ON ZERO LOWER BOUND TRAPS: A FRAMEWORK FOR THE ANALYSIS OF MONETARY POLICY IN THE ‘AGE’ OF CENTRAL BANKS

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ON ZERO LOWER BOUND TRAPS: A FRAMEWORK FOR THE ANALYSIS OF MONETARY POLICY IN THE 'AGE' OF CENTRAL BANKS

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Abstract: Conventional explanations of how a growing potential output generates an equi-proportional increase in aggregate demand in the long run rely either on the operation of the real balance effect or on a combination of the permanent income hypothesis and the assumption of individuals´ perfect foresight. We argue that these two mechanisms are grossly unrealistic and that the bulk of the adjustment process occurs through the impact of conventional monetary policy actions. As a result of it, the main constraint this mechanism is subject to takes the form of a zero lower bound on short-term nominal interest rates. We develop a general framework based on a small model for a closed economy without government sector in which a central bank attempts to hit an inflation target and obtain a number of results.

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Key words: Neutral interest rate, zero lower bound trap, inflation, monetary policy

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1.- Introduction

A core proposition in modern macroeconomic theory holds that market economies possess strong self-regulation mechanisms which guarantee that any expansion of potential output eventually generates an equi-proportional increase in the level of aggregate demand so that the latter adjusts passively to the former in the long run. This proposition is an implication of Say's law, i.e., the notion that supply creates its own demand. The mechanism through which this adjustment process takes place is a crucial area of macroeconomic theory yet it is frequently overlooked. In modern economic analysis, such mechanism usually comes in the form of the Scitovszky-Pigou-Haberler-Patinkin effect or 'real balance effect'[1]. However, a number of scholars have cast serious doubts into its practical relevance. For instance, Greenwald and Stiglitz argue that:

'The enormous attention that the real balance effect has received over the years hardly speaks well for the profession. Quantitatively, it is surely an *n*th order effect; one calculation put it that, even at the fastest rate at which prices fell in the Great Depression, it would take more than two centuries to restore the economy to full employment. And in the short run even its sign is ambiguous, as intertemporal substitution effects may (depending on expectations) more than offset the wealth effects' (Greenwald and Stiglitz, 1993, p.36).

[1] Notwithstanding its survival in macroeconomic theory the real balance effect is missing from the FRB/US model of the U.S. Federal Reserve or the model utilized at the Bank of England. In both models there is no mechanism for a change in the money supply to influence the economy other than its role in standard open-market operations.

We will not discuss here the shortcomings of the real balance effect[2]. We may note, though, that some authors appear to be leaving it behind and resort to another type of mechanism. Practitioners of the so-called 'New Consensus View' in macroeconomics use an aggregate demand function of the form $y = -ar + u$, where y is the output-gap, r is the real interest rate and u is a stochastic component with zero mean (Clarida *et al*., 1999, pp. 1665-66; Taylor, 2000, p. 91; Fuhrer and Madigan, 1997). However, this aggregate relation only holds true if aggregate demand shocks of the same sign *and* similar magnitude increase (decrease) the level of aggregate demand whenever a favorable (unfavorable) shock raises (lowers) potential output. The mechanism through which increases in the latter lead to equi-proportional increases in aggregate demand is explained as follows:

'Shocks to potential output also do not force a short-run trade-off. But they require a quite different policy response. Thus, e.g., a permanent rise in productivity raises potential output, but it also raises output demand in a perfectly offsetting manner, due to the impact of permanent income. As a consequence, the output gap does not change. In turn, there is no change in inflation. Thus, there is no reason to raise interest rates, despite the rise in output' (Clarida *et al*., 1999, pp. 1675)

[2] The classical exposition of the unreliability of the real balance effect as a self-adjustment mechanism is in Tobin (1975). A detailed discussion on the shortcomings of this effect can be found in Palacio-Vera (2005) and a comprehensive analysis of the consequences of deflation is in Palley (2004). In contrast, some authors are supportive of the power of the real balance effect to stabilize the economy. For instance, Sims (2000) argues that there is a potential for a large real balance effect in a deflationary environment and that its presence 'makes it extremely unlikely that we get into a liquidity trap'.

Apparently, these authors implicitly assume that increases in potential output are ‘perfectly’ observed by individuals and then interpreted as leading to an equivalent rise in expected lifetime wealth. In turn, insofar as individuals tend to smooth consumption overtime the expectation of higher expected lifetime wealth leads them to consume more in the future and in the present. However, by resorting to this ‘perfect’ foresight assumption practitioners of the ‘New Consensus View’ assume the essential problem away. This is because even if we accept that consumption is determined by individuals´ wealth there is still the problem that the level and rate of growth of potential output cannot be observed in practice, let alone known in advance. Hence, the reliability of this self-adjustment mechanism is open to question.

We don’t wish to deny that there may be other self-adjustment mechanisms at work. First, we recognize that the foreign sector may play a significant role through the effect that changes in potential output have – owing to changes in the rate of inflation - on the real exchange rate and this, in turn, on aggregate demand. Second, there is a role for changes in income distribution. For example, Skott (1989) provides an extensive theoretical analysis of the role of income distribution as a self-adjustment mechanism in market economies[3]. Income distribution also plays a crucial role within the Marxian tradition where increases in the rate of unemployment bring about reductions in real wages which, in turn, increase the rate of profit and raise the rate of accumulation (Goodwin, 1967). Finally, there is also a role for fiscal policy through the effect of automatic stabilizers. This is because increases in the rate of unemployment and stagnant income growth usually prompt a rise (fall) in the government budget deficit (surplus)

[3] Nevertheless he shows that the economy exhibits an unstable steady growth path albeit one that does not need to lead to cumulative divergence but may instead lead to cyclical fluctuations.

which, in turn, increases aggregate demand and vice-versa. The empirical relevance of these alternative mechanisms is extremely difficult to assess. However, it was probably higher in previous historical periods when Central Banks (hereafter CBs) played a less prominent role in macroeconomic stabilization. We believe it is uncontroversial to argue that the institutional framework that characterizes most, if not all, OECD economies is one where the CB fine-tunes the economy through changes in short-term nominal interest rates. Therefore, an assumption of this paper is that all these mechanisms currently play a less important role so the bulk of the adjustment of aggregate demand to potential output actually occurs through the impact on aggregate demand of conventional monetary policy actions. By conventional monetary policy we mean the regular actions that characterize the day-to-day setting of short-term interest rates by CBs with a view to achieving price stability.

