy. More often than not, a Taylor-type rule is formulated which relates the nominal interest rate  $i_t$  to the output gap and the difference between inflation and the central bank's inflation target  $\pi^*$ :

$$i_t = \bar{i} + \gamma_\pi \cdot (\pi_t - \pi^*) + \gamma_y \cdot \hat{y}_t, \quad (18)$$

where  $\bar{i}$  represents the equilibrium nominal interest rate, and  $\gamma_\pi$  and  $\gamma_y$  are the reaction coefficients with respect to deviations of inflation and output from their desired levels.<sup>41</sup> Under such a rule, the quantity of money is endogenously demand-determined at the nominal interest rate set by the central bank. For this purpose, a money demand function could additionally be specified, but since the quantity of money is

---

<sup>40</sup> Nominal and real interest rates are linked by the Fisher equation, which makes the nominal interest rate equal to the sum of real interest rate and expected inflation.

<sup>41</sup> The interest rate rule in equation 18 abstracts from any latched values of the nominal interest rate, which would indicate some interest rate smoothing behaviour, and from any expectational terms, which would state that the central bank reacts to expected inflation instead of actual inflation. The reaction coefficient with respect to inflation has to be greater than one in order to ensure stability. This is known as the 'Taylor-principle'.



not relevant in determining macroeconomic activity, models are often formulated without introducing money at all.<sup>42</sup>

Compared to the traditional IS-LM model, there are at least three innovations worth mentioning (Meyer 2001). First, whereas the traditional IS-LM model assumes either prices or output to be fixed, the consensus model allows for both sticky prices in the short run and full price flexibility in the long run. Second, the consensus model replaces the LM equation which formerly described money market equilibrium by the policy rule. Modelling the process of interest rate adjustment by the central bank is much closer to the actual central bank policy observed in reality than treating the money supply as the relevant instrument. Third, and in my view the most important innovation, is the explicit treatment of forward-looking economic behaviour. If, additionally, adjustment costs or 'rule-of-thumb' consumers are modelled, the consensus model allows for both forward-looking elements and lagged adjustment.

The consensus model is much easier to communicate than the large-scale models described above, and it can also be presented in familiar graphical form (see King 2000). But since the model is forward-looking in its nature, the macroeconomic analysis cannot be conducted by simply shifting curves. Instead, in order to analyze the consequences of policy action or shocks, the first necessary step is to solve simultaneously for current and expected future variables by determining the complete path of the economy. Once this path is known, it is possible to perform the graphical analysis.

## 7. Conclusions

The *new neoclassical synthesis* denotes a significant step in business cycle analysis. It combines the elements of *Real Business Cycle* analysis and *New Keynesian Macroeconomics*. In my view, its main advantages are that it brings together (again) results of research of different schools of thought formerly confronting one another as irreconcilable. With the NNS at hand they are now able to work within one unified

---

<sup>42</sup> See Friedman (2003) on that issue. For discussion of how the consensus model relates to monetarist ideas in which money plays the central role, see Meyer (2001).

framework and they can exchange their arguments on the basis of substantially similar models, while the methodological vicinity makes it far easier to compare positive and normative results in business cycle theory.

The new approach ascribes both schools of thought, 'Keynesian' and 'classical', their importance by assigning each a distinct role within complete dynamic general equilibrium models. But the distinction no longer lies in the fact that the Keynesian theory explains the short run while classical theory explains the long run, as was the case in the 'original' synthesis. Rather, the factors stressed by RBC-theory explain the evolution over time of potential output, while transitory deviations from the potential value result from delays in the adjustment of prices and wages. Since this adjustment process is explicitly modelled, the NNS provides enough space for a thorough dynamic short-run analysis.

