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“Solvency rule” versus “Taylor rule”

An alternative interpretation of the relation between monetary policy and the economic crisis

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Abstract

One of the more debated interpretations of the economic crisis that started in 2007-2008 is based on the “Taylor rule” equation, namely the idea that over the period 2002-2005 the Fed has implemented a low-interest policy which has led to the housing bubble, and finally to the ‘Great Recession’. This paper shows that the “Taylor rule” equation not only rests on the so-called “New Consensus Macroeconomics”, but also on the neoclassical theory of growth. The various criticisms raised against these theoretical foundations suggest that interpretations of the ‘Great Recession’ based on the Taylor rule equation are building their arguments on shaky theoretical premises. Furthermore, this paper shows that an equation formally similar but logically alternative to the Taylor rule can be regarded as the expression of a general condition of solvency of firms and workers. According to this “solvency rule” the prevailing outcome of monetary policy decisions is the “regulation” of insolvencies.

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JEL classifications: E11, E12, E13, E5, G33

Mr. Taylor unequivocally claimed that had the Federal Reserve from 2003-2005 kept short-term interest rates at the levels implied by his "Taylor Rule", "it would have prevented this housing boom and bust". This notion has been cited and repeated so often that it has taken on the aura of conventional wisdom.

Alan Greenspan (2009)

1. Introduction

The world-wide economic crisis that first manifested itself with the financial crisis of 2007, and then the 'Great Recession' in 2008, has given rise to an intense debate about its causes and the necessary changes in economic policy required to address it. One outstanding aspect of the discussion is the remarkable degree of attention devoted to the "Taylor rule" equation, a simple reaction function originally designed to identify the "optimal" monetary policy of the central banker (Taylor, 1993, 1999; Clarida *et al.*, 2000; Woodford, 2001).

John Taylor has argued that the main reason for the crisis lies in the decision by Federal Reserve (Fed) to set an interest rate on federal funds far below the level suggested by the "optimal rule" bearing his name (Taylor, 2009a, 2009b). He accuses this low-interest policy, implemented by the Fed over the period from 2002 to 2005, of generating the real-estate bubble of recent years, and thus paving the way for the financial and economic collapse of the US economy. Furthermore, the Stanford economist regards the policy of a Fed rate close to zero as necessary to cope with the outbreak of the crisis, but he adds that this line of action should have to be abandoned quickly in order to avoid new speculative bubbles (Taylor, 2009c).

Taylor's views have drawn immediate reactions and criticisms from some of the key figures in the US Federal Reserve system (see, e.g., Rudebusch 2009, Dokko *et al.*, 2009) and from leading economists like Paul Krugman, among others. The debate is still ongoing. However, it should be pointed out that the controversy does not regard the theoretical foundations of the monetary policy rule, but appears to boil down to no more than a problem of the choice of the parameters and variables to be used in the Taylor rule equation. In other words, the conceptual basis of the Taylor rule equation seems to be accepted among those involved in the discussion.[1] But, the rule in question is not theoretically "neutral". It rests on the New Consensus Macroeconomics (NCM) model (Arestis, 2009), which in turn is based on the traditional neoclassical model of growth developed by Solow (1956).

The first objective of this paper is therefore to make explicit the link between the Taylor rule equation, in which adjustments to the short run nominal interest rate are used to maintain an inflation target and the trend level of economic growth, and the neoclassical growth model. Once this link is made explicit, the second objective of the paper is to show that the inadequacy of the neoclassical growth model raises serious issues about the Taylor rule equation, which in turn means that interpretations of the 'Great Recession' based on the Taylor rule equation are building their arguments on shaky theoretical premises. The third and final objective of the paper is then to show that from a Post Keynesian and Sraffian perspective[2] it is possible to derive a monetary policy rule equation which is formally similar but logically alternative to that developed by Taylor. This alternative "Solvency rule" equation allows for a formal rationalization of the substantial amount of empirical evidence linking inflation and growth rates on the one hand, and the nominal interest rate set by the central bank, on the other. However, the Solvency rule equation shows that the prevailing outcome of the policy decisions of the monetary authorities is actually the "regulation" of insolvencies of firms and workers, rather than long-run price stability and short-run output stabilization as in the Taylor rule equation.

2. The neoclassical foundations of the Taylor rule equation

The Taylor rule equation is not theoretically neutral. It is embedded in a conceptual framework that appears to have won most acceptances during the last two decades and can be encapsulated in the following five assertions (e.g. Taylor, 2000; Meyer, 2001). First, the economy tends in the long run towards a "natural" equilibrium that can be correctly described by the condition of proportional growth of the neoclassical model of Solow (1956) or one of its many variants, like those based on Cass-Koopmans dynamic optimisation models. Second, there is no trade-off between inflation and unemployment in the long run. Third, due to imperfections and asymmetries causing prices to become temporarily rigid, a trade-off emerges in the short run that can give rise to fluctuations of the system around the equilibrium of proportional growth. Fourth, the scale of fluctuations depends largely on expectations as regards inflation and future decisions of the monetary authorities. Fifth, the decisions of the monetary authorities can be interpreted in terms of policy "rules" in which the short-run nominal interest rate constitutes the policy tool, and is adjusted in response to economic fluctuations.

