Credit and Prices in Woodford's New Neoclassical Synthesis

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Abstract

Following the recent debates in the New Neoclassical Synthesis, the theory of monetary policy had been renewed. The method that prevails, illustrated by Woodford's *Interest and Prices*, is a Dynamic General Stochastic Equilibrium Model (DGSE) 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 the monetary prices. The recent debate puts attention on the de-emphasis on nominal monetary aggregate that doesn't play any explicit role in monetary policy deliberations. Following Calvo's model, Woodford's neo-Wicksellian framework only considered monetary prices in equilibrium. As a consequence no cumulative process in the spirit of Wicksell is allowed since monetary policy—under the form of a Taylor rule—always corrects any deviation of monetary prices from its target value. The monetary nature of Woodford's approach is, then, purely arbitrary. Contrary to Woodford's ambitions to provide microeconomic foundations of a monetary policy theory, this article tries to demonstrate that Woodford's approach contains the same problem as the one embodied in the old static macroeconomics model: the lack of an explicit mechanism that endogenously explains the formation of monetary prices emerging from the spontaneous behaviour of the agents in the market.

Keywords: Credit, Prices, New Neoclassical Synthesis, History of Macroeconomics, Monetary Equilibrium.

1. INTRODUCTION

During more than thirty years, the Neoclassical Synthesis has been the dominant theoretical approach in macroeconomics theory. The expression "Neoclassical Synthesis" had been proposed by Paul Samuelson to involve the works developed by Hicks (1937), Modigliani (1944) and Patinkin (1956). This Synthesis adopts Hicks' macroeconomic IS-LM framework which is of a Keynesian type, to be later completed with the equations obtained from the behavior of maximizing agents, i.e. the Neoclassical microeconomic framework. This first Neoclassic Synthesis inaugurates a scientific project which seeks the microeconomic bases of the macroeconomics. The Phillips' curve offered the necessary "bridge" between macroeconomics and the microeconomics through the establishment of a relationship between employment, wages and inflation concepts. The adoption of this curve will involve, a few years later, the absorption of macroeconomics by microeconomics.

A clear demonstration of the success in this scientific project is the recent consolidation of a New Neoclassical Synthesis or "New Consensus" or "New Keynesian Synthesis" (Lavoie-Seccareccia, 2004). This approach groups some published works at the end of the Nineties, such as Goodfriend and King (1997, 2001), Clarida, Gali and Gertler (1999), Goodfriend (2002) and, particularly Woodford (2003), which makes the most complete presentation of this New Synthesis. These authors establish a consensus between two apparently opposite groups of economists: it adopts as the basic framework the RBC model (Real Business Cycles), taking certain assumptions of New Classicals such as rational expectations, to be then complemented with certain assumptions from the New Keynesians such as nominal rigidities on the prices and the wages. The New Neoclassical Synthesis appears as a set of models that show the bond between prices and the rate of interest as monetary policy rules, but without stressing the monetary aggregate.

The aim of this article is to show that even though the New Neoclassical Synthesis considers that it is essential to dispose a monetary theory for the monetary policy, it offers primarily the same answers as the traditional static macroeconomics. More precisely, we show that the use of dynamic optimization does not contribute in a decisive way to improve our understanding of the role that prices play in the monetary theory. In spite of that, the New Neoclassical Synthesis has the merit to try to return to the Pre-Keynesians intuitions of Wicksell (1898), which may contribute in the search not of better answers but in the search of new questions about the role of prices in a monetary theory.

We divide this paper in five sections. In the second section, we point out the general Wicksellian principles explicitly adopted by Woodford. In the third section we specify, through a very synthetic framework, the determination of the steady state in a dynamic general equilibrium model proposed by Woodford (2003). In the fourth section, we point out how the monetary price is determined in Woodford's model. Finally, we present the concluding remarks. It is important to notice that the model is sketched and not presented rigorously because our aim is to show its main features. For a rigorous presentation of the models, the reader can address directly Woodford's book.