In the NNS, real disturbances may play an important role as the ultimate source of short-run variations in economic activity. But in contrast to the RBC models, this does not mean that the fluctuations in economic activity are necessarily desirable, nor does it imply that there is no rule for monetary policy. Because of the delay in the adjustment process of prices and/or wages, the consequences of real disturbances can be inefficient, which leaves a role for active monetary policy to mitigate the distortions. However, although the NNS framework has become the new paradigm in the sense that almost all research in macroeconomics is carried out in dynamic general equilibrium models with Keynesian elements, this class of models is still evolving. If it is to gain more influence over actual stabilisation policies, then an array of open questions has to be answered with future research, two of which should be mentioned here. First, we need to know more about the specific rigidities that are present empirically, because the specific NNS model results are appreciably sensitive to the exact character of the rigidities. Until we succeed in identifying them the risk is that empirical policy conclusions might be drawn inappropriately. The identification of rigidities also includes the possibility that they may be sector specific, which then precludes a full stabilisation of aggregate output by re-active monetary policy, because a single monetary policy stance cannot fit all sectors. This asymmetry in rigidities and the possibility of sector specific shocks bring up the question of whether an internationally coordinated monetary policy

might be an issue to be discussed again within the NNS framework. In fact, Canzoneri, Cumby, Diba (2002b) show that the benefits of monetary policy coordination might be higher in open economy versions of NNS models than previously thought by many researchers.

Second, we still need more general empirical tests of the NNS models. So far, the empirical evidence is rather mixed and does not support the new theory in general, as has also been argued with respect to the Phillips curve estimates. More tests are needed to discriminate between the competing theories. One such attempt is Ireland (2002), who investigates whether the correlation between nominal and real variables in the US postwar data is indicative of significant price rigidities or whether it simply reflects the particular way monetary authorities react to developments in the real economy. A model of endogenous money that allows for, but does not require, nominal price rigidities is estimated using a maximum likelihood procedure. The results show that nominal price rigidity, in addition to endogenous money, plays a role in accounting for the key features of the data, which offers significant support for the NNS models.

#### REFERENCES

- ALTIG, D, L.J. CHRISTIANO, M. EICHENBAUM and J. LINDE (2002), "Technology shocks and aggregate fluctuations", Northwestern University, Chicago, mimeograph.
- ANDOLFATTO, D. (1996), "Business cycles and labor-market search", *American Economic Review*, vol. 86, no. 1, pp. 112-32.
- ARNOLD, L.G. (2002), *Business Cycle Theory*, Oxford University Press, Oxford.
- BASU, S., J. FERNALD and M. KIMBALL (1998), "Are technology improvements contractionary?", *International Finance Discussion Paper*, no. 625, Federal Reserve Board.
- BEETSMA, R. and H. JENSEN (2002), "Monetary and fiscal policy interaction in a micro-founded model of a monetary union", *ECB Working Paper*, no. 166, European Central Bank, Frankfurt.
- BLANCHARD, O. (1997), "Comment", *NBER Macroeconomics Annual*, pp. 289-93.
- BLANCHARD, O. and N. KIYOTAKI (1987), "Monopolistic competition and the effects of aggregate demand", *American Economic Review*, vol. 77, no. 4, pp. 647-66.
- CALVO, G. (1983), "Staggered prices in a utility-maximizing framework", *Journal of Monetary Economics*, vol. 12, no. 3, pp. 383-98.
- CANZONERI, M.B., R.E. CUMBY and B.T. DIBA (2002a), "Recent developments in the macroeconomic stabilization literature: is price stability a good stabilization strategy?", Georgetown University, Washington, mimeograph.