The main purpose of this paper is to analyze the mechanism through which the level of aggregate demand grows in line with potential output in the long run. We argue that the main constraint monetary policy is subject to comes in the form of a zero lower bound (hereafter ZLB) on short-term nominal interest rates that may prevent the CB from setting real interest rates low enough. This constraint arises because, in a money-using economy, individuals will not be willing to hold any financial asset other than money when the nominal yield of the former is equal or less than zero. For that purpose, we develop a small model representative of a closed economy without a government sector in which the CB sets interest rates in order to hit an (explicit) inflation target. Central to our discussion are the notions of the 'neutral' real interest rate and the zero lower bound trap (hereafter ZLBT). A dynamical analysis follows the presentation of the model. We assume that the CB sets real interest rates according to a Taylor-type policy rule and analyze the behavior of the economy in the neighborhood of the equilibrium point. We find that its stability crucially depends on the size of the response coefficient of the policy rule. In general, increases in its size increase the likelihood of the economy being stable, i.e., that the system converges asymptotically to the long-run equilibrium position or that cyclical fluctuations are damped. Finally, we run a non-stochastic simulation exercise that allows us to calibrate the model and obtain a number of additional results.

According to us the main contributions of this study are the following. First, we provide a general framework for the analysis of the mechanism that allows the level of aggregate demand to grow in line with potential output in the long run in the absence of any self-regulating mechanism. Second, we provide a formal definition of the notion of the ZLBT that, we believe, helps clarifying recent discussions in the literature. In particular, we argue that the focus on low inflation as the apparent sole cause of an economy getting stuck in a ZLBT misses the point that, as we show, a negative 'neutral' real interest rate or a high term premium are also potential causes. Third, we develop a small theoretical model that allows us to identify the determinants of the 'neutral' real interest rate and its behavior in the short and the long run. This allows us to determine algebraically the minimum size of inflation shocks and demand shocks that will push the economy into a ZLBT. Fourth, we show that the steady growth real interest rate depends positively on the target rate of inflation - thus casting doubt on the long-run neutrality of money proposition - and the 'natural' rate of growth. In terms of the discussion about the ZLBT, we show that a low or negative steady growth real interest rate may be the result of a high saving ratio, a low natural rate of growth, a low rate of inflation or a suitable combination of the former three factors. Fifth, the dynamical analysis shows that the larger is the response of current real interest rates to changes in the inflation gap, i.e., the difference between current and target inflation, the more likely it is that the economy will be dynamically stable. In turn, this suggests that the nature of the CB policy rule becomes of paramount importance for the stability of the system. Sixth, the numerical simulation exercise reveals that the 'neutral' real interest rate fluctuates as much as the current interest rate thus lending support to studies which suggest that the former exhibits a considerable degree of volatility. Finally, we argue that our results lend support to those authors who claim that the Japanese economy has been in a ZLBT for the last decade or so (Krugman, 1998; Svensson, 2001). In particular, our model implies that characteristics of the Japanese economy like a high saving ratio, a low rate of inflation and a low 'natural' rate of growth increase the chances of an economy getting stuck in a ZLBT.

The structure of the paper is as follows. Section 2 presents a small model for a closed economy without a government sector. The steady growth properties of the model are obtained. We then obtain a formal expression for the 'neutral' interest rate and for the ZLBT. Next, we also determine the minimum size of shocks that will push the economy into a ZLBT. Section 3 contains the dynamic analysis of the model as well as a discussion on the results of the simulation exercise. Section 4 concludes.

2.- The model

The equilibrium condition in the product market for a closed economy without a government sector when current output equals potential output is:

$$s(r) \cdot \overline{Y} = I(r) \tag{1}$$

where s is the saving ratio, $\overline{Y}$ is potential output and I is the (gross) level of investment. The real interest rate that results from (1) is the 'neutral' real interest rate or r^n, i.e., the interest rate that makes *ex-ante* saving at potential output equal to *ex-ante* investment. It is better thought of as a long-term real interest rate. If $\overline{Y}$ is the level of output that keeps inflation constant in the absence of inflation shocks (hereafter INSs) we have that inflation will rise (fall) when $r \prec r^n$ ($r \succ r^n$). This is the Neo-Wicksellian approach to monetary policy (see Woodford, 2003). As a result, r^n represents a critical benchmark for the setting of real interest rates by the CB.

As pointed out in the introduction, we assume that the most important regulation mechanism at work in modern market economies comes in the form of a CB who brings about changes in real interest rates so as to achieve price stability. Notwithstanding CBs can solely control the path of short-term nominal interest rates. However, as long as nominal interest rates remain above the ZLB, CBs will also be able to move real interest rates in the desired direction owing to the presence of some inertia in the (expected) rate of inflation. In turn, if the level of aggregate demand is a negative function of the real interest rate then CBs can, under normal circumstances, set real interest rates so as to generate a rate of expansion of aggregate demand that matches a growing potential output. Let us present the following simple model:

$$\dot{\pi} = f_1(r - r^n) \tag{2}$$

$$r - r^n = f_2(\pi - \pi^d) \tag{3}$$

and substituting (3) into (2) yields:

$$\dot{\pi} = f_3(\pi - \pi^d) \tag{4}$$

where $f_1' \prec 0$, $f_2' \succ 0$, $f_3' \prec 0$, π is the inflation rate, π^d is the inflation target and *r* is the current real interest rate. Differential equation (2) captures the dynamics of inflation in a Wicksellian fashion. Equation (3) is a Taylor-type monetary policy rule. It can be seen that - since $f_3' \prec 0$ - the rate of inflation will converge to π^d in equation (4). Thus, as long as the (real) interest rate rule is governed by (3), the CB will eventually hit π^d. Nevertheless, CBs face a good deal of difficulties when implementing a rule like (3). A first problem is how to set nominal interest rates in order to push *ex-ante* current real interest rates by a given magnitude. This is because there is some uncertainty as to the rate of inflation expected by the public. A second and more important problem stems from the fact that CBs do not actually know the value of r^n at any point in time since it usually exhibits a large degree of uncertainty. Furthermore, there may be circumstances when, even if a CB knows the value of r^n and the rate of inflation expected by the public, it may be unable to vary real interest rates as dictated by expression (3). If so the economy will stagnate. This will be the case when the CB needs to yield a negative real interest rate to stimulate aggregate demand but it cannot do so because the nominal interest rate is already at the ZLB. This situation is usually referred to as a ZLBT[4].

