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Credit and Prices in Woodford's New Neoclassical Synthesis

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Abstract

Following recent debates on the New Neoclassical Synthesis, the theory of monetary policy has been renewed. The prevailing method, illustrated by Woodford's version of *Interest and Prices,* is a Dynamic Stochastic General Equilibrium Model in which the old LM curve is voluntarily substituted by an optimal monetary rule. Such a turning point requires a peculiar set of assumptions, especially regarding *monetary* prices. The recent debate pays attention to *de*-emphasis on the nominal monetary aggregate, which does not play any explicit role in monetary policy deliberations. Following Calvo's model, Woodford's neo-Wicksellian framework only considered *monetary* prices in equilibrium. This article demonstrates that even though the New Neoclassical Synthesis considers it essential to have a monetary theory for policymaking, the former offers the same answers as the traditional static macroeconomics. More precisely, it shows that the use of dynamic optimisation – such as the one developed by Woodford's approach – does not contribute in a decisive way to improving our understanding of the role that money prices play in monetary theory. Woodford's canvas is silent about the mechanisms whereby monetary policy induces agents to adjust *individual* money prices to the values that generate an *equilibrium* price level. Thus, if we want to close this gap, it may be useful to consider a 'forward guidance' strategy. By means of such a tool, central bankers are able to shape the public's expectations on economic outcomes by pre-announcing the time path of future policy actions.

Keywords: credit, prices, New Neoclassical Synthesis, history of macroeconomics, monetary equilibrium

JEL Codes: B22, E31, E42, E52, E58

1. Introduction

For more than 30 years, the Neoclassical Synthesis has been the dominant theoretical approach in macroeconomic theory. The expression 'Neoclassical Synthesis' was proposed by Paul Samuelson to describe the theory developed by Hicks (1937), Modigliani (1944), and Patinkin (1965). The 'Synthesis' adopts Hicks' macroeconomic IS-LM framework, which is of a Keynesian type, and which was later completed with equations derived from the behaviour of maximising agents, *i.e.* a Neoclassical microeconomic framework. This first Neoclassical Synthesis inaugurates a scientific project that seeks the microeconomic basis of macroeconomics. The Phillips curve offered the necessary 'bridge' between macroeconomics and microeconomics through the setting up of a relationship between employment, wages, and inflation concepts. The adoption of this curve involved, a few years later, the absorption of macroeconomics by microeconomics.

A clear demonstration of the success of this scientific and methodological project is the recent consolidation of a New Neoclassical Synthesis (hereafter NNS) or 'New Consensus' or 'New Keynesian Synthesis' (Lavoie and Seccareccia, 2004). This new approach brings together some works published in or just after the late 1990s, such as those pioneered by Goodfriend and King (1997; 2001), Clarida, Gali and Gertler (1999), Goodfriend (2002) and, particularly, Woodford (2003), who provides the most complete presentation of the NNS. These authors establish a consensus between two apparently opposing groups of economists: the RBC (Real Business Cycles) model is adopted as the basic framework, along with certain assumptions of the New Classicals, such as rational expectations, and is then complemented with certain assumptions from the New Keynesians, such as nominal rigidities on prices and wages. The resulting NNS appears as a set of models that show the link between prices and the rate of interest as monetary policy rules, but without stressing the monetary aggregate.

At the FED, Woodford (2003) saw monetary aggregates as mere statistics, whereas most policymakers – more or less Monetarist minded – saw these parameters as relevant information tools. However, Woodford's thinking went far beyond a mere divergence on the relevance of monetary aggregates as optimal tools for policymakers: his landmark contribution is an emphatic rejection of 'the implied path of the money supply or the determinants of money demand' (Woodford, 2003, p. 237) in the determination of the equilibrium of output and prices. In other words, Woodford made fashionable a *cashless* approach, which echoes the pioneering work of the Swedish economist, Knut Wicksell.

Wicksell's genuine 'pure credit' economic fiction quickly generated the association of Woodford's NNS framework with a 'Wicksellian flavour'. The result was that Woodford not only distanced himself from other members[1] of NNS, but also opened a new debate on the importance of considering *intertemporal* dimensions in the way policymakers establish their monetary policy decisions. In the aftermath of the Great Financial Crisis, the latter debate took the spotlight. In fact, the zero lower bound constraint has become a dominant element in considerations of policymakers with regard to the implementation of an *effective* monetary policy. Hence, consideration of the public's understanding of the future path of economic parameters has become an instrument in itself required for an optimal monetary policy. Eggertsson and Woodford (2003) were pioneers in this respect. They disseminated widely the fundamental idea that inflation targeting of the central banks cannot achieve their goal without being explicit about the future path of the leading economic data, *i.e.* the operating interest rate target. This 'forward guidance' principle stands out nowadays as an entire monetary policy tool *per se*.[2]

The aim of this article is to show that even though the NNS considers it essential to have a monetary theory for monetary policy, it offers the same answers as the traditional static macroeconomics. More precisely, this article shows that the use of dynamic optimisation – such as that developed by Woodford – does not contribute in a decisive way to improving our understanding of the role that money prices play in monetary theory. This paper supports the thesis that Woodford's canvas is silent about the mechanisms whereby monetary policy induces agents to adjust individual money prices to the values that generate an *equilibrium* price level. The article states that price level determination is only possible if

[1] Woodford describes his approach as follows: 'I call models of this kind "Neo-Wicksellian", in order to draw attention to the fundamental role in such models of a transmission mechanism in which interest rates affect intertemporal spending decisions, so that monetary policy needs not to be specified in terms of an implied path of the money supply; but the terminology "new Keynesian" for such models has become commonplace, following Clarida et al. (1999) among others' (2006b, p. 6, n. 8).

[2] Woodford: 'it will be necessary to take into account the consequences of the choice of [federal nominal rate] i_t for the expected values of all of the terms in (1.5), which will require a consideration at time t of how policy should be conducted later' (2013, p. 4).

the two representative agents are considered to know *a priori* the parameter θ, meaning that the relative price level must be known.[3] As a consequence, prices are not necessarily monetary ones, a point that contains echoes of the debate opened by Rogers (2006) on the 'inessential economy' properties of Woodford's framework. Thus, if we want to close this gap, it may be useful to consider a 'forward guidance' strategy. By means of such a tool, central bankers can link their policy actions to outcomes by influencing public expectations and hence behaviour by pre-announcing the time path of future policy actions.

This paper is divided into four sections. In the second, general Wicksellian principles are set out. In the third, the determination of the steady state in the dynamic general equilibrium model proposed by Woodford (2003), through a very synthetic framework, is specified. In the fourth section, it is pointed out that the monetary price is undetermined in Woodford's model, meaning that the model implicitly implies that representative agents know the relative prices in advance. This section provides the opportunity to give an explanation of such an assumption by way of the 'forward guidance' principle. A credible central bank that committed itself to a credible target criterion – so as to determine the forward path of policy – should be able to shape the representative agent's expectations, so that it can be assumed that the individual price index P_t is determined. Finally, the concluding comments are presented. It is important to notice that the model is sketched and not presented rigorously because the aim of the paper is to show its main features. For a rigorous presentation of the models the reader can turn directly to Woodford's book.

2. Wicksell's Model and the Price Disequilibrium Process

When Wicksell entered on the road of political economy at the late age of thirty-seven – having graduated in mathematics – it was for *practical* reasons. In fact, his aim was to explain the monetary disturbances in prices of the second half of the nineteenth century. Wicksell's *Interest and Prices* (1898) has to be read in this context. In stating, 'the function of money is here purely that of an intermediary; it comes to an end as soon as the exchange has been effected' (Wicksell, 1936[1898], p. 23), Wicksell shows that his conception of money was in agreement with the classical doctrines of the time, according to which money was *a veil.*

For sure, Wicksell mainly considers money as a medium of exchange; however, he did not ignore its store of value function. In his seminal 1898 book, Wicksell revealed his reliance upon – not to say devotion to – the older theory of money, while at the same time underlining its weakness and inadequate correspondence with reality. As defined by Trautwein and Boianovsky, the Wicksellian approach is an attempt 'to restate the Quantity Theory in credit-theoretical terms' (Trautwein and Boianovsky, 2001, p. 500). Wicksell expanded the Quantity Theory by taking into account the development of credit tools in the modern economy. The new banking system that emerged in the late nineteenth century was characterised by the increasing use of credit tools, mainly bills of exchange and bank notes. He saw in this structural development a possible cause of the inflationary/deflationary process. Wicksell's landmark contribution to monetary theory is to have endogenised the velocity of circulation of money within the Quantity Theory.