2. WICKSELL'S MODEL AND THE PRICE DISEQUILIBRIUM PROCESS

When Wicksell came on the road of Political Economy in his late thirty seven years old -after being graduate in mathematics- it was for practical reasons. In fact, he aimed at explaining the monetary disturbances of prices of the second half of the 19th century. Wicksell's "*Interest and Prices"* (1898) has to be understood in that context. Wicksell's conception of money was in agreement with the Classical doctrines in that time in which money is considered as *a veil.* By stating that "t*he 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). Fore sure, he mainly considers money as a medium of exchange, however, he did not ignore its store of value function. Among the prevailing Classical theory, the Quantity theory of money prevails. The Wicksellian framework has to be understood with regard to the Quantity theory.

In his seminal book "*Interest and Prices*". Wicksell reveals his reliance, not to say devotion to the *old* theory while underlying its weakness and the inadequancy with reality. As defended by Trautwein and Boianovsky, the Wicksellian approach is an attempt "*to restate the Quantity theory in credit-theoretical terms*" (Trautwein/Boianovsky 2001 p.500). Wicksell expanded the Quantity theory by taking into account the modern state of the economy throughout the development of credit tools. The new banking system that emerged in the late 19th century was featured by the increasing use of credit tools, mainly bills of exchange and bank notes. Wicksell saw in that structural change a possible cause of the inflationary/ deflationary process. Wicksell's landmark in monetary theory is to have endogenized the velocity of circulation of money within the Quantity Theory. For that reason, he 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 considered[1] Wicksell considers, first, a *pure cash system* and, then, its opposite, with a *pure credit system*[2].

Wicksell's entreprise lies in the idea to give a clear understanding of the causes that push up prices. The objective is to understand the causes in the changes of the velocity of circulation of money. The idea that Wicksell had in mind was that the emergence of credit tools, featured by their capacity to adapt to whatever amount of money needed, was not without consequences on the inflationary/deflationary process of the late 19th century. In fact, as soon as money is credit, there is no technical limit to the quantity of money into circulation which is not without consequences for prices.

THE CASH SYSTEM

This hypothetical kind of economy is characterized 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 that case, the cash holdings of each agent is mainly determined by the conjuncture and the level of the economic activity. People hold money for two reasons: first, for the payments of purchases at given points of time; and, second, for unforseen disbursements. However, this ideal type does not play a major role in the isssue into question. The most important motive of the money demand in this type of economy lies in the *definite payment purposes* which allows Wicksell to state that: ``*the average velocity of circulation of money is, of almost a constant magnitude. It would react immediately against accidental expansion or contraction.*" (Wicksell, 1936 [1898], p.59). Consequently, the level of prices depends on the quantity of money into circulation. The Quantity theory is here totally relevant. However, this first case is purely *imaginary* and far from reality. So that, the above conclusion does not hold in a more realistic case.

THE PURE CREDIT SYSTEM

In this second type of economy, Wicksell takes the opposite framework as 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:

1. The case of a simple credit economy (or *unorganised)* credit system.

The economy is featured 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 not absent anymore because the necessity for holding cash balances still persists in regard to precautionary reserves against unforseen payments. These primary forms of credit are seen by Wicksell as a `` *powerful pulley for accelerating the circulation of money*" (Wicksell, 1936 [1898], p.59). The advantage brought by the credit instruments is to diminish the need for money ``*to an unlimited extent*" (Wicksell, 1936 [1898], p.59). In Wicksell's own 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 (*ibid, p.60*))

However, there are limits that prevent credit to substitute money: first, the individual lending system can not be developped untill an unlimitted extent because it only concerns a minority circle of people, *i.e* the ones who can provide guarantee for the debt; and second, obtaining credit or lending money necessitate to provide precautionary measures for both debtors and

[1] Wicksell divides the pure credit system into two stages: a *simple* (in the sense of unorganized) c*redit economy* and an *organized credit economy.*

[2] Instead of the term *pure credit system*, Woodford prefers to use the term *cashless economy* for this framework.

creditors. So that, an *unorganised* credit economy reduces the necessity for cash-holdings but it does not make it diseappeared. This imaginary case introduces us an economy in which the velocity of circulation is a ``*somewhat elastic quantity*" (Wicksell, 1936 [1898], p.61) . The level of prices, with degree of differences, is still a dependent factor of the quantity of money into circulation.