We consider a one-sector economy with two inputs, labor and capital and assume that the production function has fixed coefficients. Potential output is defined as:

$$\overline{Y} = \lambda \cdot \overline{N} \leq v \cdot K \qquad (5)$$

[4] Although not explicitly referred to as a ZLBT situation, a discussion of this problem in the context of a static model capturing the basic features of the so-called 'New Consensus View' in macroeconomics is in Arestis and Sawyer (2005). The authors conclude that CBs are unlikely to be able to offset a large adverse shock to investment demand through nominal interest rate cuts.

where $\overline{N}$ is the level of employment that keeps the rate of inflation constant in the absence of INSs and λ and v are respectively the productivity of labor and capital when the factors are fully utilized. The current rate of capacity utilization is:

$$u = \frac{Y}{v \cdot K} \leq 1 \tag{6}$$

Thus, the rate of capacity utilization when $Y = \overline{Y}$ is:

$$\overline{u} = \frac{\overline{Y}}{vK} = \frac{\lambda}{v} \cdot \frac{\overline{N}}{K} \prec 1 \tag{7}$$

where $\overline{u}$ is the non-accelerating inflation rate of capacity utilization or NAICU (Corrado and Mattey, 1997). Similarly, we denote by $\overline{e}$ the employment ratio corresponding to the non-accelerating inflation rate of unemployment (NAIRU) and by L the total labor force. For simplicity, we assume that $\overline{e}$ is constant[5]. Hence, we have that expression (7) can be expressed as:

$$\overline{u} = \left(\frac{\overline{e}}{v}\right) \cdot \left(\frac{\lambda \cdot L}{K}\right) \prec 1 \tag{8}$$

where $\overline{N} = \overline{e} \cdot L$.

In turn, the dynamics of the rate of inflation are given by[6]:

$$\dot{\pi} = \phi(u - \overline{u}) \qquad \phi \succ 0 \tag{9}$$

[5] The appropriate way to interpret $\overline{e}$ in this paper is as the employment ratio corresponding to a short-term NAIRU, i.e., as that rate of unemployment consistent with stabilizing the inflation rate at its current level in the next period. Thus, it is more volatile than the NAIRU because it is affected by all supply influences, including temporary ones, expectations and inertia in the dynamic process of inflation adjustment (see Richardson et al., 2000).

[6] The assumed linearity of the inflation dynamics equation is a necessary compromise. The short-run output-inflation trade-off is likely to be non-linear albeit its precise shape – concave versus convex – is a matter of controversy (see Filardo, 1998).

If we divide (1) through by the capital stock K and denote the rate of capital accumulation by g and the rate of depreciation of physical capital by ψ we get:

$$s \cdot \frac{\overline{Y}}{K} = g + \psi \tag{10}$$

and inserting (7) into (10) yields:

$$s \cdot v \cdot \overline{u} = g + \psi \tag{11}$$

The actual real wage w/p is determined by firms' profit-maximization objectives:

$$\frac{w}{p} = \frac{\lambda}{m} \tag{12}$$

where w is the money wage, p is the price level and $m \succ 1$ is one plus the (average) mark-up. For the sake of simplicity, we assume that the latter is constant. Finally, the 'natural' rate of growth of output is:

$$g_n = l + a \tag{13}$$

where l and a are respectively the growth rate of labor force L and labor productivity λ .

We now turn our attention to functions s and g. We assume that the saving ratio s is a function of the rate of inflation π, the rate of growth of output $\hat{y}$, the real interest rate r and a measure of exogenous shocks ε_s or[7]:

$$s = s(\pi, \hat{y}, r, \varepsilon_s) \tag{14}$$

where $s_{\hat{y}} \succ 0$, $s_\pi \prec 0$, $s_r \succ 0$ and ε_s is a stochastic variable with zero mean. The positive sign of $s_{\hat{y}}$ is based on the life cycle hypothesis of saving. The latter establishes a positive relationship between s and $\hat{y}$ in the short and the long run (Modigliani and Brumberg, 1980; Modigliani, 1986). The positive sign of s_r stems from the fact that although

[7] As a referee pointed out, the saving ratio will also be determined by institutional aspects of the financial system that affect the transmission mechanism of monetary policy.

households are on average net lenders and substitution and income effects move in opposite directions for those individual households who are net lenders yet wealth effects operate in the same direction as the substitution effect thus making $s_r \leq 0$ an unlikely scenario. The sign of s_π requires some clarification. In a study by Pollin (1985), the author shows that the stability of the total outstanding debt ratio S_t of the U.S. economy's non-financial sectors has displayed essentially no trend throughout the post-World War II period. Using the formula $S_t = q_t(1+\hat{Y})/\hat{Y}$ derived in Gurley and Shaw (1957) where q_t is the marginal propensity of the aggregate non-financial sector to issue net new debt and $\hat{Y}$ is the rate of growth of nominal *GNP*, the author argues that the stability of S_t throughout the postwar period, and especially since the 1960's, has resulted from rising trends for $\hat{Y}$ and q_t coupled with a declining trend for the rate of growth of real *GNP*. As a result, the ratio $(1+\hat{Y})/\hat{Y}$ has fallen correspondingly over this period and q_t has risen along with $\hat{Y}$ in order for S_t to remain constant. According to Pollin (1985), the divergent patterns of S_t and q_t are due to the asymmetric impact of inflation on the two ratios. As for S_t, its numerator, the stock of debt, remains fixed in nominal terms regardless of variations in the price level (relative to trend) whereas its denominator, nominal *GNP*, varies in nominal terms directly with the price level. As a result, in an inflationary environment, the nominal value of the debt stock remains fixed while *GNP* rises, so that S_t is biased downwards. Conversely, with q_t, current-period flow values are in both numerator and denominator, and thus the impact of inflation on the ratio is neutral. Because of this asymmetry, an increasing reliance on debt by the non-financial sectors, i.e., a rising q_t, may not engender increases in their debt burdens.