The last of these propositions describes precisely the Taylor rule equation. This set of assertions can be regarded as the kernel of current mainstream macroeconomic thinking. Also known as the "New Consensus Macroeconomics" or NCM (Woodford, 2003), this admits fluctuations of the economic system only in the short run. In the long run, it is assumed that the economy always tends towards a level of production and distribution of resources that correspond to Solow's equilibrium of proportional growth, which is determined on the basis of the typical neoclassical fundamentals of endowments, preferences and technology (Hahn, 1982). It should be noted moreover that advocates of the NCM model regard the equilibrium stemming from the neoclassical model of growth as contributing to the determination of the Taylor rule equation. While the literature generally tends to overlook this causal link, this paper makes it explicit.[3]

The model presented here describes an economic system closed to foreign trade. The actors taken into consideration are workers, firms and their owners regarded as a whole, and the central bank. As regards technology the simplified case in which a single good is produced by means of labour and the good itself is considered. Where not specified, the period of reference is t. K is the quantity of the good available as capital, and therefore for use as a means of production, L the quantity of homogeneous labour employed, and Y the physical quantity of the good produced. Therefore, the production function can be defined as $Y = F(K, L)$. The rate of capital depreciation is assumed to be equal to one, which means that the means of production are exhausted within the space of a single period. It is also assumed that the production function has constant returns to scale, i.e. $\alpha Y = F(\alpha K, \alpha L)$. By positing $\alpha = 1/L$ and defining $k = K/L$, the quantity of product per unit of labour employed is: $y = f(k)$, where $y = f(k) = Y/L$. It is assumed that this function is continuous and differentiable, and that the following conditions are met: $f(0) = 0, f'(k) > 0, f''(k) < 0$. Finally, the following hypotheses about the distribution of income between the agents of production to those regarding the technology are included. First, it is assumed that the income produced is shared entirely between profit-earners and wage-earners. Using W to denote the monetary wage, r the own rate of interest on capital and P the monetary price of the only good produced, it follows that $PY = WL + (1+r)PK$. Dividing the whole by PL, then:

$$(1) \quad f(k) = \frac{W}{P} + (1+r)k$$

Second, it is assumed that labour and capital are remunerated in proportion to their respective marginal productivity. This can be expressed as follows in per capita terms:

$$(2) \quad f'(k) = 1 + r$$

The final element to be considered is the equation of equilibrium between produced income and expenditure, all of which are expressed in physical terms: $Y = C + I + Z$. The term $C = (1-s)Y$ indicates consumption as a function of income Y and the propensity to save s. The term $I = (1+g)K$ indicates investment, which corresponds to the replenishment and growth of capital at the rate of accumulation g. Finally, Z represents real autonomous expenditure that does not generate productive capacity (e.g. autonomous private consumption). The model also assumes that the income produced and saved is transformed entirely into investment. The equilibrium of production and expenditure is therefore given by $sY = (1 + g)K + Z$. This is divided once again by L in order to express the whole in per capita terms. In equilibrium of proportional growth $g = g_n$, where g_n is the growth rate of the workforce. By defining $z = Z/Y$, then it is:

$$(3) \quad sf(k) = (1 + g_n)k + z$$

The system of equations (1), (2), (3) concisely describes the well-known neoclassical model of growth developed by Solow (1956). Given the customary hypotheses regarding production technology, it is shown that the economy tends towards the equilibrium of proportional growth. The exogenous variables required to determine this equilibrium are z, s and g_n. As regards to the endogenous variables, equation (3) determines k, while r and W/P are obtained respectively from (2) and (1). Moreover, for every given period of time t, it is also possible to determine the equilibrium levels of the absolute magnitudes. Given the growth rate of the workforce, if the hypothetical initial endowment of labour L_0 is known, then the current endowment of labour L can also be determined. Once L is known, with k and $f(k)$ being already determined, the levels of K and Y will also be determined. In accordance with a tradition well established in neoclassical economics, the values corresponding to the equilibrium of proportional growth will be defined from now on as values of "natural" equilibrium, and therefore marked with an asterisk (r^*, Y^*, ...).
Once the equilibrium of the growth model has been determined, it is necessary to examine the possible temporary deviations from it. To this end, g_d is used to represent the percentage deviation of current production Y from the natural level Y^* deriving from Solow's equilibrium: $g_d = (Y_{t+1} - Y_t^*)/Y_t^*$. Assuming that $u = Y/Y^*$ and taking into account that $Y^* = Kf(k)/k$, the term g_d can always be related to the rate of accumulation g on the basis of the following relation: $1 + g_d = u(1 + g)$. It is now possible to introduce the so-called Taylor rule equation, according to which the central banker sets the nominal interest rate i on the basis of the divergence of current inflation π from a specific target rate π^T, and on the basis of the percentage deviation g_d of current production from its level of natural equilibrium. One typical formulation of the rule is the following:

$$i - \pi = \mathrm{r}^* + \theta(\pi - \pi^T) + \lambda g_d$$

The term r^* represents the natural real interest rate derived from the equilibrium of proportional growth. The Taylor rule equation shows that if inflation rises above the target and production above its natural level, the central bank will tend to set a nominal interest rate that must, net of inflation, be higher than the natural interest rate. The opposite course of action is taken if the opposite conditions prevail. This is the so-called Taylor principle. A central bank can stabilize the economy by raising the short-run nominal interest rate more than one-for-one in response to higher level of inflation. If instead current inflation coincides with the target ($\pi = \pi^T$) and current production Y with the natural level Y^* (for which $g_d = 0$), the nominal interest rate net of inflation must coincide with the natural interest rate. The Taylor rule equation can then be re-written as follows:

$$(4) \quad i = (r^* - \theta\pi^T) + (1+\theta)\pi + \lambda g_d$$

This is a formulation frequently used in the literature and the one used in the remaining of the paper. In accordance with Taylor's assertions, two particular versions of the *IS*-type equation and Phillips equation are introduced into the model. The *IS*-type of equation describes an inverse relation between the nominal interest rate i minus the current rate of inflation π, and the deviation g_d of current production from its natural level:

$$(5) \quad g_d = g_0 - \beta(i - \pi)$$

The Phillips curve defines a direct relation between the deviation of production from its natural level and the rate of variation of inflation $\Delta\pi$:

$$(6) \quad \Delta\pi = \varphi g_d$$

It is possible at this point to complete the solution of the system. Given the target rate of inflation, and assuming that the current rate of inflation was determined at the end of the previous period, (4) and (5) simultaneously determine the nominal interest rate i and the deviation g_d of production from its natural level. Finally, once g_d is known, (6) determines the rate of variation of inflation $\Delta\pi$.