Wicksell's idea was that the emergence of credit tools constituted a structural change in the economy to the extent that prices are disturbed. By increasing the capacity of the economy to adapt to whatever amount of money was needed, the emergence of credit tools had consequences on the inflationary/deflationary processes of the late nineteenth century. In

[3] The parameter θ measures the constant elasticity of substitution among goods in the economy in a Dixit-Stiglitz fashioned framework.

fact, as soon as credit enters into the economy there is no longer any *technical* limit to the quantity of money in circulation, and this in turn disturbs money prices. For this reason, Wicksell introduced three, or, more exactly, two hypothetical types of economy in which the velocity of circulation is a *dependent* variable of the type of economy: first, a *pure cash system* and, second, its opposite, a *pure credit system*,[4] with economic reality located between these two extreme benchmark cases.

The cash system

This hypothetical kind of economy is characterised by the total absence of credit, which is 'neither given nor received' (Wicksell, 1936[1898], p. 56), or of the lending of money. In short, transactions are exclusively paid by (gold) coins. In this case, the cash holding of each agent is mainly determined by conjuncture and the level of economic activity. People hold money for two reasons: first, for the payments of purchases at given points of time; and, second, for unforeseen disbursements. However, this ideal type does not play a major role in the issue in question. The most important reason for the demand for money in this type of economy lies in *definite payment purposes*, which allows Wicksell to state that 'the average velocity of circulation of money, is of almost constant magnitude. It would react immediately against accidental expansion or contraction' (Wicksell, 1936[1898], p. 59). Consequently, the level of prices depends exclusively on the quantity of money in circulation. The Quantity Theory is here totally relevant. However, this first case is purely *imaginary* and far from reality. Hence, the above conclusion does not fit a more realistic case.

The pure credit system

In this second type of economy, Wicksell establishes the opposite framework from the above case. In this kind of economy there is no place for money in its narrow sense; only credit prevails under different forms. He introduces two intermediary stages within the pure credit economy:

a) The case of a simple credit economy or unorganised credit system

The economy is dominated by credit instruments under the form of both simple merchandise credit, *i.e.* delay of payments, and lending of money between two people. However, money, under the form of cash, is no longer absent because the necessity for holding cash balances still persists in regard to precautionary reserves against unforeseen payments. Wicksell sees these primary forms of credit as a 'powerful pulley for accelerating the circulation of money' (Wicksell, 1936[1898], p. 59). The advantage brought by the credit instruments is a diminishing of the need for money 'to an unlimited extent' (Wicksell, 1898[1936], p. 59). In Wicksell's words: 'As soon as a sum of money, no matter how small, were brought into circulation in the market, it would zigzag rapidly backwards and forwards between buyers and sellers' (Wicksell, 1936[1898], p. 60).

However, there are limits that prevent credit from substituting for money: first, the individual lending system cannot be developed to an unlimited extent because it concerns only a minority of people, *i.e.* those who can provide guarantees for their debt; and second, obtaining credit or lending money requires precautionary measures for both debtors and creditors. So, an *unorganised* credit economy reduces the necessity for cash-holdings but it does not make it disappear. This imaginary case introduces us to an economy in which the

[4] Instead of the term *pure credit system*, Woodford used *cashless economy* in his framework.

velocity of circulation is a 'somewhat elastic quantity' (Wicksell, 1898[1936], p. 61). The price level, with degrees of difference, is still a dependent factor of the quantity of money in circulation.

b) The case of an organised credit economy

This is a model of a banking economy with centralisation of money-lending banks and monetary institutions in which 'all domestic payments are effected by means of Giro system and bookkeeping transfers' (Wicksell, 1936[1898], p. 70). Contrary to the previous model, credit is now a perfect *substitute* for money. In this purely imaginary case: 'money does not actually circulate at all, neither in the form of coin (except perhaps as small change) nor in the form of notes' (Wicksell, 1936[1898], p. 70). It is only in this model that Wicksell integrates banks into his analysis. This new actor in the monetary system is not without consequence for the economy to the extent that they provide the most *powerful pulley* (Wicksell, 1898[1936], p. 59) in the circulation of money by means of bank credit.

In this case, the elasticity of money can adapt itself to whatever quantity of money is needed and it is possible to get rid of cash money. Within this framework, Wicksell specially focuses on bank notes, which he considers: 'a kind of deposit-receipt or cheque, which passes through a number of hands before it is presented to the bank either for redemption or as a deposit' (Wicksell, 1936[1898], p. 69). The status given to notes consists in providing a reserve-instrument instead of the gold coins rather than representing an entire substitute for money. We have to keep in mind that Wicksell's purpose is not to eradicate money; what he aims to provide is an accurate theory of the value of money in a modern framework.[5]

As soon as banks or monetary institutions enter the economy the situation changes; specifically, the size of the cash requirement is pushed to an 'infinitesimally small amount' (Trautwein and Boianovsky, 2001, p. 511). The important lesson is that credit – whatever the form considered – is a *powerful weapon* for accelerating the velocity of circulation of money, so that credit is responsible for changes in the level of prices. In this context, the Wicksellian thesis begins to emerge with an underlining of the full responsibility of the banks, *via* monetary creation, in the fluctuation of the level of prices. So that a proper regulation, in the form of a *specific* rule of behaviour for the banks, is needed in order to maintain the level of prices:[6]

> 'Is it a characteristic of the banks that their power is unlimited, so that in a pure credit economy they could bring about any desired rise or fall in prices by pursuing a uniform policy with regard to the rate of interest? Is it possible that we have here found the general cause of the price fluctuations which occur under present conditions, when it is becoming more and more usual for instruments of trade and credit to pass through the hands of the banks? Does it follow that the most powerful instrument for stabilising prices lies in appropriate regulation of banking policy?' (Wicksell, 1936[1898], p. 80).

[5] Wicksell was entirely opposed to the gold standard system because of the two opposite functions of gold: gold as money and gold as raw material in the industry, which leads undoubtedly to fluctuation of its value with consequences for the value of money. Wicksell wrote as follows on this point: 'If notes of lower denominations were permissible, then for all internal requirements this reserve might without any risk be composed only of notes, i.e. of unused bank credit' (Wicksell, 1935[1906], p. 91). As a consequence, Wicksell's practical recommendation was to substitute the gold reserves by bank notes and to give up gold as bullion.

[6] We need to mention that the Wicksellian program can be traced back before 1898. According to Trautwein and Boianovsky (2001), a manuscript from 1889 already contained these basic issues and Wicksell's core monetary message.

The quotation does not go further, but the regulation Wicksell had in mind has to be followed by the central bank. This argument is what enables Humphrey to rank Wicksell among the Quantity Theorists: 'a person essentially is a quantity theorist if he believes the monetary authority can stabilize the price level through control, direct or indirect, of the stock of money or nominal purchasing power. [...] Wicksell passes this test with flying colors' (Humphrey, 1997, p. 85). This is, however, a tricky and open question since Wicksell's framework can be seen as both a Quantity Theory approach (Humphrey, 1997; Laidler 2004) and an anti-Quantity Theory approach (Leijonhufvud, 1981; Uhr, 1962; Strom and Thalberg, 1979).[7] In fact, Wicksell's original purpose was to raise the Quantity Theory to its due place in credit-theoretical terms. However, in light of his questioning of one of the pillars of the Quantity Theory, *i.e.* the assumption of a fixed velocity of circulation for money, the claim that Wicksell succeeded in saving the old monetary doctrines in a modern framework appears doubtful.