Next, we have that for a given q_t a fall in the rate of inflation will increase net borrowers' real debt burden and vice-versa[8]. In turn, this will increase the general level of bankruptcy risk. In the case of net borrower households the increase in the real level of indebtedness will lead to a fall in consumption (Bernanke, 1981). In the meantime, the increase in net borrowers' real debt burden will be coupled by a rise in net lenders' real financial wealth and, by the same token, this will tend to increase their consumption. However, it is reasonable to assume that net borrowers' marginal propensity to consume out of wealth is, on average, higher than net lenders'. In addition, the possibility of bankruptcy has an asymmetric impact on aggregate spending. This is because as the general level of bankruptcy risk rises (owing to rising real debt burdens by net borrowers) the level of spending of net lenders rises by less than the fall in the level of spending by net borrowers. Hence we have that $s_\pi \prec 0$. The size of s_π will be proportional to the size of the aggregate debt ratio and the degree of dispersion of balance sheet positions across households[9]. Next, we assume that firms have a desired rate of capacity utilization $u^d \prec 1$ so they expand capacity when $u \succ u^d$ and stop expanding it when $u \prec u^d$. A possible justification for this assumption is that firms prefer to keep some capacity idle in order to respond rapidly to unanticipated favorable demand shocks. In turn, this is equivalent to defining the rate of accumulation, g as:

$$g = v \cdot u \cdot f(u - u^d, \varepsilon_g) \tag{15}$$

[8] It is not possible to say *a priori* how the debt service in real terms will vary since this ultimately depends on the behavior of real interest rates. However, our argument only applies to the impact on the level of aggregate demand of changes in the rate of inflation for a given real interest rate.

[9] This scenario changes considerably when inflation becomes negative. In a deflationary environment the redistribution of net worth away from net borrowers and towards net lenders will be larger and, in addition, there will be a redistribution of income in the same direction stemming from high (and possibly rising) real interest rates.

where $f_u \succ 0$ captures the presence of construction and delivery lags as well as costs of adjustment in investment, $f(0) = \bar{f} \succ 0$, $E(\varepsilon_g) = 0$ and ε_g represents stochastic shocks affecting *g*. Parameter $\bar{f}$ plays an important role in this model. In principle, it is the ratio of the level of net investment to output when $u = u^d$. More generally, it captures firms´ average expected rate of growth of demand for their products. There is no mechanism that guarantees that it is equal to its steady growth value in the short run. Indeed, it will not be equal to its steady growth value in the long run either if the economy actually gets stuck in a ZLBT. This stands in stark contrast to the 'New Consensus View' where, as pointed out above, aggregate consumption grows at the same pace as the 'natural' rate of growth. Therefore, expression (11) can be rewritten as:

$$s(\pi, \hat{y}, r, \varepsilon_s) = f(\bar{u} - u^d, \varepsilon_g) + \frac{\psi}{v\bar{u}} \tag{16}$$

2.1.- Steady growth analysis

In steady growth we have that $\hat{y} = g_n$, $u = \bar{u} = u^d$, $\pi = \pi^d$ and $\varepsilon_s = \varepsilon_g = 0$ so that the two following conditions must hold:

$$v \cdot u^d \cdot \bar{f} = g_n \tag{17}$$

and

$$s(\pi^d, g_n, r^*) \cdot v \cdot u^d = g_n + \psi \tag{18}$$

Equation (17) tells us that in steady growth the rate of accumulation must equal the 'natural' rate of growth. In order to get an explicit solution for the steady growth real interest rate r^* we need to assume that function *s* adopts a linear form of the type:

$$s = \bar{s} + s_{\hat{y}} \cdot \hat{y} + s_{\pi} \cdot \pi + s_r \cdot r \tag{19}$$

where $\bar{s}$ is determined by individuals´ preferences and institutional factors. Substituting (19) into (18) and re-arranging we have that:

$$r^* = \left[\frac{g_n + \psi}{v \cdot u^d} - \bar{s} - s_{\pi} \pi^d - s_{\hat{y}} g_n \right] \frac{1}{s_r} \tag{20}$$

Thus the steady growth real interest rate r^* is a function of the ‘natural’ rate of growth, the target rate of inflation, the saving ratio, the rate of depreciation and the desired rate of capacity utilization. This result clearly runs against conventional wisdom since the latter poses that real variables are not affected by changes in nominal variables like the rate of inflation. Therefore, the model exhibits non-neutrality of monetary policy in the long run. The steady growth properties of the model are:

$$\frac{\partial r^*}{\partial \pi^d} = \frac{-s_{\pi}}{s_r} \succ 0 \tag{21}$$

$$\frac{\partial r^*}{\partial g_n} = \left(\frac{1}{v \cdot u^d} - s_{\hat{y}} \right) \cdot \frac{1}{s_r} \succ 0 \tag{22}$$

$$\frac{\partial r^*}{\partial \bar{s}} = \frac{-1}{s_r} \prec 0 \tag{23}$$

$$\frac{\partial r^*}{\partial s_r} = -\left(\frac{g_n + \psi}{v \cdot u^d} - \bar{s} - s_{\pi} \pi^d - s_{\hat{y}} g_n \right) \cdot \frac{1}{s_r^2} \succ 0 \tag{24}$$

The positive sign of (21) is the result of the expansionary effect on the level of aggregate demand of an increase in the rate of inflation. In principle, the sign of (22) is ambiguous. Nevertheless, it will be positive for reasonable values of the parameters. This is confirmed in Table 1 below where we have that $\partial r^* / \partial g_n = 1{,}0\widehat{7}$ for the combination of parameters that result from the calibration of the model. This means that a 1 percent fall in the 'natural' rate of growth will lead approximately to a 1 percent fall in r^* and vice-versa. Table 1 also shows that $\partial r^* / \partial \pi^d = 0{,}0\widehat{6}$ so we have that a 1 percent fall in the target rate of inflation leads to a 0.06 percent fall in r^*. This is a negligible effect. However, the simulation exercise revealed that reducing the value of s_π tends to increase the stability of the system by making cyclical fluctuations more damped so the actual value of s_π is subject to a considerable degree of uncertainty. For instance, if we set $s_\pi = -0.5$ rather than $s_\pi = -0.1$ we have that $\partial r^* / \partial \pi^d = 0.\widehat{3}$ and therefore a 1 percent fall in the inflation target will lead to a 0.3 percent fall in r^*. This suggests that changes in the rate of inflation have a small albeit significant impact on the steady growth real interest rate[10]. The positive sign of (23) reflects the fact that, as expected, an increase in the saving ratio reduces r^*. Finally, the sign of (24) is ambiguous. If r^* is initially positive then (24) will be negative and vice-versa. This implies that an increase in the power of the transmission mechanism of monetary policy, i.e., an increase in s_r increases the vulnerability of the economy by reducing r^*.