The system of equations (1)–(6) thus constitutes a typical New Consensus Macroeconomics (NCM) model (e.g. Taylor 2000). This is of course a simplified version, which can be complicated at will through suitable microfoundations, and particular hypotheses regarding the appropriate forms of the market. For example, the Solow equations can be supplemented with a function of intertemporal optimisation of consumption, the *IS*-type of equation can be regarded as the first-order condition of a problem of intertemporal maximum, the Phillips relation can derive from a model of staggered price setting on the part of firms endowed with market power, and the Taylor rule equation can be seen as the derivation of a target function of the central banker (Clarida *et al.*, 1999). This means that all the equations of the NCM model can be derived from precise microfoundations in complete accordance with recent advances in mainstream macroeconomics. In any case, the point to be underscored here is that this model highlights the logical dependency of the Taylor rule equation on the typical equilibrium solution of proportional growth derived from Solow's neoclassical model.

3. The Taylor rule-based interpretations of the crisis

According to Taylor, the parameters of the rule should be set at the following levels:

(4*) $i = 1 + 1.5\pi + 0.5g_d$

These parameters were initially derived from a *positive* analysis of Fed monetary policy, and in particular from a correlation test on the conduct of the US central bank between 1984 and 1992 (Taylor, 1993). Taylor subsequently has repeated the test over longer periods of time, and has claimed that the same parameters appear capable of describing the Fed's behaviour during most of the following years better than any other coefficients of correlation (Taylor, 1999, 2009). Above all, however, he suggests that not only positive but also *normative* use should be made of his analysis. In this connection, Taylor draws attention to the lower variability of the rates of inflation and growth of production registered in periods during which the Fed adopted a monetary policy in line with his estimated parameters. He has then used this as support for the idea that his equation can be interpreted as an authentic "rule", and that the central banker should always set interest rates in accordance with the estimated equation in order to obtain the best performance in terms of stability of prices and income. Taylor's indictment of the Federal Reserve is born precisely out this. The US central bank is accused of setting the rate on federal funds significantly below the level calculated on the basis of his equation in the years from 2002 to 2005. Taylor concludes from this that the Fed must have deviated from the optimal rule of monetary policy, thus generating real-estate inflation, the growth of mortgages and the associated speculative bubble all the way to the final collapse of the US economy (Taylor, 2009a, 2009b). Examining the most recent data, he then claims that the Fed is back on the right track of the Taylor rule equation, but adds that if it intends to remain on the straight and narrow, it will probably have to raise the interest rates quite soon (Taylor, 2009c).
Central bankers were quick to reply to Taylor's accusation. Taking up an argument previously put forward by present governor Bernanke (2005), the former governor Greenspan describes the Taylor rule as a useful first approximation to the path of monetary policy, a "guidepost" for helping the central bank decision making process (Greenspan, 2009; see, also, 1997). The Taylor rule produces useful insights and provides general orientations with some leeway based on a wide array of data regarding e.g. the value of the potential output and the natural rate of interest as well as judgemental considerations within the Federal Open Market Committee (FOMC).
Furthermore, Greenspan (*op. cit.*) mantains that the recent interpretation by Taylor overlooks important structural changes, including the deflationary effects of productivity changes and the drop in interest rates throughout the world caused by "excess savings" in China and other emerging countries. These important

structural changes, he argues, have constituted crucial factors in the lowering of interest rates, the growth of private borrowing and the resulting property boom. On this view, the Fed appears to be quite blameless. In setting the rate for federal funds, the central bank seems to have followed the "optimal rule", while also taking into account structural changes that Taylor instead overlooks.

Divergences on the interpretation of the Taylor rule equation have also emerged more recently. A report of the Federal Reserve Bank of San Francisco maintains that as a result of the 2007 financial crisis and related recession a correct application of the Taylor rule equation would entail negative interest rates of as much as minus five percent on federal funds (Rudebusch, 2009). This study sparked off a large debate in policy making circles and in the media, and prompted Krugman (2009) to admonish those who insist on the need to implement a restrictive policy soon in order to avert the resurgence of inflation and speculation. Taylor (2009c) immediately replied by arguing that the Fed study refers to expected future values still awaiting verification. He also pointed out that the parameters adopted in the study did not correspond to the original ones, and indeed the only ones in his view capable of making the equation an authentic "rule" of conduct. The Stanford economist basically accused the Fed report of estimating the parameters of the "rule" over an unduly extended span of time, rather than focusing the test exclusively on periods characterised by low variability of inflation and income.