2. The case of organised credit economy.

It is a model of a banking economy with centralisation of lending by banks and monetary institutions where ``*all domestic payments are effected by means of Giro system and bookkeeping transfers*" (Wicksell, 1936 [1898], p.70). Contrary to the previous stage, credit is seen as 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*" (*ibid).* That is only in that stage that Wicksell integrates the banks in his analysis. This new actor in the monetary system is not without consequence for the economy in the extent they provide the most *powerful pulley* (Wicksell, 1936 [1898], p.59) in the circulation of money by means of bank credit.

In that case, the elasticity of money can adapt itself to whatever quantity of money needed and allow to get rid off cash money. Within this framework, Wicksell puts a special focus set on the bank notes. He considers them as: `` *a kind of deposit-receipt or cheque, which passes through a number of hands before it is presented to the banks 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 has in mind is to provide an accurate theory of the value of money in a modern framework[3].

As soon as banks, or monetary institutions, enter in the economy, the situation changed, namely the size of the cash requirement is pushed to an "*infinitesimally small amount*" (Trautwein/Boianovsky, 2001, p.511). The message which is to be remembered is that credit - whatever the form considered -is a *powerful weapon* for accelerating the velocity of circulation of money, so that it is responsible for the changes in the level of prices. In that context, the Wicksellian thesis starts emerging by underlying the full responsability of the banks, via monetary creation, in the fluctuation of the level of prices. So that, a proper regulation, under the form of a *specific* rule of behaviour for the banks, is needed in order to maintain the level of prices[4]:

``*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 occurs 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 stabilizing prices lies in appropriate regulation of banking policy?* " (Wicksell, 1936 [1898], p.80)

[3] 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 lead undoubtedly to fluctuation of its value and its consequences on the value of money. Wicksell wrote as follows on that 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, p.91). As a consequence, Wicksell's practical recommandations was to substitute the gold reserves by bank notes and to give up gold as a bullion.

[4] We need to mention that the Wicksellian program can be traced back to 1898 since according to Trautwein and Boianovsky (2001), a manuscript from 1889 already contained those basic issues and the core message of Wicksell in monetary field.

The quotation does not go further but this proper regulation that Wicksell had in mind has to be made by the central bank. In that sense and in line with the thesis defended by Humphrey, Wicksell can be ranked among the Quantity theorist since " *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 pass this test with flying colors*" (Humphrey, 1997, p.85). In this type of pure credit economy, as soon as prices start increasing / decreasing, there is no mechanism that push them back since money, under the form of credit, is endlessly elastic. This is for this reason that a *cumulative process* – in both case of inflation and deflation- appears and destabilizes the real economy (notably by forcing the economy to reallocate factors in specific industry or sectors). The best policy that Wicksell recommands 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 apparition of whatever disturbances in prices.

3. GENERAL EQUILIBRIUM IN MODERN MACROECONOMICS MODELS

The New Classical and New Keynesian economists disagree on the assumptions used to analyze 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 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.

The New Neoclassical Synthesis reconciles two types of Neoclassical approaches. The bond which grants coherence to these two analyses is that there exists a State or Central Bank which intervenes through a monetary economic policy on the variation of the prices and the monetary interest rate. On the other hand, the New Neoclassical Synthesis allows that New Classics RBC approach, in which the monetary policy is irrelevant, to be coherent with the New Keynesians approach where monetary policy is relevant. Consequently, the New Neoclassical Synthesis is concerned for both the theoretical analysis and economic policy, reason why Woodford (2003) adopts as a subtitle of his work the expression "Foundations of a Theory of the Monetary Policy".

The role of monetary prices is related to the definition of steady state in the general equilibrium macromodel. The variations of prices are compatible with a certain rule of monetary policy which takes into account the variations of the rate of interest. This bond is not new in the economic theory since the quantity theory of money, the oldest of economic theories, establishes already a fundamental link. The innovation is then in the technical rigor of the method adopted by the New Neoclassical Synthesis: the dynamic optimization in stochastic terms, which is an adequate tool to make this analysis compatible with the study of the business cycles. The New Neoclassical Synthesis is synthesized by Woodford (2003, 246) through three equations which represent the goods market, prices and rate of interest:

-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[5]. The expected short-term real rate of return determines the incentive for intertemporal substitution between expenditures in *t* and *t+1*.