In this type of pure credit economy, as soon as prices start increasing/decreasing there is no mechanism that pushes them back since money, under the form of credit, is endlessly elastic. For this reason a *cumulative process* – in both cases of inflation and deflation – appears and destabilises the real economy (notably by forcing the economy to reallocate factors in specific industries or sectors). The best policy that Wicksell recommends is to put the interest rates charged by the banks – called the *monetary rate of interest* – at par with the *natural-normal* (exogenous) interest rate of the economy in order to prevent the appearance of disturbances in prices. Many recent central bankers have recognised their debt to this policy recommendation when deliberating on monetary policy (Clinton, 2006; Lavoie and Secarreccia, 2004).

Wicksell was a pioneer in monetary policymaking in two ways: first, he demonstrated to what extent the money prices disequilibrium process is rooted in the monetary structure of the economy (depending on the elasticity of the money supply); second, he underlined the key role played by monetary policy – under the supervision of a central institution – so as to constrain the monetary creation process, and thus, the general price level as well. The core element at the heart of the Wicksellian theory was a thorough study of the link between money prices adjustment and monetary policy. Wicksell claimed that the latter was an effective tool to regulate the former when they were in a disequilibrium process. Woodford took the opposite path, entering the debate by designing an *optimal* monetary policy in order to assure a perfect stability of prices.

3. Wicksell and Woodford on the Price (Dis)Equilibrium Process

Woodford (1999) portrayed the history of macroeconomics as an endless succession of *revolution* and *evolution*. Among the last of such developments, the emergence of the NNS prevails. The New Classical and New Keynesian economists disagree on the assumptions used to analyse the market in a theoretical framework. For the New Classicals, such as Lucas (1981) and Ljungqvist and Sargent (2000), what matters is perfect competition with price and wage flexibility, where general equilibrium translates into the rational expectations hypothesis. For the New Keynesians, such as Mankiw (1990), Mankiw and Romer (1991) and Romer (1993), what matters is asymmetrical information, nominal rigidities on prices and wages, monopolies, and incomplete markets. Woodford's 2003 evolution of the macro family tree enables him to gather those two opposite views, notably regarding the price general equilibrium process.

[7] For more details on this point see Barbaroux (2013, pp. 54-56).

The modern approach to price general equilibrium

The NNS reconciles two types of Neoclassical approach. The link granting coherence to these two analyses is the existence of a central bank that intervenes, through a monetary policy, on the variation of prices and the operating interest rate. On the other hand, the NNS allows coherence between the New Classical RBC approach, in which monetary policy is irrelevant, and the New Keynesian approach, where monetary policy is relevant. Consequently, the NNS is concerned with both theoretical analysis and economic policy; and this is the reason why Woodford (2003) adopts as the subtitle of his work the expression '*Foundations* of a Theory of Monetary Policy'.

The role of monetary prices refers to the definition of the steady state in the general equilibrium macromodel. The variations of prices are compatible with a certain rule of monetary policy that takes into account the variations of the nominal rate of interest. While it is not new to link base money with prices, the fundamental innovation that NNS introduced is to be found in the technical rigour of the method adopted. The latter uses dynamic optimisation in stochastic terms, which tool is adequate to make the analysis compatible with the study of business cycles. The NNS *à la Woodford* can be summarised under a three equations block that deals with the goods market, prices, and the rate of interest (Woodford, 2003, p. 246):

- An intertemporal IS equation: this equation links the aggregate demand for goods and services to the nominal rate of interest controlled by the central bank.[8] The expected short-term real rate of return determines the incentive for intertemporal substitution between expenditures in *t* and *t+1*.

$$x_t = E_t x_{t+1} - \sigma(\hat{i}_t - E_t \pi_{t+1} - r_t^n) \qquad (1)$$

  where x_t is the actual output gap; E_t expresses the rational expectation process; σ is the intertemporal elasticity of substitution of aggregate expenditure (notably between private and public expenditure); i_t is the operating instrument of the central bank (here the nominal interest rate); r_t^n is the exogenous parameter for variations in the natural rate of interest (due to real disturbances).[9] The idea of equation (1) is that aggregate demand depends upon the expected value for the output gap and the short-term nominal interest rate.

- An AS equation (also called New Keynesian Phillips curve): this links the rate of inflation to the gap between aggregate demand and a number of long-term equilibrium levels of aggregate supply and to the expected value of the inflation rate. Each departure of aggregate output from its natural rate gives firms an incentive to choose a higher price than the one compatible with the zero inflation trend rate. A gap therefore results and creates an inflationary (deflationary) process.

$$\pi_t = \kappa x_t + \beta E_t \pi_{t+1} \qquad (2)$$

  where π_t is the inflation rate in time *t*; κ is a coefficient that depends on both the frequency of price adjustment and the elasticity of real marginal cost with respect to

[8] The IS equation is obtained by log-linearizing the first order household equilibrium conditions.
[9] This term r_t^n represents the deviation of the *natural rate* from the value consistent with a zero inflation steady state rate.

the level of real activity; β is the discount factor defined between 0 and 1; E_t is still the rational expectation process, and x_t is the output gap defined as the discrepancy between variation in actual output and the exogenous variation in the natural rate of output that results from several types of real disturbance. The log-linear AS relation is also called the New Keynesian Phillips curve because of the rational expectation process that supplements the *old* Phillips curve relationship.[10]

- A monetary Taylor's policy rule:

$$\hat{i}_t = i_t^* + \Phi_\pi(\pi_t - \pi^*) + \Phi_x(x_t - x^*)/4 \qquad (3)$$

where i_t is the operating instrument of the central bank (here the nominal interest rate); i_t^* is an exogenous intercept that reflects variation in both the target rate π_t^* and an exogenous disturbance term (errors of measurement by the central bank); Φ represents the monetary policy coefficients that allow for a greater or lesser weight on either of these two policy goals (inflation and output); π^* is the target rate of inflation and x^* is the steady state value of output consistent with the inflation target.

The above three equations constitute a Dynamic Stochastic General Equilibrium Model (DSGE) in which the old LM curve is voluntarily substituted by an optimal monetary rule. The economy is considered under an IS-AS-monetary policy rule system in which the money aggregate does not appear explicitly.[11] The general steady state is defined like a 'rational-expectations equilibrium', in which there exists a path (or variation) of the general price level that ensures that aggregate demand is at its potential level (or desired gap) and that this path is consistent with the policy on the rate of interest imposed by Taylor's rule. As we saw in section two above, this general policy conclusion fits with Wicksell's *paleo*-theory.

The relevance – or not – of the Wicksellian connection to Woodford's 2003 publication has been widely discussed (Tamborini, 2006b; Trautwein and Boianovsky, 2010; Trautwein and Zouache, 2009; Fontana 2006; Hoover 2004), mainly because Woodford defined his approach with this marketing argument. Many commentators referred to the first lines of Woodford's book, which were quite explicit as to the Wicksellian inheritance:

> 'the present study considers the design of a rule to be used in determining a central bank's operating target for a short-term nominal interest-rate […]. The present study seeks to revive the earlier approach of Knut Wicksell and considers the advantage of systematic monetary policies that are described in terms of rules for setting a nominal interest rate' (Woodford, 2003, pp. 24–25).

According to Tamborini (2006b, p. 4), there are two ways of addressing the Wicksellian connection in modern macroeconomics: first, the path of exegesis, in which the consistency between Paleo-Wicksellianism and Neo-Wicksellianism is analysed; second, the added value path, in which we determine to what extent macroeconomic theory can learn from Wicksell's

[10] The New Keynesian Phillips curve is a response by Keynesian economists to both Friedman's 1968 sharp critique of the Keynesian Phillips curve and to the rational expectations school of thought in the 1970s (led by Lucas and Sargent). The principal response was an attempt to build models that incorporate rational expectations and that provide microeconomic foundations for monetary policy having at least short-run effects. The main microeconomic rationale has been the hypothesis: *sticky prices*, notably the staggered pricing model by Calvo (1983). According to the New Keynesian Phillips curve, the inflation rate can be expressed as a dynamic process with a forward looking flavour.