Be that as it may, this paper is not concerned with in-depth examination of the terms of the dispute. It is instead important to stress that the debate does not concern the theoretical foundations of the monetary policy rule, but appears to be simply a problem about the choice of the parameters and variables to be used in the Taylor rule. In other words all of the participants involved in the discussion essentially agree on the use of the Taylor rule equation, and hence they implicitly accept the New Consensus Macroeconomics model in which the equation is embedded.[4]

4. Criticisms of the Taylor rule equation and the New Consensus Macroeconomics model

Is it therefore possible to assert that there exists unanimous agreement about the New Consensus Macroeconomics (NCM) and the associated Taylor rule equation? Not exactly: it is in fact possible to find numerous criticisms to the New Consensus Macroeconomics model (e.g. Arestis, 2009), and also to the neoclassical growth model foundations on which the NCM rests (e.g. Setterfield, 2002). These criticisms find inspiration in the work of Keynes, Sraffa, Kalecki, Kaldor, Joan Robinson, and their followers. Some of these criticisms question the existence of the *IS-type* and Phillips equations, and more generally they dispute the admissibility of a natural equilibrium associated with the neoclassical growth model. Critics of the NCM model have also cast doubt upon the existence of a precise causal link between interest rates and aggregate demand (e.g. Kriesler and

Lavoie, 2007). In a similar way, they have called into question the thesis of an inverse relation between interest rates and inflation, and suggested the possibility of a direct relation based on costs (e.g. Lima and Setterfield, 2011). At a deeper level, critics of the NCM have recalled that the natural equilibrium of the neoclassical models of growth is vulnerable to the same objections as the neoclassical theory of capital, and therefore permissible only within the unrealistic hypothesis of a world with a single good (Pasinetti, 2000; Petri, 2004).[5] These criticisms have then been joined by other more general criticisms, challenging the attempts of mainstream analysis to identify changes in the neoclassical fundamentals of scarcity and utility as the root causes of the general economic equilibrium (e.g. Graziani, 2003). The criticisms listed above are only an example of the possible criticisms of the New Consensus Macroeconomics and the neoclassical growth models. The basic point here is that once the NCM model and its neoclassical foundations are rejected, it is no longer possible to accept the Taylor rule equation. It is in fact clear that if the inverse relation between the interest rate and aggregate demand is not accepted, and the existence of the natural equilibrium denied, then the logical foundations of the "optimal" rule of monetary policy also crumble.[6]

A question arises at this point. If the conceptual basis of the Taylor rule equation is rejected, is it possible to find an alternative theoretical explanation for the existence of a statistical correlation underpinning equation (4)? It should be borne in mind in this connection that there is a fairly substantial amount of empirical evidence that appears to confirm the link between inflation and growth rates on the one hand, and the nominal interest rate set by the central bank on the other.[7] It is thus interesting to ascertain whether or not it is possible to delineate an alternative theoretical interpretation of this empirical evidence.

5. An alternative monetary policy rule: the "solvency rule" equation

The purpose of this section is to show that it is possible to formulate an equation similar to (4) within a theoretical context alternative to the New Consensus Macroeconomics (NCM) model. It is worthy to clarify that in the literature critical of the NCM model, it is already possible to find some alternative monetary policy rules. Atesoglu (2008), for example, proposes a new rule designed primarily for maintaining full employment. However his approach is *normative* because is aimed to show what the monetary authorities ought to do in order to pursue certain goals. On the contrary, the analysis in this section is mainly *positive*, being based on the aim of unveiling some neglected foundations of the actual behaviour of central banks.

The alternative policy rule presented here has the following basic features. First, both in the short and in the long run income and employment are determined by means of a Keynesian macroeconomic equation with different propensities to consume out of wages and profits.[8] Second, and in line with the Sraffian tradition, "normal" prices and distribution are determined on the basis of a given distributive variable, such as the "normal" profit rate. These two features are made mutually consistent by the fact that the degree of utilization of productive capacity is assumed to be endogenous.[9] Third, the relationships between real and monetary variables, the deviations of market prices and distribution from their "normal" levels, the role of credit and the related solvency conditions of the macro agents involved in the production and accumulation processes are made explicit.[10]

With respect to the NCM model, the object of the analysis does not change: a capitalist system closed to foreign trade. The economic agents considered are workers, firms and their owners regarded as a whole, and the central bank. Banks are examined only for the financial relationships that they establish with firms and workers: no explicit reference will be made to financial services produced, and the resulting income distributed. Unlike the NCM model, this scheme is not vulnerable to the criticism of the neoclassical theory of capital, and is therefore fully capable of representing a multi-sector system as well. For the sole purpose of immediate comparison with the NCM model, however, use will be made here too of a model with production limited to just one good.[11] Starting with the equation of income produced: $PY = WL + (1+r)PK$, dividing the whole by PL, it follows:

$$(1') \quad f(k) = \frac{W}{P} + (1+r)k$$

As regards technology, it should be borne in mind that in this theoretical framework no particular hypotheses about the production function is required.[12] For the sake of simplicity, it is assumed here that there is only one production technique, which corresponds in conditions of normal utilization of productive capacity to $k = K/L$ and $f(k) = Y/L$. It therefore follows that:

$$(2') \quad k = \bar{k}$$

It is now assumed that the exogenous rate of profit r represents "normal" distribution, which depends on a set of political and institutional factors and ultimately on the balance of power between different macroeconomic agents. For every given monetary wage W, equations (1') and (2') therefore make it possible to determine not only the normal level of the real wage, but also the monetary price P corresponding to normal distribution. It is also assumed, however, that actual distribution may persistently deviate from its normal value. The reason is that changes in monetary wages and prices or in the use of productive capacity can determine continuous changes in the current rate of profit. The deviation of the current profit r_t from the normal rate r is represented by $\gamma = r_t/r$. Finally, it is assumed that workers save a share s_w of their income and firms and their owners save a share s_f of theirs, with $s_f > s_w$. Given all these hypotheses, the macroeconomic equilibrium is defined as follows:

$$WL + (1+\gamma r)P_{t-1}K = (1-s_w)WL + (1-s_f)(1+\gamma r)P_{t-1}K + (1+g)PK + PZ$$