- CANZONERI, M.B., R.E. CUMBY and B.T. DIBA (2002b), "The need for international policy coordination: what's old, what's new, what's yet to come?", *NBER Working Paper*, no. 8765, Cambridge, Mass.
- CHARI, V.V., P.J. KEHOE and E. MCGRATTAN (2000), "Sticky price models of the business cycle: can the contract multiplier solve the persistence problem?", *Econometrica*, vol. 68, no. 5, pp. 1151-79.
- CHRISTIANO, L.J., M. EICHENBAUM and C.L. EVANS (1997), "Sticky price and limited participation models: a comparison", *European Economic Review*, vol. 41, no. 6, pp. 1201-49.
- CHRISTIANO, L.J., R. VIGFUSSON and M. EICHENBAUM (2004), "The response of hours to a technology shock: evidence based on direct measures of technology", *Journal of the European Economic Association*, vol. 2, no. 2-3, pp. 381-95.
- CLARIDA, R., J. GALÍ and M. GERTLER (1999), "The science of monetary policy: a new Keynesian perspective", *Journal of Economic Literature*, vol. XXXVII, December, pp. 1661-707.
- CLARIDA, R., J. GALÍ and M. GERTLER (2001), "Optimal monetary policy in open versus closed economies: an integrated approach", *American Economic Review (Papers and Proceedings)*, vol. 79, no. 2, pp. 248-52.
- CLARIDA, R., J. GALÍ and M. GERTLER (2002), "A simple framework for international monetary policy analysis", *Journal of Monetary Economics*, vol. 49, no. 5, pp. 879-904.
- COOLEY, T.F. (1995), *Frontiers in Business Cycle Research*, Princeton University Press, Princeton.
- COOLEY, T.F. and G.D. HANSEN (1989), "The inflation tax in a real business cycle model", *American Economic Review*, vol. 79, no. 4, pp. 733-46.
- ERCEG, C., D. HENDERSON and A. LEVIN (2000), "Optimal monetary policy with staggered wage and price setting", *Journal of Monetary Economics*, vol. 46, no. 2, pp. 281-313.
- FRANCIS, N. and V. RAMEY (2001), "Is the technology-driven real business cycle hypothesis dead? Shocks and aggregate fluctuations revisited", University of California at San Diego, San Diego, mimeograph.
- FRIEDMAN, B. (2003), "The LM curve: a not-so-fond farewell", *NBER Working Paper*, no. 10123, Cambridge, Mass.
- FUHRER, J.C. (1997), "The (un)importance of forward looking behavior in price setting", *Journal of Money, Credit and Banking*, vol. 29, no. 3, pp. 338-50.
- FUHRER, J.C. and G.R. MOORE (1995), "Inflation persistence", *Quarterly Journal of Economics*, vol. 110, no. 1, pp. 127-60.
- GALÍ, J. (1999), "Technology, employment, and the business cycle: do technology shocks explain aggregate fluctuations?", *American Economic Review*, vol. 89, no. 1, pp. 249-71.
- GALÍ, J. (2002), "New perspectives on monetary policy, inflation and business cycle", in M. Dewatripont, L. Hansen and S. Turnovsky eds, *Advances in Economic Theory*, vol. III, Cambridge University Press, Cambridge, pp. 51-197.