[11] In Woodford (2003, p. 24) '*Monetary Policy without Control of a Monetary Aggregate'*.

monetary insights. Both of these two paths have been taken by recent literature.[12]

At first sight, the general thesis supported by his book precludes contesting Woodford's Wicksellian connection. As demonstrated by the three equation blocks, Woodford established the endogenous roots of inflation, meaning that inflation emerges from interest rate gaps and can be eliminated by a feedback monetary policy rule. Such a position clearly refers back to Wicksell (1936[1898]). However, the question is trickier than it seems. Woodford himself reflects this doubt in his 2003 book because of the divergence of respective frameworks: a static framework in Wicksell's case and a dynamic one in his case.

Woodford and Wicksell on prices: reconstructed discussion

Woodford (2003, p. 53) considers himself as a 'neo-Wicksellian' due to the above system of equations. This Wicksellian inheritance in Woodford's approach is interesting because it offers clues as to the theoretical range of the NNS at large. Woodford is right in his analysis of Wicksell's (1936[1898]) theory because the definition of the Wicksellian equilibrium conditions is also given by three simultaneous settings: (1) gross investment is equal to savings, (2) the general price level does not change, and (3) the interest rate is equal to the natural rate of interest:

$$I = S \qquad (1a)$$
$$\dot{P} = 0 \qquad (2a)$$
$$i_m = i_n \qquad (3a)$$

The first condition refers to the equilibrium condition in the market for goods, the second condition implies that the rate of inflation is zero, and the third indicates the level of the nominal rate of interest that is compatible with the stability of prices (Blaug, 1968, pp. 622-623). The consistency and simultaneity of these three equilibrium conditions are subject to debate. According to Laidler:

> 'in some places [Wicksell] defined the natural rate of interest as that which would bring about equilibrium between saving and investment in a frictionless barter economy, and in one place in particular […] he defined it as the marginal product of capital; […]. But would saving and investment be equal to one another at a rate of interest equal to the marginal product of capital […] in a growing barter economy in which saving and investment were positive?' (Laidler, 1999, p. 30).

According to Leijonhufvud (1981), it is lack of consensus about the coherence of these three conditions that has impacted upon the monetary debates of the Stockholm School and the Austrian School – a point described by him as 'The Wicksell Connection'. These debates are distinct from those arising from Friedman's monetarism, which, in turn, were born from the interpretation of Fisher's Quantity Theory of Money. Now, what really does distinguish 'The Wicksell Connection' from Friedman's monetarism? The answer is that in 'The Wicksell Connection' savings and investment guarantee income fluctuations through a mechanism in which coordination failures[13] exist, while in monetarism, perfect coordination is evident.

[12] To name a few: Trautwein and Zouache (2009), Trautwein and Boianovsky (2006a; 2006b), Tamborini (2006a; 2006b), Fontana (2006), Hoover (2004), and Laidler (2004).
[13] This is about an important aspect of Wicksell's monetary theory being rescued and refined by Tamborini *et al* (2009, p. 9).

These three conditions constitute a simple rule of monetary policy of price level stabilisation, which intuitively coincides with the three equations in Woodford's model. However, Wicksell's monetary equilibrium is not a steady state; consequently, if we are interested in focusing on the business cycle, it is necessary to refer to the *disequilibrium* situation that is explicit in Wicksell's model but absent in Woodford's. This is a key point in illuminating the limits of Woodford's framework.

According to Wicksell, when the monetary interest rate *is not equal* to the natural interest rate, investment is higher than saving – which remains at its full employment level – and all prices increase. The disequilibrium situation is then perceived as a cumulative process of prices or inflation.[14] However, as explained previously in the second section, the disequilibrium situation depends on the monetary regime: cash system (gold standard) and pure credit system (or cashless model in Woodford's terms). Thus, we can divide the economy into two types of monetary regime.

First, for the cash system, if the nominal interest rate is lower than the natural rate, a disequilibrium situation emerges: the agents demand money and all prices increase until the moment the central bank is likely to lose the totality of its gold reserves. At this moment, the central bank stops credit and, consequently, the cumulative process also stops and an equilibrium situation is obtained with zero inflation. In short, the rate of inflation is determined by the central bank. Second, in a pure credit system, if the nominal interest rate is lower than the natural rate a disequilibrium situation arises: the agents demand credit and all prices increase, but since money does not have a metallic support, the central bank satisfies all the demand for money, and so the *market for money is always in equilibrium*. The moment at which the central bank stops offering money is arbitrary, so the equilibrium situation (stopping the cumulative process of prices) is determined by the central bank.

Woodford proposes a monetary policy framework in a pure credit fashion economy, in which it is assumed that there are:

> 'no transactions frictions that can be reduced through the use of money balances, and that accordingly provide a reason for holding such balances even when they earn a rate of return' (Woodford, 2003, p. 61).

Thus, money is defined as 'a claim to a certain quantity of a liability of the central bank, which may or may not have any physical existence' (Woodford, 2003, p. 63); money, then, is only *base money*. However, equations (1), (2) and (3) do not contain the quantity of money, whatever its definition (cash or pure credit). It should be mentioned that Woodford reacted to the rough criticism he received concerning the *cashless* hypothesis of his framework. By *cashless,* he refers to a frictionless economy without considering that actual economies are moneyless. The cashless metaphor is just:

> '… a useful simplification, one which allows a simpler and more transparent development of basic insights that are believed also to be relevant to more complex models incorporating empirically realistic monetary frictions' (Woodford, 2006a, p. 190).

[14] According to Laidler, Wicksell: 'developed his cumulative process analysis not with a view to understanding the cycle, but mainly as an aid to understanding the problems raised by secular price-level movements, particularly as they occurred in a monetary system dominated by commercial banks but nevertheless anchored by adherence to the gold standard. His aim was thus to extend the quantity theory of money, as he had inherited it from classical theory' (Laidler, 1999, p. 28).

We observed for Wicksell that if money is defined as pure credit then the money market is always in equilibrium; so Woodford's decision to analyse a pure credit system is convenient since this economy is always at the steady state. Disagreement is to be found in the status given to money by each of them.

The nature of money in Wicksell is also subject to discussion. Indeed, Wicksell used the word 'money' as synonymous with 'currency', thus making the distance between his analysis and any based on the Quantity Theory of Money appear greater than perhaps it really is. According to Patinkin:

> 'Wicksell is assuming money to be an abstract unit of account; hence the "price ratios" he is referring to are – in our terminology – the ratios of accounting, and not money prices. Thus his statements are completely unobjectionable. A little later in this chapter Wicksell does, however, refer to the case of a money which has concrete existence and which can therefore act as a "store of value". But even here he leaves his position uncomfortably obscure' (Patinkin, 1965, pp. 586-587, Note E).

Nevertheless, the inflation rate verified in the disequilibrium situation in Wicksell's theory is foreseen by the Quantity Theory of Money, *i.e.* all prices increase in the same proportion as the quantity of money (in a cash system or pure credit system). In order to verify the Quantity Theory of Money, it is necessary to adopt the assumption that agents cannot know in advance any price variation (the rate of inflation). Wicksell must then suppose that expectations on prices are static (Laidler, 1999, p. 28). Myrdal (1939) and other Wicksellians – such as Lindahl – introduced dynamic expectations on the variation of prices into Wicksell's theory, but simultaneously rejected the Quantity Theory (Tobon, 2006). This point fits with the demonstration of Trautwein and Boianovsky (2006a; 2006b) that Woodford's approach is closer to Lindahl's work when discussing the real effects of monetary policy.

Wicksell's theory is thus enriched: in the disequilibrium situation it is now possible for agents to expect the variation of prices and to be mistaken in their forecasts, whereas their equilibrium situation expectations are perfect. This part of Wicksell's model cannot be introduced into Woodford's approach because expectations are rational, i.e. there is no place for the disequilibrium situation because the agents do not make mistakes in their forecasts of price variations.[15] Woodford stands off on the most important contribution of Wicksellianism: the study of prices in disequilibrium. In this context, we can ask if this lacuna in Woodford's theory is acceptable in a supposedly 'neo-Wicksellian framework'.