By dividing the whole by PY, defining the total amount of the rate of inflation as $(P/P_{t-1}) = (1 + \pi)$ and rearranging the terms, the condition of macroeconomic equilibrium is:

$$(3')\quad 1+\gamma r = \frac{(1+\pi)}{s_f}\left[1+g+z\frac{f(k)}{k}-s_w\frac{W/P}{k}\right]$$

It may worthy to consider now the problem of solvency. For the sake of simplicity, it is assumed that at the end of the current period firms must repay to banks the loans obtained in the previous period for investment. At the end of each period, firms are solvent (on average) if their incomes and the loans which they obtain are greater than or equal to expenditures, repayments of previous loans and net acquisitions of assets:

$$WL+(1+\gamma r)P_{t-1}K+FL \geq (1-s_f)(1+\gamma r)P_{t-1}K+(1+g)PK+(1+i)FL_{t-1}+WL+NA$$

where FL represents the loans obtained and NA is the net acquisition of assets by firms in the current period. If it is assumed that in the aggregate $NA = 0$ and that the owners of firms do not finance consumption by means of debts, then the amount of loans in each period corresponds to:

$$FL=(1+g)PK+\lambda(1+i)FL_{t-1}$$
$$FL_{t-1}=(1+g)P_{t-1}K_{t-1}+\lambda_{t-1}(1+i)FL_{t-2}$$

The term λ represents the degree of "financial instability" (Minsky 1977) and indicates to what extent firms draw on refinancing. This variable does not simply reflect the behaviour of firms. Rather, it depends on the orientation of the institutions that regulate the financial system. When $\lambda = 0$ firms can be considered "hedge" borrowers because they pay back all maturing loans and relative interests at the end of each period. When $\lambda \leq 1/(1+i)$ firms can be defined "speculative" borrowers because instead of refunding all the debt they demand and obtain a renewal of the loan on part of the capital borrowed. When $1/(1+i) \leq \lambda \leq 1$ firms are "ultra-speculative" or "Ponzi" borrowers, because they rely on a renewal of the loan not only on capital but also on due interests. Following the literature on the "financial instability hypothesis", it is assumed that after a period of "financial tranquillity" public authorities tend to loosen their controls over the financial system, and economic agents move from hedge to speculative positions (Minsky 1977, Kindleberger 1978). In order to examine the effects of this change, the degree of financial instability of the previous period is set at $\lambda_{t-1} = 0$. On the basis of these definitions and hypotheses, the average solvency condition of firms becomes:

$$(1-\lambda)(1+i) \leq s_f(1+\gamma r)$$

By substituting (3') in the solvency condition, remembering (1'), considering πg and πr negligible and imposing the symbol of strict equality, it follows:

$$(4')\quad i=\left(\frac{1}{1-\lambda}\right)\left[1+s_w(1+r)+\left(1+(z-s_w)\frac{f(k)}{k}\right)\pi+g\right]-1$$

The alternative scheme described by equations (1')–(4') is complete at this point. There is in fact no space left for a re-visitation of the NCM equations (5) and (6), since the alternative approach presented here denies the existence of deterministic causal relations between interest rates and aggregate demand, and between aggregate demand and variations in inflation. The solution of the alternative system is thus as follows: given *k*, *W* and *r*, (1') and (2') determine *P* and therefore W/P too; with *P* known and P_{t-1} given from the previous period, π will also be determined; given *g* from the autonomous decisions of firms, and assuming that *z* is also given, (3') determines γ and then the current rate of profit γr capable of ensuring macroeconomic equilibrium; finally, (4') determines the rate of monetary interest compatible with the average solvency condition of firms.
It is not difficult to note a formal similarity between equation (4') and equations (4) and (4*) representing the Taylor rule.[13] The structure of (4') appears to present some characteristics that could on closer examination prove compatible with (4*), and even with some of the empirical tests on the Taylor rule carried out in more recent years. It is, however, important to clarify that the meaning of (4') changes radically in this context with respect to the original equation. Taylor sees the optimal rule described by (4) as indicating the intention of the central banker to calibrate interest rates in relation to the objective of ensuring the stability of inflation around the target rate, and the convergence of income towards its natural rate equilibrium. Within the alternative approach, (4') instead assigns to the central bank the very different task of adjusting interest rates in relation to the average conditions of solvency of firms. In other words (4') can be seen as a sort of "solvency rule" for the monetary authorities. If the central bank follows this rule, firms will be on average solvent.
But what happens behind the average values? To this regard it may be useful to remember that, for any given level of λ, the right hand side of (4') expresses the average level of the current profit rate. Around this average level there will be a whole range of profit rates. The dispersion of these rates reflects the specific situation of the various firms in the system, which in turn depends on the allocation among them of the monetary aggregate demand. Therefore, on the basis of their respective profit rates, firms can be ordered according to their economic and financial position, from the more profitable and hedge to the less profitable and then more exposed to bankruptcy. Some firms will generate profits above the average rate of profit contained in the right hand side of (4'), while others will generate profits below the average. On this view, the central banker assumes the role of "regulator" of a social conflict in production and distribution between firms capable of accumulating profits much higher than interest rates, and hence abundantly solvent, and firms which tend to make losses and hence become insolvent. The higher the interest rates set by monetary policy with respect to the

one deriving from (4'), the greater the number of firms at risk of insolvency and the greater the probability of a tendency towards bankruptcies, takeovers and hence the "centralisation" of capital (Marx 1867). The solvency rule then reveals a link between monetary policy and the conflicting and hierarchical relationships among firms, which so far has not found room in the NCM model.