- GALÍ, J. (2004), "On the role of technology shocks as a source of business cycles: some new evidence", *Journal of the European Economic Association*, vol. 2, no. 2-3, pp. 372-80.
- GALÍ, J. and M. GERTLER (1999), "Inflation dynamics: a structural econometric analysis", *Journal of Monetary Economics*, vol. 44, no. 2, pp. 195-222.
- GALÍ, J., M. GERTLER and D. LÓPEZ-SALIDO (2001), "European inflation dynamics", *European Economic Review*, vol. 45, no. 7, pp. 1237-70.
- GERTLER, M., S. GILCHRIST and F.M. NATALUCCI (2001), "External constraints on monetary policy and the financial accelerator", mimeograph.
- GOODFRIEND, M. (2002), "Monetary policy in the new neoclassical synthesis: a primer", *International Finance*, vol. 5, no. 2, pp. 165-91.
- GOODFRIEND, M. and R. KING (1997), "The new neoclassical synthesis and the role of monetary policy", *NBER Macroeconomics Annual*, pp. 231-83.
- HALL, R.E. (1978), "Stochastic implications of the life cycle-permanent income hypothesis: theory and evidence", *Journal of Political Economy*, vol. 86, no. 6, pp. 971-87.
- HALL, R.E. (1988a), "Intertemporal substitution in consumption", *Journal of Political Economy*, vol. 96, no. 2, pp. 339-57.
- HALL, R.E. (1988b), "The relationship between price and marginal cost in U.S. industry", *Journal of Political Economy*, vol. 96, no. 5, pp. 921-47.
- IRELAND, P.N. (2002), "Endogenous money or sticky prices", *NBER Working Paper*, no. 9390, Cambridge, Mass.
- KIMBALL, M. (1995), "The quantitative analytics of the basic neomonetarist model", *Journal of Money, Credit, and Banking*, vol. 27, no. 4, pp. 1241-77.
- KING, R.G. (2000), "The new IS-LM model: language, logic, and limits", *Federal Reserve Bank of Richmond Economic Quarterly*, vol. 86, no. 3, pp. 45-103.
- KING, R.G. and A. WOLMAN (1996), "Inflation targeting in a St. Louis model of the 21<sup>st</sup> century", *Federal Reserve Bank of St. Louis Review*, vol. 78, no. 3, pp. 83-107.
- LINDEMANN, L.A. and SCHABERT (2003), "Fiscal policy in the new neoclassical synthesis", *Journal of Money, Credit, and Banking*, vol. 35, no. 6, pp. 911-29.
- LUCAS, R.E. (1973), "Some international evidence on output-inflation tradeoffs", *American Economic Review*, vol. 63, no. 3, pp. 326-34.
- MANKIW, N.G. and R. REIS (2002), "Sticky information versus sticky prices: a proposal to replace the new Keynesian Phillips curve", *Quarterly Journal of Economics*, vol. 117, no. 4, pp. 1295-328.
- MCCALLUM, B.T. and E. NELSON (1999a), "An optimizing IS-LM specification for monetary policy and business cycle analysis", *Journal of Money, Credit, and Banking*, vol. 31, no. 3, pp. 296-316.
- MCCALLUM, B.T. and E. NELSON (1999b), "Nominal income targeting in an open economy optimizing model", *Journal of Monetary Economics*, vol. 43, no. 3, pp. 553-78.
- MCGRATTAN, E.R. (1994), "The macroeconomic effects of distortionary taxation", *Journal of Monetary Economics*, vol. 33, no. 3, pp. 573-601.

- MERZ, M. (1995), "Search in the labor market and the real business cycle", *Journal of Monetary Economics*, vol. 36, no. 2, pp. 269-300.
- MEYER, L.H. (2001), "Does money matter?", *Federal Reserve Bank of St. Louis Review*, vol. 83, no. 5, pp. 1-15.
- ROTEMBERG, J.J. and M. WOODFORD (1999), "The cyclical behavior of prices and costs", in J.B. Taylor and M. Woodford eds, *Handbook of Macroeconomics*, Elsevier Publisher, New York *et al.*, pp. 1051-135.
- SHAPIRO, M.D. and M. WATSON (1988), "Sources of business cycle fluctuations", *NBER Macroeconomics Annual*, pp. 111-48.
- SHEA, J. (1998), "What do technology shocks do?", *NBER Macroeconomics Annual*, pp. 275-310.
- SMETS, F. and R. WOUTERS (2002), "An estimated stochastic dynamic general equilibrium model of the Euro area", *ECB Working Paper*, no. 171, European Central Bank, Frankfurt.
- SYLOS LABINI, P. (1988), "The great debates on the laws of returns and the value of capital: when will economists finally accept their own logic?", *Banca Nazionale del Lavoro Quarterly Review*, vol. 41, no. 166, pp. 263-91.
- TAYLOR, J.B. (1980), "Aggregate dynamics and staggered contracts", *Journal of Political Economy*, vol. 88, no. 1, pp. 1-23.
- TAYLOR, J.B. (1999a), "Staggered price and wage setting in macroeconomics", in J.B. Taylor and M. Woodford eds, *Handbook of Macroeconomics*, Elsevier Publisher, New York *et al.*, pp. 1009-050.
- TAYLOR, J.B. (1999b), *Monetary Policy Rules*, University of Chicago Press, Chicago.
- UHLIG, H. (2004), "Do technology shocks lead to a fall in total hours worked?", *Journal of the European Economic Association*, vol. 2, no. 2-3, pp. 361-71.
- WOODFORD, M. (2003), *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press, Princeton.
- YUN, T. (1996), "Nominal price rigidity, money supply endogeneity, and business cycles", *Journal of Monetary Economics*, vol. 37, no. 2, pp. 345-70.