Tamborini *et al* (2009) present a macromodel, named by them the 'Wicksell-Keynes Triangle', according to which the importance of Wicksell's disequilibrium process prevails. The macromodel establishes a relationship between three interconnected equations: intertemporal coordination, imperfect capital market, and wrong interest rate settings (Tamborini *et al* 2009, p. 22). This model contrasts with the traditional NNS – which they name the 'NNS triangle'- in which the links among equations are related to: intertemporal optimisation, imperfect competition, and sticky prices. The 'NNS triangle' corresponds to the IS-AS-MP framework, which we have made explicit here in equations (1), (2) and (3). Being in a steady-state scenario, the intertemporal disequilibrium appears through a misalignment of interest rates, which means that:

[15] According to Tamborini *et al* (2009, p. 9), the NNS is '*not contemplated*' and the disequilibrium phenomenon '*cannot be captured*'.

> '(i) excess investment or saving is accommodated at the "wrong" real interest rate, (ii) the goods market clears at the 'wrong' levels of output and inflation, and (iii) the expected rate of inflation is "wrong" with respect to actual inflation' (Tamborini et al, 2009, p. 16).

Under the assumption of price flexibility, the disequilibrium phenomenon is a good basis for a theory of business cycles.

4. Monetary Prices in Woodford's Approach

The determination of the price level

In the NNS the aggregate magnitudes are derived from agents' behaviour using a dynamic general equilibrium model. Consequently, prices must play a role in the allocation of resources and the determination of their employment level. Indeed, the IS curve and the Phillips curve are obtained starting from an intertemporal process of maximisation of the consumer's utility and the entrepreneur's profit. Thus, monetary prices intervene explicitly in the evaluation of their decisions. Woodford (2003, p. 143) presents these processes of maximisation through a basic model of rigid prices under a monopolistic competition setting. Let us analyse a theoretical approach of this model; this will enable us to show the proper role of monetary prices.

Let us assume an economy composed by a list of n different consumer goods, which are imperfect substitutes (there can be good substitutes and bad substitutes). The group of goods is associated with a probability density function. Each z good has a probability $(1/n)$ to be chosen by the consumer and this probability multiplied by n goods is equal to 1 or 100%. In short, the group of goods conforms to a unitary mass. Thus, there exists a continuum of goods that goes from 0 to 1, which corresponds to a monetary price list. The total monetary expenditure of the representative consumer is given by the sum in value of the consumer goods that he wishes to buy. The latter is represented by an integral function in continuous time.

$$P_t C_t = \int_0^1 p_t(z) c_t(z) dz \qquad (4)$$

The total monetary expenditure is composed of two elements: the sum of the quantities of consumer goods C_t and the sum of the prices or the general price level, P_t. Let us examine these two elements in detail. First, the quantity of consumer goods C_t is, by definition, a constant-elasticity-of-substitution aggregator, adopting a CES-type utility function, such as is presented by Dixit and Stiglitz (1977).

$$C_t \equiv \left[\int_0^1 c_t(z)^{(\theta-1)/\theta} dz \right]^{\frac{\theta}{(\theta-1)}} \qquad (5)$$

$c_t(z)$ is the distribution of consumption on a continuum of goods. If all goods are substitutes, the parameter θ measures the constant elasticity of substitution between them, with $\theta > 1$. The larger is θ, the larger will be the possibility of substitution among these goods. Now, in order to add up $c_t(z)$, it must be correctly measured. We are trying to add up all the different

quantities of goods into a single physical measurement. In the end, it becomes clear that C_t is not a pure number but rather a physical magnitude.

Second, monetary prices – which are used to evaluate the expenditure devoted to the consumption of goods – are summarised in the general price level index. Considering expression (5), the *corresponding* price level is:

$$P_t \equiv \left[\int_0^1 p_t(z)^{1-\theta} dz \right]^{\frac{1}{(1-\theta)}} \qquad (6)$$

P_t is the sum of the individual monetary prices given a priori and consequently it is a magnitude measured in monetary terms. According to Woodford P_t:

> 'defines the minimum cost of a unit of the aggregate defined by [C_t], given the individual goods prices { $P_t(z)$ }. Since a household cares only about the number of units of this aggregate that it can purchase, deflation by P_t is an appropriate measure of the purchasing power of nominal money balance M_t' Woodford (2003, p. 146).

The quotient ($1/P_t$) represents the purchasing power of a monetary unit, or simply the value of money, as expressed by the old Quantity Theory.[16] Equation (6) *corresponds to* or is compatible with equation (5) because it is obtained by minimising equation (4) subject to (5), while assuming that C_t is given or fixed.[17] Now as C_t is measured in physical terms and P_t is measured in monetary terms, therefore $P_t C_t$ from (4) is a monetary quantity.[18]

Individual prices considered in P_t are given *a priori* to the representative consumer because prices are fixed by the entrepreneur herself under the presence of a monopolistic competition. In this framework, prices are set according to a strategy or rule *in the spirit* of Calvo's (1983) price staggered model. Let us intuitively see the implications of this strategy for monetary policymaking.

The problem facing each entrepreneur is to maximize at each period the present value of issued stock, *i.e.* to guarantee equilibrium. For this purpose, he must fix the equilibrium monetary price of the consumption good to be produced, which allows him to obtain the profits (dividends) to be distributed among the stockholders. We suppose that each entrepreneur knows the equilibrium price that was set in the previous period. To fix the new equilibrium price, the entrepreneur's strategy is to interpret the market signals about the *evolution* of the economic variables, which inform him if modification of the equilibrium price is required. Each entrepreneur's strategy is to modify this price when he receives a signal that indicates he should do so. This signal arrives with a probability of $(1-\theta)$ whereas the probability of receiving a signal that indicates he should not modify this price is θ. According to Woodford:

> 'As each supplier that chooses a new price for its good in period t faces exactly the same decision problem, the optimal price p_t^* is the same for all of

[16] Tamborini *et al* (2009, p. 9) also determine the value of money in this way.
[17] In Appendix 1 we show how to obtain (6), beginning with the expenditure minimisation.
[18] It is also possible to consider C_t as a monetary aggregate when the sum of physical quantities of goods is multiplied by their prices on a base year. This is called the constant price method. In this case, the index P_t is a pure number computed using a weighted sum of the physical quantities of the goods (e. g., the Laspayres' index). Thus, $P_t C_t$ is a monetary magnitude.

> them, and so in equilibrium, all prices that are chosen in period t have the common value p_t^*' (Woodford, 2003, p. 178).

We thus arrive at the central problem of prices. The entrepreneur's strategy to determine prices must be compatible with the general price level of goods used by the representative consumer. We can rewrite the general price level using the entrepreneur's strategy; by taking the $1/(1-\theta)$ root on both sides of (6) we obtain:

$$P_t^{1-\theta} \equiv \int_0^1 p_t(z)^{1-\theta} dz \qquad (6a)$$

Including in (6a) the entrepreneur's strategy, we have:

$$P_t^{1-\theta} = \int_0^1 \left[(1-\phi) p_t^{*1-\theta} + \phi p_{t-1}(z)^{1-\theta}\right] dz \qquad (7)$$

After simplifying:[19]

$$P_t = \left[(1-\phi) p_t^{*1-\theta} + \phi P_{t-1}^{1-\theta}\right]^{\frac{1}{(1-\theta)}} \qquad (7a)$$