6. Indebtedness and solvency of workers

The previous section has shown the formal similarities and the substantial differences between the monetary rules expressed by (4) and (4'). However, the analysis has only focused on the solvency of firms. In order to determine a more general solvency condition it is necessary to consider the indebtedness of workers too.[14] Assuming that *Z* represents the additional consumption of workers financed by loans, then at the end of each period workers are solvent (on average) if their loans and incomes are greater than or equal to expenditures, repayments of previous loans, and net acquisitions of assets:

$$WL + FL^w \geq (1 - s_w)WL + NA^w + (1 + \alpha i)FL^w_{t-1}$$

where FL^w are the loans of workers, NA^w represents the net acquisition of assets by workers and α is the ratio between the interest rate on loans to firms and the interest rate on loans to workers. It is also assumed that in the aggregate $NA^w=0$. Then it follows that:

$$FL^w_t = Z_t + \lambda(1+i)Z_{t-1}$$
$$FL^w_{t-1} = Z_{t-1} + \lambda_{t-1}(1+i)Z_{t-1}$$

For the sake of simplicity it is assumed here that firms and workers have the same degree λ of financial instability. As it has been assumed for firms, the previous degree of financial instability of workers is set to $\lambda_{t-1} = 0$. As a consequence, the solvency condition of workers becomes:

$$s_w WL \geq (1-\lambda)(1+i)Z_{t-1}$$

It can be then written that $Z_t = (1+b)Z_{t-1}$, where b is the growth rate of expenditures financed by workers indebtedness. Dividing now all terms for PY, substituting (1') and imposing a symbol of strict equality, then the solvency condition for workers can be rewritten in these terms:

$$(5') \quad \alpha i = \frac{1+b}{z(1-\lambda)}\left[s_w\left(1 - \frac{(1+r)k}{f(k)}\right)\right] - 1$$

7. The "solvency rule" as a general monetary policy rule

Together equations (4') and (5') form a general alternative "solvency rule" equation of monetary policy. For any given degree λ of financial instability, the alternative rule determines the rate of interest i consistent with the average solvency conditions of both firms and workers. The addition of (5') to the system of equations (1')–(4') does not change its formal solution. The only novelty is that for ensuring the average solvibility of the whole system, the central banker has to fix an interest rate that cannot be greater of the lowest rate resulting from conditions (4') and (5').
The solvency conditions can also be represented in graphical terms. They can be expressed by making explicit i as a function of λ. Both (4') and (5') have always an upward slope: $\delta i/\delta\lambda$ is positive because a tendency towards more speculative positions allows firms and workers to bear the weight of higher interest rates. Obviously, the (relative) position of the functions changes according to the values assumed by the variables and the parameters of the alternative rule. For example, if the exogenous normal rate of profit r grows, then the normal real wage decreases. As a consequence, (4') will move upward, while (5') will move downward, i.e. the interest rate consistent with the solvency of firms will increase, while the interest rate determined on the basis of the solvency of workers will decrease. This is not surprising: a change in income distribution in favour of profits makes workers more exposed to insolvency in case of high interest rates. It should also be noted that in some cases the functions intersect for a specific value assumed by λ. For example, with $\alpha > 1$ and considering the interval $0 \leq \lambda < 1$, an intersection exists if both of the following conditions are respected:

$$\frac{1+\mathrm{b}}{\alpha z}\left[s_w\left(1-\frac{(1+r)k}{f(k)}\right)\right] < \left[1+s_w(1+r)+\left(1+(z-s_w)\frac{f(k)}{k}+s_w\right)\pi+g\right]$$

$$1-\frac{1}{\alpha}+\frac{1+b}{\alpha z}\left[s_w\left(1-\frac{(1+r)k}{f(k)}\right)\right] > \left[1+s_w(1+r)+\left(1+(z-s_w)\frac{f(k)}{k}+s_w\right)\pi+g\right]$$

This case shows that in some circumstances an increase in the degree of financial instability λ affects the relative financial expositions of firms and workers. For example, it may bring workers from a relatively safe to a relatively fragile financial situation, and *vice versa*. Figure 1 below shows the graphical representations of equations (4') and (5') in both cases, without and with an intersection, respectively:

PLEASE INSERT FIGURE 1

In summary, equations (4') and (5') constitute a general monetary policy rule equation which is conceptually antagonistic to the Taylor rule equation. The alternative rule does not focus on the traditional problems of managing the interest rates in order to achieve specific objectives in terms of inflation and growth rates. Rather, it suggests that the monetary policy decisions of the central banker affect the solvency conditions of firms and workers.[15]

8. Solvency rule-based interpretations of the crisis

The Taylor rule equation has several attractive features. It represents a simple and parsimonious structure of the economy. It assumes that, under some strong assumptions about the natural rate of interest and the potential level of output,[16] the central bank can focus attention simultaneously to developments in both output and inflation. However, the previous sections have argued that the inadequacy of the neoclassical growth model and the New Consensus Macroeconomics brings into question the Taylor rule equation. This also means that interpretations of the global financial crisis based on the Taylor rule equation are building their arguments on shaky theoretical premises.

The Solvency rule also represents a simple and parsimonious structure of the economy, while embedding crucial aspects of central banking. It is derived from an alternative theoretical framework to the one used for the Taylor rule equation. As a result, the goals of the inflation target and the output gap are downgraded at the advantage of the solvency conditions for firm and workers: by linking directly interest rate decisions to the solvency of the macro agents operating in the economy, the Solvency rule offers a convenient tool for drawing attention to what Goodhart has recently defined the raison d'être of a central bank, namely its financial stability role (Goodhart 2010).[17] Furthermore, the Solvency rule seems to be consistent with the substantial amount of empirical evidence that links inflation and growth rates on the one hand, and the nominal interest rate set by the central bank on the other.