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

[5] The IS equation is obtained by log-linearizing the first order household equilibrium conditions.

Where x_t is the actual output gap; E_t expresses the rationale 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 the variations in the natural rate of interest (due to real disturbances)[6]. The idea of equation (1) is that the 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.

$$\pi_t = \kappa x_t + \beta E_t \pi_{t+1} \tag{2}$$

Where π_t is the inflation rate in t ; κ is a coefficient that depends on both the frequency of price adjustment and the elasticity of real marginal cost with respect to the level of real activity; β is the discount factor defined between 0 and 1; E_t is still the rationale expectation process and x_t is the output gap defined as the discrepancy between variation in the actual output and exogenous variation in the natural rate of output which results from several types of real disturbances. The log-linear AS relation is also called the *New Keynesian Phillips curve* because of the rationale expectation process that supplements the *old* Philips curve relationship[7].

- A monetary Taylor policy rule:

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

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 which 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.

It's a Dynamic General Stochastic Equilibrium Model (DGSE) in which the old LM curve is voluntarily substituted by an optimal monetary rule. The economy should be considered under an IS-AS-monetary policy rule system in which money aggregate does not appear explicitly[8]. The general steady state is defined like a "rational-expectations equilibrium," in which there exists a path (or variation) of the general price level which ensures that the aggregate demand is

[6] This term r_t^n represents the deviation of the *natural rate* from the value consistent with a zero inflation steady state rate.

[7] The New Keynesian Phillips curve is a response from Keynesian economists to both Friedman's 1968 sharp critique of the Keynesian Phillips curve and to the rationale expectations school of thought in the 1970's (led by R. Lucas and T. Sargent). The principal answer was an attempt to build models that incorporate rationale expectations and that provide microeconomic foundations for monetary policy having at least short-run effects. The main microeconomic rationale has been *sticky prices* notably the staggered pricing model by Calvo (1983). According to such New Keynesian Phillips curve, the inflation rate can be expressed as a dynamic process with a forward looking flavour.

[8] According to Woodford (2003, p.24) is a "*Monetary Policy without Control of a Monetary Aggregate*".

on its potential level (or gap wished) and that this path is consistent with the policy on the rate of interest imposed by Taylor's rule.

Woodford (2003, p.53) considers that this system of equations is a "neo-Wicksellian framework." This adhesion of Woodford with certain proposals of Knut Wicksell is interesting because it offers clues on the theoretical range of the New Neoclassic Synthesis. Woodford is right on analyzing Wicksell's (1936 [1898]) theory because the definition of the Wicksellian equilibrium is also given by three simultaneous conditions: gross investment is equal to saving, the general price level does not change and the interest rate is equal to the natural rate of interest:

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

The first condition can be interpreted as an equilibrium on the market of goods, the second condition implies that the rate of inflation is zero and the third indicates the level of the rate of interest which is compatible with the stability of prices. These three conditions constitute a simple rule of monetary policy of stabilization, which intuitively coincides with the three equations in Woodford's model. However, Wicksell's monetary equilibrium is not a steady state, consequently, if our interest is focused on the business cycle, it is then necessary to refer to the disequilibrium situation explicit in Wicksell's model but absent in Woodford's. This is a key point to show the limits in Woodford's framework.

According to Wicksell, when the monetary interest rate is not equal to the natural interest rate, investment is higher than saving—remaining on its full employment level—and all prices increase. The disequilibrium situation is then perceived like a cumulative process of prices or inflation. However, as explained previously in section 2, the disequilibrium situation depends of the monetary regime: *cash system* (gold standard) and *pure credit system* (or *cashless* model in Woodford's terms); thus we have two types of economies. Firstly, for a 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 up to the moment when the Central Bank is likely to lose the totality of its gold reserves. In this moment, the Central Bank stop credits 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. Secondly, in a pure credit system, if the nominal interest rate is lower than the natural rate a disequilibrium situation appears: the agents demand credit and all prices increase, but since money does not have a metallic support, the Central Bank satisfies all the demands for money, then the *market of money is always in equilibriu*m. The moment in which the Central Bank stops offering money is arbitrary, so the equilibrium situation (stopping the cumulative process of the prices) is determined by the Central Bank.