To easily interpret this price relation and the probability of its variation in time according to ∅, we log-linearise equation (7a) using a first order Taylor's expansion around the steady state, which is defined by price stability in time (zero inflation rate), i.e. $P_{t-1} = P_t = \mathrm{p}_\mathrm{t}^*$. Thus we obtain (7b):[20]

$$LnP_t \approx (1-\phi) Lnp_t^* + \phi LnP_{t-1} \qquad (7b)$$

Which can be defined by the following expression:

$$\tilde{P}_t \approx (1-\phi)\tilde{p}_t^* + \phi\tilde{P}_{t-1} \qquad (7c)$$

If the representative entrepreneur receives a signal ∅ = 1, then the general price level (expressed in natural logs) of the *current* period remains constant with regard to the previous period, $\tilde{P}_t \approx \tilde{P}_{t-1}$. These are also the prices that the representative consumer takes into

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[19] Simplifying (7) we obtain:

$$P_t^{1-\theta} = \int_0^1 (1-\phi) p_t^{*1-\theta} dz + \int_0^1 \phi p_{t-1}(z)^{1-\theta} dz \,.$$

Since the first term is not indexed in Z , we get:

$$P_t^{1-\theta} = (1-\phi) p_t^{*1-\theta} + \phi \int_0^1 p_{t-1}(z)^{1-\theta} dz \,.$$

The second term of this last expression is equivalent to (6a) but evaluated at period $t-1$, so we obtain $P_t^{1-\theta} = (1-\phi) p_t^{*1-\theta} + \phi P_{t-1}^{1-\theta}$. Taking the $1/(1-\emptyset)$ power on both sides of this last equation, we obtain (7a).

[20] Appendix 2 shows the log-linearisation process of (7a).

account when he assesses his expenditure. By contrast, if the representative entrepreneur receives a signal $\emptyset = 0$, the general price level of the current period will be fixed according to the market equilibrium reference price for this (current) period, $\widetilde{P}_t \approx \widetilde{p}_t^*$. But if $0 < \theta < 1$ the general price level is then proportionally fixed according to the market equilibrium reference price for this (current) period and the price level fixed during the previous period.

Now the key role played by price determination in the NNS has been presented, we can ask about its theoretical implications. Moving from the microeconomic approach to the macroeconomic approach – by way of the representative agent hypothesis – is controversial. This hypothesis implies an economy composed of two representative agents, whose production and consumption decisions relate to only one composite good and only one monetary price, *i.e.* the general price level.

From the consumer's point of view, the composite good is obtained through the sum of the different quantities of the goods brought to a unique and even physical measuring unit, for example kilograms of corn. Now, this is only possible because the consumer knows *a priori* the parameter θ, which means that relative prices are known; such prices are not necessarily monetary ones. We are in the presence of the standard Neoclassic Theory of Value characterised by a moneyless – not necessarily monetary – theory. Further, we will see that Rogers (2006) shares this same opinion regarding Woodford's model, even though he used a different concept, inherited from Hahn (1973), which he labelled 'inessential economies'.

From the entrepreneur's point of view the general price level is considered as given while, following a particular strategy, compatible with consumption decisions. Indeed, according to (7c), determination of the general price level requires, beforehand, three major pieces of information: the probability $\emptyset$, the general equilibrium price level of the previous period P_{t-1} and the general equilibrium price level of reference in t, p_t^*. These three components show that the general price level is determined by knowing *a priori* other monetary prices. But it is not easy to justify how the latter are determined. First, P_{t-1} depends on the price determined during the previous period *t*-2, and so on. But, how is the *first* price determined? Such information is a mystery. One way to solve the problem is to suppose that we use a mark-up on marginal cost in the following way: $P_t = \mu$ (marginal cost). However, this implies that we know the mark-up value in advance, when actually this was what we sought to determine in the equilibrium.

Second, the existence of p_t^* is also a mystery. How does the representative entrepreneur imagine this price? A clue concerns the parameter θ, which can be interpreted as a social convention or as an institution that appears in an anonymous way on the market. It is on this parameter that the general price level formation mechanism can be based in period *t*; however there cannot be an explanation per se because this parameter is exogenous. The lack of a price formation mechanism limits the range of a monetary theory since it is the existence of such a mechanism that must precisely explain the monetary structure of the economy. Equation (7c) only determines the intertemporal *variation* of the given *a priori* monetary prices that ensure the steady state in imperfect competition.

Our review is consistent with Rogers' (2006) thesis. Indeed, this author believes that monetary prices are undetermined in Woodford's model because the numeraire used to measure prices is arbitrary. This last conclusion is disappointing, because in a monetary economy prices cannot be underdetermined. According to Rogers, Woodford is a victim of the same well-known criticism as that concerning the models of integration of money into the Neoclassical Walrasian General Equilibrium Theory of the Arrow-Debreu type.[21] In particular, the criticism of Hahn (1973) is enlightening, showing as it does that, through this integration

[21] See Patinkin (1965) and Clower (1967).

method, a monetary economy *is the same* as an economy without money (or a barter economy). According to Hahn (1973), this is called 'inessential economies' (Rogers, 2006, p. 295). Applying Hahn's criticism allows Rogers (2006) to reach the following conclusions:

i. Woodford's neo-Wicksellian monetary theory is an example of an 'inessential economy'. Indeed, money is considered as a *friction* (or distortion), which is removed (Rogers, 2006, p. 296) through a cash-in-advance constraint, with a distinction between formal credit and informal credit (forms of payments).

ii. Then: 'Formal credit is extinguished in the cashless limit, leaving only informal credit', thus having actually a cash-in-arrears constraint *à la* Hoover (1996) (Rogers, 2006, pp. 296-297).

iii. Informal credit is a code for what MacCallum (1985; 2003) calls an 'accounting system of exchange – a non-monetary model – in which the unit of account function is represented by an arbitrarily selected numeraire' (Rogers, 2006, p. 297).

iv. According to Woodford, 'there exists a monetary unit of account in terms of which prices (of both goods and financial assets) are quoted (2003, p. 63)', but 'the unit of account in a purely fiat system is defined in terms of the liabilities of the central bank' (2003, p. 35) 'which may or may not have any physical existence' (2003, p. 63). Since the unit of account is an arbitrary numeraire, we thus have an 'inessential economy', *i.e.* the economy with money in Woodford is the same as an economy without money (barter). A true monetary economy is one in which the choice of numeraire *cannot* be arbitrary, that is, the numeraire is an 'essential property' (Rogers, 2006, p. 302, n.1).[22]

v. By conceiving an economy with an arbitrary numeraire, Woodford sows a '*confusion*' (Rogers, 2006, p. 296) or '*conceptual error*' (Rogers, 2006, pp. 303-304): prices of goods are relative and correspond to those determined in a Theory of Value (the Neoclassical General Equilibrium Theory of Arrow-Debreu type), which explains why the price of money is indeterminate as well as monetary prices of goods.

vi. Thus, Woodford confuses: 'the existence of an Arrow-Debreu auction that has computing power to determine all commodity inter-temporal relative prices, with the computing power required to run an electronic money system' (Rogers, 2006, p. 296).

vii. If the price level is indeterminate then 'Woodford's model cannot provide the basis for sensible advice about the process of inflation or price level targeting undertaken by central bankers' (Rogers, 2006, p. 303), and the central bank has no role in the economy; and monetary policy disappears.

Rogers' thesis (2006) is then implemented in Rogers (2013) in order to criticise the NNS (or New Keynesian Monetary Theory) as a whole. The emphasis is thus placed upon the fragility of the microfoundations of the theory. Rogers (2013) states that Hahn's conclusion remains: the existence of a classic monetary-real dichotomy, which prevents the theory serving as a guide to inflation targeting policy from the interest rate.[23] For Rogers (2006, p. 303),

[22] This is the same conclusion reached in the analysis of Patinkin (1965) about prices of account. See also Arrow (1981) and Rebeyrol (1999, pp.108-121).
[23] Rogers (2011) rejects another aspect of Woodford's work: the channel system in the cashless economy, which is also considered a '*conceptual error'*.

Woodford's Wicksellian inheritance is a caricature and his notion of money is comparable to 'phlogiston – the mythical substance once thought to cause combustion' (Rogers, 2006, n.1, p. 304). We fully share this view.