To be sure, the Solvency rule should not be considered a mechanistic formula for setting the operating variables controlled by the central bank. The Solvency rule only provides a rough benchmark for policy decisions. The actual response of the central bank would always depend on the best estimates and judgments at the time. The Solvency rule is the starting point, a simple guide or aid for thinking about those policy decisions. But, this is still a very useful role to play for a policy rule. For instance, it can be used to assess the Taylor rule-based interpretations of the crisis. From this perspective, even if it is accepted Taylor's thesis that the Fed did set the interest rate below the level established by (4'), it is impossible to establish with any certainty what effect this decision might have had on the rate of inflation. By the same token, Greenspan's interpretation also fails to find adequate theoretical support. While an increase in the propensity to save would indeed bring about a decrease in the rate of profit γr, it would also involve a drop in the overall volume of income and saving. According to the Solvency rule, it is problematic to speak of *excess* world savings pouring into the US financial market, and thereby generating a speculative bubble. Finally, the Solvency rule also emphasizes the shortcomings of the debate between Taylor, Krugman and others on the post-crisis level of interest rates. In accordance with (4') and (5'), decisions on interest rates will primarily regard the socially acceptable levels of insolvency among workers, bankruptcies of firms, takeovers and centralisation of capital, while their implications as regards the growth of income and employment will remain uncertain and largely indeterminate.

The Solvency rule supports alternative interpretations of the crisis that began in 2007-2008. In this regard, it should be noted that the Solvency rule presented in this paper has significant limitations made with the explicit purpose of facilitating comparison with the NCM model and the Taylor rule equation. However, even with this proviso, the Solvency rule supports recent research (e.g. IMF-ILO, 2010; Brancaccio and Fontana 2011) suggesting that the redistribution of income away from wages toward profits and higher incomes may have created favourable conditions for the financial and economic collapse of the US economy in 2007.

For instance, Fitoussi and Stiglitz (2009; see, also, Fitoussi and Saraceno, 2010) maintain that the post-1980s rise in income inequality in the USA led to a decline in savings, while household borrowing increased as the relatively poor sought to maintain their (relative) living standard. This meant that despite the rise in inequality aggregate demand was stimulated. But the co-existence of rising income inequality and (relatively) constant living standard was maintained at the expense of an unsustainable credit boom, which at the end led to the financial crisis. To this regard, it is interesting to note that an exogenous increase in the normal rate of profit r causes an upward shift of (4'), and a downward movement of (5'). In addition, when the two curves intersect, any change in distribution in favour of profits means that the intersection point moves down and left, at lower levels of λ and i. This indicates that the redistribution towards profits makes the solvency condition of workers relatively more stringent. If the central banker continues to set interest rates according to the solvency condition of firms, then it may pave the way to a surge of defaults among workers. Of course, this conclusion is very speculative, and cannot be considered comprehensive. However, it also suggests a potentially significant but largely ignored problem: monetary authorities around the world may not have realized in time that as result of their policy decisions an outbreak of defaults were spreading especially among wage-earners.

9. Conclusions

This paper has shown that the interpretations of the economic crisis based on the Taylor rule equation are logically dependent on the neoclassical theory of growth, and are therefore exposed to various criticisms that during the twentieth century have been advanced against that theory. This paper has also shown that in a different theoretical context is possible to generate an alternative monetary policy rule equation according to which the primary objective of the central banker is to adjust the interest rates on the basis of the conditions of solvency of firms and maybe workers.

The macroeconomic model outlined here presents some obvious simplifications. Suffice it to note that it describes a bare-bones system of production with just one good. Furthermore, apart from the reference to the term α, the complex structure of revenues from the various types of real and financial activities in existence is completely overlooked. At the same time, it is precisely by paring the logical structures examined down to their bare essentials that this analysis is able to highlight the substantial conceptual homogeneity of the interpretations of the crisis put forward by supporters of the New Consensus Macroeconomics model and the associated Taylor rule equation. The internal dialectic of the NCM view appears to boil down to a problem of estimating the parameters of the equations. However, turning the logic of the NMC model upside down, this paper has put forward a different interpretation of the crisis and the monetary policy rule equation itself. The central banker can be seen in this context as a sort of "regulator" of social conflict. In this case, however, the prevailing conflict does not concern only the traditional contest between labour and capital in the distribution of social product. It also concerns the aim of adjusting the monetary policy taking into account the different needs and the potential conflicts of interest between hedge and potentially insolvent groups of economic agents. Largely overlooked in the predominant literature, this aspect could provide essential insights into the crisis now underway.