Woodford proposes a monetary policy framework in a pure credit economy, in which "*there are assumed to be 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). We observed in Wicksell that if money is defined as pure credit, the money market is always in equilibrium; so Woodford's selection to analyze a pure credit system is convenient since this economy is always at the steady state.

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 that agents cannot know in advance any price variation (the rate of inflation). Wicksell must then suppose that expectations on prices are static. It was Myrdal (1939), and the others Wicksellians which introduced dynamic expectations on the variation of prices in Wicksell's theory but simultaneously rejecting the quantity theory (Tobon, 2006b).

Wicksell's theory is thus enriched: in the disequilibrium situation the agents have the possibility 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 in 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 on price variations. Woodford stands off of the most important contribution of Wicksellianism: the study of prices in disequilibrium. In this context, we can ask if this lack in Woodford's theory can be acceptable whereas he supports a "neo-Wicksellian framework". This question is developed in the following section.

4. MONETARY PRICES IN WOODFORD'S APPROACH

In the New Neoclassical Synthesis the aggregate magnitudes are derived from agent's behavior 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 maximization 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 maximization through a basic model of rigid prices. Let us analyze a theoretical approach of this model; this will enable us to show the 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 goods substitutes and bad substitutes). The whole of the goods is associated with a density of probability 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 whole of goods conform a unitary mass. Thus, there exists a continuum of goods which 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 she wishes to buy, which is represented by an integral in continuous time.

$$P_t C_t = \int_0^1 p_t(z) c_t(z) dz \tag{4}$$

The total monetary expenditure is composed by 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 see in detail these two elements. Firstly, the quantity of consumer goods C_t is, by definition, a constant-elasticity-of-substitution aggregator, adopting a utility function type CES, such as it is presented by Dixit and Stiglitz (1977).

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

$c_t(z)$ is the distribution of consumption on a continuum of goods. If all the goods are substitutes, the parameter θ measures the constant elasticity of substitution between them, with $\theta > 1$. The larger is θ, larger will be the possibility of substitution between goods. Now, in order to add-up $c_t(z)$, it must be measured correctly. Then we are trying to add-up all the different quantities of goods into a single physical measurement. At the end C_t is not a pure number but a physical magnitude.

Secondly, monetary prices which are used to evaluate the expenditure devoted to the consumption of goods are summarized in the general price level. 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 (2003, 146), 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." 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. Equation (6) *corresponds* or is compatible with equation (5) because it is obtained by minimizing equation (4) subject to (5), while assuming that C_t is given or fixed[9]. Now, because C_t is measured in physical terms and P_t is measured in monetary terms, then $P_t C_t$ from (4) is a monetary quantity[10].

The individual prices considered in P_t are given *a priori* by the representative consumer because prices are fixed by the entrepreneur which, in the presence of monopolistic competition, she can fix them according to a strategy or rule, for example that introduced by Calvo (1983). Let us see intuitively this strategy.

The problem of each entrepreneur is to maximize at each period the present value of issued stock, i.e. to guarantee equilibrium. For this purpose, it must fix the equilibrium monetary price of the consumption good to be produced, which allows her to obtain the profits (dividends) to be distributed between the stockholders. We suppose that each entrepreneur knows the equilibrium price fixed 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 signal if is adequate to modify the equilibrium price. Each entrepreneur's strategy is to modify this price if she receives a signal which indicates to do it. This signal arrives with a probability of $(1-\phi)$, whereas the probability of receiving a signal that indicates not to modify this price is ϕ. According to Woodford (2003, p.178), "*As each supplier that choose a new price for its*

[9] In Appendix 1 we show how to obtain (6), beginning with the expenditure minimization.