Expression (22) also suggests that phenomena like the 'New Economy' whereby g_n has allegedly increased due to the spread of information technology across the economy has translated into a rise in r^*. More important for our discussion, it has been argued that the cause of the stagnation experienced by the Japanese economy in the last decade or so is its low 'natural' rate of growth and the resulting low rate of profit

[10] This result runs against the argument in McCallum (2000) that a permanent reduction in the inflation target of the CB may not reduce sharply the difference between the steady growth real interest rate and the ZLB because of an increase in the former. Presumably, the reason for this argument is the Mundell-Tobin effect. According to it, a decreased pecuniary yield differential between (physical) capital and money may induce wealth-holders to allocate a larger fraction of their wealth to money and less to capital thereby leading to an increase in the marginal product of capital and in the steady growth real interest rate.

(Nakatani and Skott, 2005). According to these authors the low Japanese ‘natural’ rate of growth is the result of a negative rate of growth of labor force due to adverse demographic trends and a low rate of growth of labor productivity due to the completion of the technological catch-up phase. This hypothesis can be easily accommodated into our model and, in turn, it lends support to the views of those authors who argue that the Japanese economy is in a ZLBT (Krugman, 1998; Svensson, 2001)[11]. This is because the low Japanese ‘natural’ rate of growth, its relatively high saving ratio and its low rate of inflation combine to yield a very low and possibly negative ‘neutral’ real interest rate[12]. As we will see below, a low ‘neutral’ real interest rate, not to speak of a negative one, increases the likelihood that an economy gets stuck in a ZLBT[13].

2.2.- The behavior of the economy in the short run

We now focus on the behavior of the economy in the short run. As we did with the saving ratio we assume that the investment function f adopts a linear form or:

$$f(u-u^d,\varepsilon_g)=\bar{f}+f_u\cdot(u-u^d) \qquad (25)$$

Substituting (25) into expression (16) we obtain the equilibrium condition in the product market:

[11] This hypothesis is not shared by proponents of the ‘credit crunch’ or ‘credit deadlock’ hypothesis (see Cargill, *et al.*, 1997 and Laidler, 2004) or by authors like Orphanides (2004) who consider that, even if short-term nominal rates are at zero there is still room for further monetary easing through reductions in the yields of longer-dated securities.

[12] In this respect, the rate of change of the Japanese CPI has been roughly zero or negative from 1998 through to 2004 (Oda and Ueda, 2005).

[13] If an economy has been in a LT for a relatively long period one would expect that it exhibits a large (negative) output-gap. In this respect, Krugman (1998) argues that the negative output-gap exhibited by the Japanese economy in the late 1990s is largely underestimated in official statistics. He adds that it could be as large as 8 per cent of GDP and it may have grown much larger since 1998.

$$\bar{s} + s_{\hat{y}} \cdot \hat{y} + s_{\pi} \cdot \pi + s_r \cdot r = \bar{f} + f_u \cdot u - f_u \cdot u^d + \frac{\psi}{v \cdot u} \tag{26}$$

and, as a result, the rate of growth of output $\hat{y}$ is:

$$\hat{y} = \frac{\bar{f} - \bar{s} + f_u \cdot u - f_u \cdot u^d - s_{\pi} \cdot \pi - s_r \cdot r}{s_{\hat{y}}} + \frac{\psi}{s_{\hat{y}} \cdot v \cdot u} \tag{27}$$

so that:

$$\frac{\partial \hat{y}}{\partial r} = \frac{-s_r}{s_{\hat{y}}} \prec 0 \tag{28}$$

and
$$\frac{\partial \hat{y}}{\partial \pi} = \frac{-s_{\pi}}{s_{\hat{y}}} \succ 0 \tag{29}$$

Rearranging (26) we obtain the expression for the real rate of interest that clears the product market when $\hat{y} = 0$ and $\hat{y} = g_n$ or:

$$r^{\hat{y}=0} = \frac{\bar{f} + f_u \cdot u - f_u \cdot u^d - s_{\pi} \cdot \pi - \bar{s}}{s_r} + \frac{\psi}{s_r \cdot v \cdot u} \tag{30}$$

$$r^g = \frac{\bar{f} + f_u \cdot u - f_u \cdot u^d - s_{\pi} \cdot \pi - \bar{s} - s_{\hat{y}} \cdot g_n}{s_r} + \frac{\psi}{s_r \cdot v \cdot u} \tag{31}$$

Expression (30) corresponds to point *A* in Figure 1 below. For lack of a better name we will name r^g the ‘pseudo-warranted’ rate of interest in the sense of being the real rate of interest that yields $\hat{y} = g_n$ for a given *u* and π. In turn, the ‘warranted’ rate of interest will be the interest rate that yields $\hat{y} = g_n$ when $u = u^d$. Therefore, the difference between the ‘pseudo-warranted’ interest rate and the ‘steady growth’ interest rate is that in the former it will not generally be the case that $\pi = \pi^d$ and $u = u^d$. Setting $r = 0$ in (27) we obtain point *B* in Figure 1 or:

$$\hat{y}^{r=0} = \frac{\bar{f} - \bar{s} + f_u \cdot u - s_\pi \cdot \pi - f_u \cdot u^d}{s_{\hat{y}}} + \frac{\psi}{s_{\hat{y}} \cdot v \cdot u} \quad (32)$$

We are now interested in analyzing the impact of INSs and demand shocks (hereafter DSs) on r^g. As expression (33) below shows, unfavorable (favorable) INSs lead to a rise (fall) in r^g. Likewise, expressions (34) and (35) show that favorable (unfavorable) DSs lead to a rise (fall) in r^g.

$$\frac{\partial r^g}{\partial \pi} = \frac{-s_\pi}{s_r} \succ 0 \quad (33)$$

$$\frac{\partial r^g}{\partial \bar{f}} = \frac{1}{s_r} \succ 0 \quad (34)$$

$$\frac{\partial r^g}{\partial \bar{s}} = \frac{-1}{s_r} \prec 0 \quad (35)$$

The determination of r^g is illustrated graphically in Figure 1. We measure the real interest rate *r* in the vertical axis and the rate of growth of output $\hat{y}$ in the horizontal axis. The line denoting $\hat{y}$ for every value of *r* is downward-sloping as stems from (28). We refer to it as the dynamic aggregate demand line or *DAD* line. In general it will not be a line owing to the presence of *u* and π in expression (27). Thus, we impose on it the assumption of linearity for presentational purposes. Its position is determined by the current rate of inflation and rate of capacity utilization. Since $\partial r^g / \partial \pi \succ 0$ we have that an increase in the rate of inflation from say π_0 to π_1 shifts the *DAD* line upwards from DAD_0 to DAD_1 thereby leading to a rise in r^g. Similarly, a rise in $\bar{f}$ or a fall in $\bar{s}$ also shifts the *DAD* line upwards.