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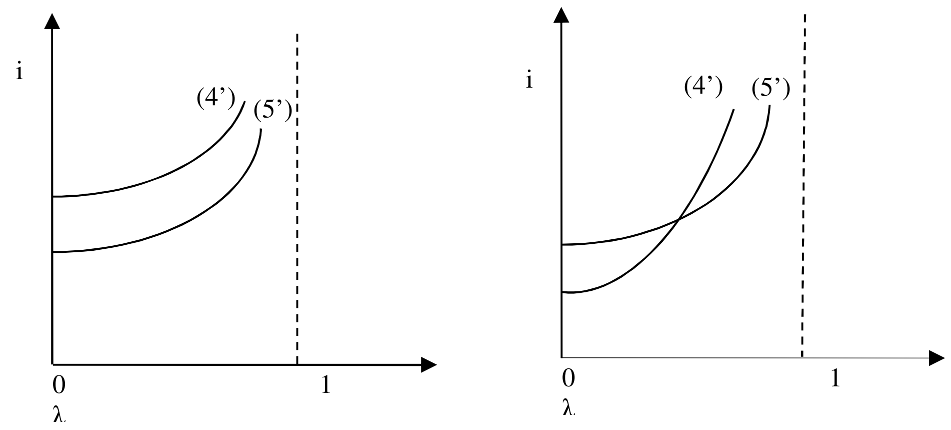

Figure 1: A graphical representation of the solvency conditions

[1] Greenspan (2009) describes the Taylor rule as a "useful first approximation", Krugman (2009) regards it as a "standard" rule of economic policy, and Rudebusch (2009) draws direct implications from it as regards the sort of monetary policy the Fed should adopt. A slightly more prudent approach was taken by Bernanke (2007), who placed it within a broader set of "rules" examined by those responsible for monetary policy before taking their decisions on interest rates.

[2] For an account of the evolution of Post Keynesian economics, see King (2002), Harcourt (2006), and Fontana (2010, Ch. 2). On the Sraffian approach and its links with Post Keynesian contributions, see Aspromourgos (2004).

[3] It is also interesting to note that when money is considered endogenous in a mainstream macroeconomic model, the Taylor rule becomes a necessary condition for determinacy (Docherty 2009).

[4] A special issue of *Ekonomia* (2008) has been devoted to the question of the extent to which the macro-econometric models developed by central banks are consistent with the New Consensus Macroeconomics (NCM) model. Arestis and Sawyer (2008) show that the macro-models used at the European Central Bank (ECB) and the Bank of England are firmly embedded in the NCM model. Similarly, Fontana (2008) analyses the structural models used at the Federal Reserve Board (FRB) and demonstrates that the FRB/US and the FRB/Global models encompass some of the key features of the NCM model, like the natural rate hypothesis.

[5] For an overview of the ongoing research on growth models alternative to neoclassical theory, see Setterfield (2010).

[6] For further criticisms of the Taylor rule equation and the mainstream conceptions of monetary policy, see Wray (2007). Wray criticizes those Post Keynesians who seem to have accepted the "activist" conception of monetary policy which derives from the Taylor rule equation and the New Consensus approach. For an empirical investigation on the distributive implications of mainstream monetary policy rules see Argitis (2008-9). As regards the agreements of central banks to mainstream monetary policy rules and its possible relationships with the economic crisis started in 2008, see Morgan (2009).

[7] For the broad range of empirical tests carried out on the rule of monetary policy and for the variety of results obtained for the estimated parameters, see Taylor (1999) and Taylor and Williams (2010).

[8] On the difference between the different concepts of short- and long-run in the neoclassical tradition and of short- and long-period in the Keynesian and Sraffian traditions, see, among others, Petri (2004) and Harcort (2011).

[9] When the utilization of productive capacity is considered endogenous, the Cambridge equation does not hold and the Keynesian principle of effective demand can be combined with a given distribution of income in the sense of the Classical economists and Sraffians. See, on this point, Garegnani (1992) and Kurz (1994), among others. As regards the consistence and fruitfulness of a connection between Keynesian and Sraffian analyses, see Aspromourgos (2004) and Lavoie (2010).

[10] For the sake of simplicity, the monetary circuit linking via commercial banks the central bank to firms and workers is left in the background. Graziani (2003, Ch. 3 and Ch. 4), Brancaccio (2008), and Fontana (2009, Ch. 5, pp. 64-69) provide a description of the monetary circuit that underlines the analysis in this paper.

[11] For the legitimacy of using this technique of theoretical comparison in order to facilitate discussion between the various schools of thought, see Brancaccio (2010).

[12] The typical conclusions of these schemes are always valid even if the implausible assumption of a continuous and differentiable production function typical of the neoclassical approach is adopted. Barro and Sala-i-Martin (1995, par. 1.3.4), among others, do not seem to be aware of this fact.

[13] As regards the difference between g_d in equation (4) and g in equation (4'), it has to be taken in account that $1+g_d = u(1+g)$. It follows that for equation (4) it is always possible to relate the deviation g_d of current production from its normal level to the rate of capital accumulation g.

[14] On the indebtedness of workers see also Barba and Pivetti (2009).

[15] In order to fully appreciate its explanatory power the alternative "rule" should be further developed. In particular, the complex role of λ should be examined at a deeper level. The degree of financial instability can be influenced by the strategies of private banks: for example, a lower level of λ could indicate credit rationing phenomena. Furthermore, the same variable could be seen as a direct policy tool affectedby the institutional framework and the decisions of public authorities.

[16] Kozicki (1999) has reviewed specification details of different Taylor-type rules, including alternative assumptions on the measure of inflation, output gap and the estimation of the equilibrium real rate of interest. Kozicki concludes that Taylor-type rule recommendations "are not robust to reasonable minor variations in assumptions, and their reliability is questionable" (*op. cit.*, p. 25).

[17] There is evidence that policy decisions at the Fed have been influenced on many occasions by economic events not well described by inflation and output gaps. For instance, in 1988 Greenspan noted that "the stock market crash of late October [1987] shifted the balance of risks, and the Federal Reserve modified its approach to monetary policy accordingly. In particular, [the Federal Reserve] took steps to ensure adequate liquidity in the financial system during the period of serious turmoil, and … encouraged some decline in short-term interest rates" (Greenspan, 1988; as quoted in Kozicki, 1999, p. 24).