[10] 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 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.

good in period t faces exactly the same decision problem, the optimal price p_t^* *is the same for all of them, and so in equilibrium, all prices that are chosen in period t have the common value* p_t^*". Given this assumption, we deduce that there exists only one representative entrepreneur.

We thus arrive at the central problem about 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:

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

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

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

After simplifying[11]:

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

To interpret easily this price relation and the probability of its variation in time according to ϕ, we log-linearize equation (7a) using a first order Taylor expansion around the steady state, which is defined by price stability in time (zero inflation rate), i.e. $P_{t-1} = P_t = p_t^*$. Thus we obtain (7b)[12]:

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

Which we can define by the following expression:

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

If the representative entrepreneur receives a signal $\phi = 1$, then the general price level (expressed in natural logs) of the current period remains constant with regard to the previous

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[11] 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 $1/(1-\theta)$ power on both sides of this last equation, we obtain (7a).

[12] Appendix 2 shows log-linearization process of (7a).

period, $\widetilde{P}_t \approx \widetilde{P}_{t-1}$. These are also the prices that the representative consumer takes into account when she assesses her expenditure. On the contrary, if the representative entrepreneur receives a signal $\phi = 0$, the general price level of the current period will be will fix according to the market equilibrium reference price for this (current) period, $\widetilde{P}_t \approx \widetilde{p}_t^*$. But if $0 < \phi < 1$, the general price level is then fixed proportionally according to the market equilibrium reference price for this (current) period and the price level is fixed during the previous period.

Once presented in a very synthetic way the role play the prices in the New Neoclassical Synthesis, we can ask about their theoretical implications. Going from the microeconomics approach to the macroeconomics approach by the means of the representative agent hypothesis is controversial. This hypothesis implies an economy composed by two representative agents, who's decisions of production and consumption relate to only one composite goods and only one monetary price: 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 possible because she knows *a priori* the parameter θ, which means that the relative prices are known; then the prices are not necessarily monetary. We are in the presence of the standard Neoclassic Theory of the Value (there is no money) and not necessarily a monetary theory.

From the entrepreneur's point of view, the only monetary price or general price level is given while following a particular strategy, compatible with the decisions of consumption. Indeed, according to (7c), it is necessary to know: the probability ϕ, 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 is not easy to justify how the latter are determined. Firstly, P_{t-1} depends on the price determined during the previous period *t*-2 and so on. But, how do we determine the first price? A possibility is to suppose that we use a markup on marginal cost in the following way $P_t = \mu(Cmg)$, however this implies that we know *a priori* the markup, when this was what we sought to determine in the equilibrium, like Goodfriend (2002).

Secondly, the existence of p_t^* is a mystery, how does the representative entrepreneur imagine this price? A clue to answer this question is precisely the parameter ϕ which can be interpreted as a social convention or an institution which 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 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 which must precisely explain the monetary structure of the economy. Equation (7c) only determines the intertemporal *variation* of the given *a priori* monetary prices which ensure the steady state in imperfect competition.

5. CONCLUDING REMARKS

The New Neoclassical Synthesis is undoubtedly the proof of the power of the general equilibrium theory. 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 symptom of a current trend in the economic scene according to which the purely theoretical problems are relegated *vis-à-vis* to the concern of giving a pragmatic support to the economic policy. Even if the New Neoclassical Synthesis uses an extremely interesting mathematical tool, it is applied to the old static theory.

It is difficult to believe that the New Neoclassical Synthesis can be regarded as a satisfactory foundation for the monetary *policy* because the monetary *theory* which is used like a rational base 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 she is only valid in imperfect competition. The New Neoclassical Synthesis would be more interesting if it had adopted some endogenous mechanisms of formation of monetary prices which have some Non-Cooperative Game Theory models. The adoption of the Wicksellian theory is undoubtedly one of the most positive aspects of the New Neoclassical Synthesis. We think that Wicksell's theory, the Stockholm School monetary theory and the Austrian theory of capital can offer new intuitions about the role of monetary prices in dynamic macroeconomics.

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 1level of consumption, which is obtained from (5).

Min. $P_t C_t = \int_0^1 p_t(z)c_t(z)dz$ 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.

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

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.

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

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

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 :

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

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

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

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

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

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

We get :

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

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