Finally, we define the 'neutral' real interest rate r^n as the real interest rate that yields a level of aggregate spending such that $u = \bar{u}$. It is clear from expression (36) below that r^n is a function of π and $\hat{y}$. An explicit solution of r^n can be obtained from (26) by setting $u = \bar{u}$ and rearranging or:

$$r^n = \frac{\bar{f} + f_u \cdot \bar{u} - f_u \cdot u^d + \dfrac{\psi}{v \cdot \bar{u}} - \bar{s} - s_{\hat{y}} \cdot \hat{y} - s_\pi \cdot \pi}{s_r} \qquad (36)$$

2.3.- The zero lower bound traps

We now consider the ability of a CB to generate a level of aggregate demand that matches a growing potential output through conventional monetary policy actions. If we denote by ω the *minimum* (ex-ante) real interest rate a CB can set we can then define a 'zero lower bound growth trap' (ZLBGT hereafter) as a situation where:

$$r^g \prec \omega \qquad (37)$$

If we think of *r* as a short-term real interest rate then it is reasonable to assume that the minimum nominal interest rate the CB can set is zero. However, if we think of *r* as a long-term interest rate, the minimum nominal interest rate the CB can set will be positive. This is because investors require a (time-varying) term premium $\mu \succ 0$ to purchase long-dated securities. If we further assume that the expected rate of inflation is equal to the current rate of inflation we have that:

$$\omega = \mu - \pi^e = \mu - \pi \qquad (38)$$

Therefore, we will say that an economy finds itself in a ZLBGT if:

$$r^g + \pi \prec \mu \qquad (39)$$

This corresponds to the case illustrated in Figure 1. The horizontal line denotes the value of ω for a rate of inflation π_0. Hence, the economy is in a ZLBGT insofar as $r^g \prec \mu - \pi_0 = \omega$. As a result of it, we have that $\hat{y} \prec g_n$ and either an initial positive output-gap will tend to narrow or a negative one will tend to widen. Likewise, if the economy is in a ZLBGT we will observe that the rate of unemployment exhibits an upward trend despite short-term nominal interest rates being at zero. This scenario seems to correspond to Japan´s recent experience since, as shown in Orphanides (2004, p.116), its rate of unemployment has risen steadily from about 2 percent in 1990 to more than 5 percent in 2002.[14]

Next, a favorable INS will push the economy into a ZLBGT if:

$$d\pi \prec \frac{-(r_0^g + \pi_0 - \mu)}{1 + \partial r^g / \partial \pi} \tag{40}$$

where π_0 and r_0^g are the initial inflation rate and r^g respectively. Finally, an unfavorable DS due to a rise in the saving ratio will push the economy into a ZLBGT if:

$$\pi_0 + r_0^g - \mu + \frac{\partial r^g}{\partial \overline{s}} \prec 0 \tag{41}$$

A ZLBT is usually defined as a situation in which conventional monetary policies have become impotent because nominal interest rates are at or near zero. In turn, this will be the case when desired saving exceeds desired investment at full employment even at a zero short-term nominal interest rate. We will refer to this scenario as a ‘conventional

[14] We may wonder why, as the NAIRU theory predicts, the Japanese rate of inflation has not exhibited a downward trend despite a rising rate of unemployment. An explanation of this phenomenon is provided in Yellen and Akerlof (2004) who argue that the evidence suggests a diminished tendency for inflation to fall in the face of high unemployment due to a lower pass-through of inflationary expectations into inflation once inflation is already low. They blame downward nominal wage rigidity for this effect. In this respect, Mourougane and Ibaragi (2004) estimate Phillips curves for Japan and find strong evidence that at low or negative inflation rates, indicators of demand pressure have no statistically significant effect on price inflation.

zero lower bound trap' or CZLBT or as a situation where $r^n \prec \omega$. Unlike a ZLBGT, if an economy finds itself in a CZLBT - but not in a ZLBGT - then the rate of unemployment may persistently be below the NAIRU without exhibiting any trend. If we assume that the minimum long-term nominal interest rate that the CB can set is equal to $\mu \succ 0$ and the expected rate of inflation is equal to the current rate of inflation then we will say that an economy is in a CZLBT if:

$$r^n + \pi \prec \mu \tag{42}$$

Expression (42) tells us that the lower are r^n and π the more likely it is that the economy will get stuck in a CZLBT in the aftermath of a favorable INS or an unfavorable DS. In turn, this suggests that the setting of an inflation target that is very close to zero increases the probability of the economy sliding into a CZLBT. However, and in contrast to recent discussions in the literature, expressions (31) and (42) show that the focus on (very) low inflation targets as the sole cause of an economy getting stuck into a ZLBT ignores the fact that a negative r^g or r^n - due for instance to a high saving ratio - or even a high term premium μ are as potentially dangerous as the setting of a low inflation target[15].

Conventional wisdom regarding the ZLBT seems to be that the latter may arise under certain circumstances as a result of large shocks in a low inflation environment. For instance, if the rate of inflation is already close to zero, then either a large favorable INS or an unfavorable DS may push the rate of inflation to or even below zero. Since the nominal interest rate may already be very close to the ZLB, the CB may thus be unable to

[15] In the context of a closed economy with a government sector a negative 'neutral' real interest rate may also be the result of a large government budget surplus.

push real interest rates further down. As pointed out above, the prevailing position is that this is an unlikely scenario as long as target (measured) inflation is at or above 2 percent (Fuhrer and Madigan, 1997; De Long, 1999). Yet the literature tends to sidestep the fact that, as expressions (31) and (42) show, *the economy may get stuck into a ZLBT even if the rate of inflation is well above zero*. Finally, expressions (31) and (42) also suggest that an escape route from a ZLBT is, as argued in Krugman (1998) and in Eggertsson and Woodford (2003), the creation of inflationary expectations. Nevertheless, as long as the expected rate of inflation tracks the current rate of inflation there is no way the CB can overcome the so-called 'inverted credibility' problem[16]. In our model, CBs can only raise inflationary expectations by actually generating inflation but, and this is the crux of the matter, they cannot generate it as long as the economy remains stuck in a ZLBT[17]. Therefore, in the absence of unconventional monetary policy options only expansionary fiscal policy like reductions in tax rates and increases in expenditures will do the job of kick-starting the economy.