Interestingly, these reviews seem also to be applied to the alternative proposal from Tamborini et al (2009). Indeed, there is no evidence in their article of a discussion of the monetary nature of the economy; in fact they seem to evade the issue by including an exogenous quantitative equation (e.g. the Cambridge equation) to determine the price level and the general-equilibrium output level, without a consistent theoretical explanation on the lines of the old neoclassical monetary theory (Tamborini et al, 2009, p. 11). In summary, the authors state:

> 'we begin with a simplified monetary system that consists of a central bank, representing the system of bank loans and deposits as a whole […] the central bank is ready to create or retire base money' (Tamborini et al, 2009, p. 12).

In the absence of a justification of the endogenous character in the selection of the numeraire in which the bank loans and deposits are measured, it can be argued that the economy of Tamborini *et al* (2009) is also an 'inessential economy'. One way to see the monetary foundation of such a system more clearly is to look at the way public expectations concerning the (*forward*) monetary indicators influence, in turn, monetary policy implementation.

The forward guidance mechanism as a tool to bridge the relevancy of Woodford's model on price determination

In the aftermath of the Great Financial Crisis, central bankers and academics discovered a new interest in the way monetary policy can shape the public's expectations of future economic outcomes. When monetary policy faces a zero lower bound constraint and a liquidity trap situation, central bankers have no choice but to reach a new channel of transmission. In this respect, the work done by Eggertsson and Woodford (2003) is interesting. Mostly known under the name of 'forward guidance', this policy strategy refers to the belief that the public's understanding of the future path of leading economic data is an effective policy instrument. In fact, monetary policy has something to do with the issue of communication rather than with interest rate settings per se. In summary, the term "forward guidance" has mostly been applied to the specific influencing of expectations of the policy rate. Previous attempts to influence expectations through central bank communications have tended to be addressed more to expectations about variables such as the rate of inflation (as in the Bank of England fan charts, for example, which show the path by which inflation is expected to approach its target rate), with only indirect implications for policy rate expectations.

This way of thinking and speaking about monetary policy is a rediscovery of the Wicksellian school. The fact that central bankers and academics consider that monetary policy is first and foremost a useful tool to manage expectations has a Wicksellian flavour. In the 1920s and 1930s, Stockholm school members[24] – Myrdal and Lindahl to name a couple – pioneered different approaches that shared a willingness to study economic change – meaning dynamic processes – in common. The Swedish wanted to substitute the prevailing timeless static equilibrium approach – used by Wicksell himself – with a new one allowing

[24] By definition, the Stockholm School refers 'to the scientific work of Alf Johansson, Dag Hammarskjold, Erik Lindahl, Erik Lundberg, Gunnar Myrdal and himself that was published between 1927 and 1937' (Myhrman, 1991, p. 267).

anticipation, risk, and uncertainty as disequilibrium elements. The Swedish School won international recognition only with Ohlin's 1937 contribution to the *Economic Journal*, which presented the Stockholm School's work as an alternative to Keynes' *General Theory* analysis.

Among the lessons learned over the last two decades, central banks with explicit inflation targets have understood that it is not reasonable to expect a central bank to be able to keep the measured rate of inflation exactly equal to the target rate *at all times*. Indeed, in his 2013 article prepared for the conference '*Two Decades of Inflation Targeting: Main Lessons and Remaining Challenges*' at the Sveriges Riksbank, Woodford argued that a shift in monetary policy, even a relatively drastic one, cannot greatly affect the rate of inflation over the short term. Central bankers have accordingly admitted that the goal of policy should rather be to ensure that the central bank *can be expected to return* to the target rate fairly soon, even when it currently differs from that targeted rate. Monetary policy decisions in period *t* depend on the public's expectations of the operating target rate in period *t+1*. As a consequence, policy decisions and communication with the public about monetary policy decisions have come to focus on *projections for the future path* of the economy (and, in particular, projections for one or more measures of inflation) and the extent to which these are consistent with the bank's official target. This new way of thinking about monetary policymaking is gathered under the 'forward guidance' concept.

In the previous section, it was concluded that Woodford's model failed to establish a monetary economy framework due to the impossibility of explaining how monetary prices are set under a DSGE framework. The latter does not bring something new to the old static neoclassical approach. Indeed, Woodford's approach implicitly implied that representative agents knew in advance not only the relative prices (under the probability parameter θ, but also the general equilibrium price level of the previous period P_{t-1} and the general *equilibrium* price level of reference in t, p_t^* Without the last conditions, the determination of the price index P_t in the model is also a missing piece of the puzzle.

The best way to cope with this problem involves recalling some recent elements of the 'forward guidance' philosophy. A credible central bank that committed itself to a credible target criterion – so as to determine the forward path of policy – should be able to shape the representative agent's expectations on monetary data. So that, we can assume that the individual price index P_t in equation (6) or in equation (7c) is perfectly determined since the current and past level of prices are known.

In fact, we demonstrated that most of the monetary price determination mystery turns upon the θ parameter enigma as expressed in equation (7c). By applying the 'forward guidance' concept to our ontological problem, we can try to see with crystal clarity. If $0 < \theta < 1$, the general price level is then fixed proportionally according to the market equilibrium reference price for this (current) period and the price level fixed during the previous period. As part of the central bank's projections, these two items of information are broadcast to representative agents by way of a forward looking monetary policy strategy. If we consider – or assume – that the Central Bank is sufficiently credible, we can expect that the representative agent knows the relative prices of the past and those of the current period since those prices are the same as broadcasted by central bankers' publications. The same can be assumed regarding the representative entrepreneur, who should fix the monetary price of the consumption good to be produced at the same level as the one required by the equilibrium level. As representative agents receive the same information in the economy we can expect that the agents' expectations on the future path of the economic indicators are those that central bankers anticipate *to be expected* by representative agents. In this way, it is not surprising that Woodford implicitly considered that relative prices – from past and current periods – were known in advance by representative agents. To some extent, it was *as if* the

θ parameter captured the degree to which the central bank perfectly shapes the representative agent's economic foresight. It plays the same role as a social convention between the central bank and the representative agent.

However, all of this opens a new and tricky monetary policy debate on the conditions according to which a 'forward guidance' policy is effective and optimal. This issue is debated in Woodford's 2013 paper on '*Forward Guidance by Inflation Targeting Central Banks*'. In other words, central bankers – and academics – should face the well-known problem of both internal and intertemporal inconsistency, such as demonstrated by the 2004 Nobel Prize winners Kydland and Prescott in their 1977 works. They have to consider whether the forecasting strategy they implemented is optimal or not. More precisely, they should determine the requirements on the public's forecasts. Are those forecasts based on market expectations or on a projected path with a constrained interest rates assumption? The answer to this ontological monetary issue could not be solved without considering the help of auxiliary sciences, such as cognitive science or even neuroeconomics.

5. Concluding Remarks

The NNS is undoubted proof of the power of General Equilibrium Theory methodology when academics and central bankers turn their attention to monetary policymaking. Indeed, this theory is able to reconcile two opposed analyses, eliminating the debates within the same Neoclassic Theory. This consensus between the New Classicals and New Keynesians is symptomatic of a current trend in the economic scene according to which purely theoretical problems are regarded as of secondary importance in relation to pragmatic support of economic policy. Even if the NNS uses an extremely interesting mathematical tool, it is applied to the old static theory.

It is difficult to believe that the NNS can be regarded as a satisfactory *foundation* for monetary *policy* – as claimed by Woodford – because the monetary *theory* which is used is limited by the lack of a monetary price determination mechanism. Indeed, the general price level is a *unique* monetary price computed by a representative agent based on the strategy according to which it is necessary to have knowledge *a priori* of other monetary prices. This strategy is arbitrary and it is only valid in an *imperfect* competition framework. The NNS would have been more interesting if it had adopted some *endogenous* mechanisms of formation of monetary prices, such as those developed by some Non-Cooperative Game Theory models for instance.

We have developed the idea that recent work on 'forward guidance' concepts could be one candidate for the missing piece of this puzzle. Considering that a credible central bank committed itself to a credible target criterion – so as to determine the forward path of policy – enables Woodford's model to explain the price determination process. Under a forward guidance principle, a central bank is able to shape the representative agent's expectations on the future path of the monetary data, including the relative prices of the differentiated composite goods in the economy.