We now turn to the analysis of the behavior of r^n in the aftermath of INSs and DSs and to the analysis of the conditions that will push the economy into a CZLBT. Differentiating (36) and rearranging we obtain:

$$d\, r^n = \frac{-s_\pi \cdot d\pi - s_{\hat{y}} \cdot d\hat{y} - d\bar{s} + d\bar{f}}{s_r} \tag{43}$$

[16] Krugman (1998) argues that if a CB can credibly commit to pursue inflation and ratify inflation when it comes, it should be able to increase inflationary expectations despite the absence of any traction on the economy by means of conventional monetary policy. Eggertsson and Woodford (2003) present a more fully dynamic analysis of the problem. To them, a commitment to create subsequent inflation is presented as a commitment to keep interest rates low for some time in the future.

[17] As pointed out by Blinder (2000, p. 1089), 'the problem, in a word, is that such a policy pronouncement will not be credible once a country is already in the soup'.

If we initially set $d\hat{y} = d\bar{s} = d\bar{f} = 0$ then (43) becomes:

$$d\, r^n = \Pi_0 \cdot d\pi \tag{44}$$

where $\Pi_0 = \frac{-s_\pi}{s_r} \succ 0$.

Thus, we have that INSs *per se* induce changes of r^n in the same direction as the current rate of inflation. Insofar as the CB will lower (raise) current real interest rates following a fall (rise) in the rate of inflation, then r^n will tend to move in a destabilizing fashion. As a result, any given CB-induced change in current real interest rates will be less effective in affecting output and inflation than if r^n remained constant. If we retrieve expression (42) above we may conclude that in the absence of changes in $\hat{y}$ the economy will get stuck into a CZLBT in the wake of a favorable INS ($d\pi \prec 0$) if:

$$d\pi \prec \frac{-(r_0^n + \pi_0 - \mu)}{(1 + \Pi_0)} \tag{45}$$

It is clear from this that, in the absence of changes in $\hat{y}$ and, for given values of π_0, r_0^n and μ, the likelihood that the economy gets stuck into a CZLBT depends on the magnitude of the initial INS ($d\pi$) and on the size of Π_0. For a given favorable INS, the larger Π_0 is the more likely it is that the economy will get into a CZLBT. If we use the values of the parameters obtained from the calibration of the model (see Table 1 below), we have that, assuming that $\pi_0 = 0.02$ and $\mu = 0.01$, and taking the value of r^* in Table 1 as a proxy for r_0^n we have that $\Pi_0 = 0.06$ so the minimum size of a favorable INS that will push the economy into a CZLBT is equal to -3.73 percentage points. Admittedly, such a favorable INS is extremely unlikely. However, an increase in $s_{\hat{y}}$, $\bar{s}$ or μ, or a fall in g_n will necessarily reduce this figure. For instance, if $g_n = 0.015$ then we have that

$r^* = 0.003$ and the minimum size of an INS that will push the economy into a CZLBT becomes as low as -1.2 percentage points.

In a closed economy without a government sector DSs initially affect r^n through their direct impact on either *s* or *g*. We restrict the analysis to the case of shocks hitting the saving ratio, $\bar{s}$ ($d\bar{s} \neq 0$). Notwithstanding, results are qualitatively similar for shocks affecting *g* ($d\bar{f} \neq 0$). If we set $d\pi = d\hat{y} = d\bar{f} = 0$ in (43) we obtain:

$$d\, r^n = \Pi_1 \cdot d\bar{s} \tag{46}$$

where $\Pi_1 = \frac{-1}{s_r} \prec 0$.

Expression (46) tells us that the impact on r^n of a shock to the saving ratio when $d\pi = d\hat{y} = d\bar{f} = 0$ depends on the magnitude of Π_1. Since Π_1 is negative the behavior of r^n will also tend to be destabilizing. If condition (42) does not hold, then the minimum size of the variation in the real interest rate (Δr) required to offset a shock to $\bar{s}$ is:

$$\Delta r = (r_0^n - r_0) + \Pi_1 \cdot d\bar{s} \tag{47}$$

where r_0 is the initial current real interest rate. In turn, the economy will get stuck into a CZLBT in the wake of an adverse DS ($d\bar{s} \succ 0$) if:

$$d\bar{s} \succ \frac{-(r_0^n + \pi_0 - \mu)}{\Pi_1} \tag{48}$$

If we use the values of the parameters derived from the calibration of the model (see Table 1), we have that assuming again that $\pi_0 = 0.02$ and $\mu = 0.01$ and taking the value of r^* as a proxy for r_0^n we have that $\Pi_1 = -0.6$ so the minimum rise in $\bar{s}$ required to push the economy into a CZLBT trap is equal to 0.066. However, this value gets as low as 0.021 if $g_n = 0.015$. Given the high degree of uncertainty surrounding the values of these parameters this result suggests, as a minimum, the need to complement monetary policy with fiscal policy. If the economy is stuck in a ZLBT a sufficiently large increase in the government budget deficit will raise both r^n and r^g thus making monetary policy more effective.

3.- Dynamic analysis

In order to perform a full dynamic analysis of the model presented in Section 3 we need to rewrite expression (3) as[18]:

$$r = r^* + \alpha(\pi - \pi^d) \tag{49}$$

where $\alpha \succ 0$ is the response coefficient of monetary policy and we assume that the CB knows the value of r^*. This rule implies that policymakers respond in a systematic fashion to deviations of inflation from its target level. By definition, we have that:

$$\frac{\dot{u}}{u} = \hat{y} - g \tag{50}$$

and substituting (25) and (27) into (50) yields:

$$\dot{u} = h(u, \pi) \tag{51}$$

If we take logarithms in (8) and differentiate it with respect to time we get:

$$\dot{\bar{u}} = \bar{u} \cdot (g_n - g) \tag{52}$$

and substituting (25) into (15) and then into (52) yields:

$$\dot{\bar{u}} = \bar{u} \cdot \left[g_n - v \cdot u \cdot (\bar{f} + f_u \cdot (u - u^d))\right] \tag{53}$$

[18] In the simulation exercise the current real interest rate may be subject to the ZLB constraint on nominal interest rates so expression (49) was replaced by equation (59).