The adoption of the Wicksellian theory is undoubtedly one of the most positive aspects of the NNS. However, this theoretical inheritance is not worth considering when thinking about how monetary policy should be made. Other Wicksellians could have been better candidates for such a marriage, as demonstrated by the works of Trautwein and Boianovsky. It is not only the monetary theory of the Stockholm School but also the Austrian Theory of Capital that can offer new intuitions about the role of monetary prices in dynamic macroeconomics.

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Appendix 1

The minimization expenditure programme of the representative consumer subject to a given level of consumption allows us to show that (6) *corresponds* to the equilibrium level of consumption, which is obtained from (5).

$$\text{Min. } P_t C_t = \int_0^1 p_t(z)c_t(z)dz \text{ subject to } \overline{C}_t \equiv \left[\int_0^1 c_t(z)^{(\theta-1)/\theta}dz\right]^{\frac{\theta}{(\theta-1)}}$$

Lagrange's method:

$$L = \int_0^1 p_t(z)c_t(z)dz - \lambda\left\{\left[\int_0^1 c_t(z)^{(\theta-1)/\theta}dz\right]^{\frac{\theta}{(\theta-1)}} - \overline{C}_t\right\}$$

The first order conditions are:

$$\frac{\partial L}{\partial c_t(z)} = p_t(z) - \lambda\left\{\frac{\theta}{(\theta-1)}\frac{(\theta-1)}{\theta}c_t(z)^{-\left(\frac{1}{\theta}\right)}\left[\int_0^1 c_t(z)^{(\theta-1)/\theta}dz\right]^{\frac{1}{(\theta-1)}} - 0\right\} = 0 \qquad \text{(I)}$$

$$\frac{\partial L}{\partial \lambda} = -\left\{\left[\int_0^1 c_t(z)^{(\theta-1)/\theta}dz\right]^{\frac{\theta}{(\theta-1)}} - \overline{C}_t\right\} = 0 \qquad \text{(II)}$$

We deduce $\overline{C}_t$ from (II),

$$\overline{C}_t = \left[\int_0^1 c_t(z)^{(\theta-1)/\theta}dz\right]^{\frac{\theta}{(\theta-1)}} \qquad \text{(IIa)}$$

Simplifying (I),

$$p_t(z) - \lambda c_t(z)^{-\left(\frac{1}{\theta}\right)}\left[\int_0^1 c_t(z)^{(\theta-1)/\theta}dz\right]^{\frac{1}{(\theta-1)}} = 0$$

By substituting (IIa) in the previous equation, we have:

$$p_t(z) - \lambda c_t(z)^{-\left(\frac{1}{\theta}\right)} \overline{C}_t^{\left(\frac{1}{\theta}\right)} = 0$$

We deduce $c_t(z)$,

$$c_t(z) = \left(\frac{1}{\lambda}\right)^{-\theta} \overline{C}_t \, p_t(z)^{-\theta} \qquad \text{(Ia)}$$

By substituting (Ia) in (IIa)

$$\overline{C}_t = \left[\int_0^1 \left\{\left(\frac{1}{\lambda}\right)^{-(\theta-1)} \overline{C}_t^{\frac{(\theta-1)}{\theta}} p_t(z)^{-(\theta-1)}\right\} dz\right]^{\frac{\theta}{(\theta-1)}}$$

We deduce λ,

$$\lambda = \left[\int_0^1 p_t(z)^{-(\theta-1)} dz\right]^{-\left(\frac{1}{(\theta-1)}\right)} \qquad \text{(III)}$$

By substituting (III) in (Ia),

$$c_t(z) = \frac{p_t(z)^{-\theta}}{\left\{\left[\int_0^1 p_t(z)^{1-\theta} dz\right]^{1/(1-\theta)}\right\}^{-\theta}} \overline{C}_t$$

We can write the previous equation as:

$$c_t(z) = \overline{C}_t \left(\frac{p_t(z)}{\left[\int_0^1 p_t(z)^{1-\theta} dz\right]^{1/(1-\theta)}}\right)^{-\theta}$$

We can also write $\left[\int_0^1 p_t(z)^{1-\theta}\,dz\right]^{1/(1-\theta)} = P_t$

if we want to deduce the optimum level of consumption:

$$c_t(z) = \overline{C}_t\left(\frac{p_t(z)}{P_t}\right)^{-\theta}$$

Appendix 2

We can log-linearize (7a) to obtain (7c) using a first order Taylor expansion around the steady state, which is defined by the price stability in time.

$$P_t = \left[(1-\phi)\,p_t^{*1-\theta} + \phi P_{t-1}^{1-\theta}\right]^{\frac{1}{(1-\theta)}} \qquad (7a)$$

We take natural logs to both sides:

$$LnP_t = \frac{1}{(1-\theta)}\,Ln\left[(1-\phi)\,p_t^{*1-\theta} + \phi P_{t-1}^{1-\theta}\right]$$

We write : $p_t^{*1-\theta} = e^{(1-\theta)Lnp_t^*}$ and $P_{t-1}^{1-\theta} = e^{(1-\theta)LnP_{t-1}}$,

$$LnP_t = \frac{1}{(1-\theta)}\,Ln\left[(1-\phi)e^{(1-\theta)Lnp_t^*} + \phi e^{(1-\theta)LnP_{t-1}}\right]$$

To get Taylor's expansion we need the partial derivatives.

$$\frac{\partial LnP_t}{\partial Lnp_t^*} = \frac{1}{(1-\theta)}\,\frac{1}{(1-\phi)e^{(1-\theta)Lnp_t^*} + \phi e^{(1-\theta)LnP_{t-1}}}(1-\theta)(1-\phi)e^{(1-\theta)Lnp_t^*} \qquad (I)$$

$$\frac{\partial LnP_t}{\partial LnP_{t-1}} = \frac{1}{(1-\theta)}\,\frac{1}{(1-\phi)e^{(1-\theta)Lnp_t^*} + \phi e^{(1-\theta)LnP_{t-1}}}\theta(1-\phi)e^{(1-\theta)LnP_{t-1}} \qquad (II)$$

Evaluating these derivatives around the steady state and by taking into account that $p_t^{*1-\theta} = e^{(1-\theta)Lnp_t^*}$ and $P_{t-1}^{1-\theta} = e^{(1-\theta)LnP_{t-1}}$, we get :

$$\left.\frac{\partial LnP_t}{\partial Lnp_t^*}\right|_{P_{t-1}=P_t=p_t^*} = \frac{(1-\phi)P_t^{1-\theta}}{(1-\phi)P_t^{1-\theta}+\phi P_t^{1-\theta}} = \frac{(1-\phi)P_t^{1-\theta}}{P_t^{1-\theta}} = (1-\phi) \tag{Ia}$$

$$\left.\frac{\partial LnP_t}{\partial LnP_{t-1}}\right|_{P_{t-1}=P_t=p_t^*} = \frac{\phi P_t^{1-\theta}}{(1-\phi)P_t^{1-\theta}+\phi P_t^{1-\theta}} = \phi \tag{IIa}$$

Using (Ia) and (IIa), the first order of Taylor's expansion is:

$$LnP_t \approx LnP_t + (1-\phi)(Lnp_t^* - LnP_t) + \phi(LnP_{t-1} - LnP_t)$$

Simplifying

$$LnP_t \approx LnP_t + (1-\phi)Lnp_t^* + \phi LnP_{t-1} - (1-\phi)LnP_t - \phi LnP_t$$

$$LnP_t \approx (1-\phi)Lnp_t^* + \phi LnP_{t-1} \tag{7b}$$

$$LnP_t \approx (1-\phi)Lnp_t^* + \phi LnP_{t-1}$$

We get:

$$\tilde{P}_t \approx (1-\phi)\tilde{p}_t^* + \phi\tilde{P}_{t-1} \tag{7c}$$

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