Therefore, the dynamical system is made up of differential equations (9), (51) and (53). We also assume for convenience that $\bar{f} = (g_n / v \cdot u^d)$ as stems from expression (17). We can then proceed to obtain the singular points of the system by setting $\dot{\pi} = \dot{u} = \dot{\bar{u}} = 0$ which then yields two singular points. However, the only singular point with economic meaning is[19]:

$$P_1^* = (\pi^d, u^d, u^d)$$

As the expression for P_1^* shows the system converges to the inflation target set by the CB, π^d and to the rate of capacity utilization desired by firms, u^d. This can be seen in Figures 2 and 3 below which show the time-path of these two variables. The details of the formal dynamical analysis can be found in appendix A. A *necessary* and *sufficient* condition for the system made up of equations (9), (51) and (53) to be locally stable is:

$$\Delta_1 = \frac{f_u u^d - \dfrac{\psi}{v u^d}}{s_{\hat{y}}} - g_n - v\, f_u {u^d}^2 \prec 0 \qquad (54)$$

$$\Delta_2 = \frac{(s_\pi + \alpha\, s_r) \cdot u^d \phi}{s_{\hat{y}}} \cdot \left(- g_n - v\, f_u {u^d}^2\right) \prec 0 \qquad (55)$$

$$\Delta_3 = \frac{(s_\pi + \alpha\, s_r) \phi u^d}{s_{\hat{y}}} \succ 0 \qquad (56)$$

and

$$\Delta_4 = \frac{(s_\pi + s_r \alpha) u^d \phi}{s_{\hat{y}}} \left[\frac{- f_u u^d + \psi / v u^d}{s_{\hat{y}}}\right] \succ 0 \qquad (57)$$

Table 1 below shows that $\Delta_1 < 0$, $\Delta_2 < 0$, $\Delta_3 > 0$ and $\Delta_4 > 0$ for the combination of parameters that stems from the calibration of the model. In addition, there exists a

[19] The full expressions for the singular points are shown in appendix A below.

critical value α^* of the response coefficient of monetary policy for which the stability of the system changes dramatically. This critical value is obtained by setting $\Delta_4 = 0$ and is:

$$\alpha^* = \frac{-s_\pi}{s_r} \succ 0$$

so that the system will be unstable if $\alpha \prec \alpha^*$ and vice-versa. This means that dynamic stability requires not only that $\alpha \succ 0$ so that monetary policy provides a nominal anchor to the economy but also that $\alpha \succ \alpha^*$. Therefore, an important result is that the dynamic stability of the economy crucially depends on the behavior of the CB, i.e., on the size of the response of current real interest rates to changes in the inflation gap. The value of α^* obtained in the simulation exercise is about 0.07. This value is below the values obtained for this parameter in studies where a Taylor-type monetary policy rule is estimated using time series data (Taylor, 1999; Clarida *et al.*, 1998). However, as pointed out above the value of s_π may be much larger in absolute terms than the value reported in Table 1 so α^* may actually take a larger (positive) value. For instance, if $s_\pi = -0.5$ then $\alpha^* = 0.\widehat{3}$.

Appendix B presents the details of a simulation exercise aimed at calibrating the model. By calibrating the model we sought to assign plausible values to the parameters of the model so as to compute the multipliers and partial derivatives obtained in Section 2 as well as the operators utilized in Section 3. In order to evaluate the behavior of the economy in the presence of a ZLB on nominal interest rates we need to modify the monetary policy rule implemented by the CB. This means that real interest rates will now be set according to the following rule:

$$r_t = \begin{cases} \omega_t = \mu - \pi_t & if \quad r^* + \alpha \cdot (\pi_t - \pi^d) \prec \omega_t \\ r^* + \alpha \cdot (\pi_t - \pi^d) & if \quad r^* + \alpha \cdot (\pi_t - \pi^d) \geq \omega_t \end{cases} \qquad (58)$$

Therefore, the current real interest rate will be set according to expression (49) as long as the ZLB does not bind and will be equal to the difference between the term premium and the inflation rate otherwise. Figures 2 to 9 below show the time-path of the inflation rate, the rate of capacity utilization, the NAICU, the rate of growth of output, the output-gap, the current interest rate, the 'neutral' interest rate, the 'pseudo-warranted' interest rate, the CZLBT condition ($r^n + \pi - \mu \prec 0$), the saving ratio and the net rate of investment. It can be seen that, for the set of parameter values reported in Table 1, the economy exhibits damped oscillations and eventually converges to P_1^*. As shown in Figure 7, the 'pseudo-warranted' interest rate and the CZLBT condition exhibit oscillations with less and more amplitude than the 'neutral' (and current) interest rate respectively. The time-paths exhibited by the 'neutral' and the current interest rate are remarkably similar so they cannot be actually distinguished from each other. This suggests that the volatility exhibited by the 'neutral' real interest rate makes it an inappropriate benchmark for setting real interest rates with a view to stabilizing inflation. In addition, its volatility lends support to results presented in recent studies[20].

Importantly, the simulation exercise revealed that increases in the saving ratio or the term premium and/or reductions in the 'natural' rate of growth or the inflation target increase the instability of the system. In other words, they increase the likelihood that the economy gets stuck into ZLBT. When this occurs the economy collapses abruptly. This is

[20] For instance, in the study by Laubach and Williams (2001), the 'natural' real rate of interest is estimated using quarterly US data over the period 1961 to 2000. In all the model specifications displayed, the authors find substantial variations in its estimated value throughout that period. For instance, in the baseline specification, the minimum value of the natural interest rate is found to be as low as 1.28 percent whereas the maximum value is found to be 4.52 percent. In addition, the authors concede there is sizeable uncertainty around most of their estimates of the natural rate of interest, the trend growth rate and potential output so the actual variation could be much larger.

due to the fact that when the economy hits a ZLBT and the output-gap is negative the rate of inflation keeps falling thus pushing real interest rates further up. In turn, the rise in the real interest rate increases the size of the (negative) output-gap further thereby setting off a deflationary spiral[21]. For instance, for the set of parameter values reported in Table 1, the economy falls apart if $g_n \prec 0.0138$. This value rises to 0.017 if $\mu = 0.015$. Similarly, the economy collapses if $\bar{s} \succ 0.142$ but this value falls to 0.135 if $\mu = 0.015$. Finally, the economy collapses if $\mu \succ 0.038$ but this value gets as low as 0.012 if $g_n = 0.015$. Of course, these results were obtained for the initial conditions reported in Table 1. They may change considerably if the initial conditions differ substantially from those reported in Table 1. In general, the closer the initial conditions for u, $\bar{u}$ and π are to point P_1^* the less likely it is that the economy gets stuck in a ZLBT for a given set of parameter values.

4.- Conclusion

Modern macroeconomic analysis has tended to sidestep the question as to through which mechanism a growing potential output level generates an equi-proportional increase in aggregate spending in the long run. Traditional stories tended to rely on the operation of the real balance effect. Yet this mechanism faces a well-known number of shortcomings notably its negligible size and its uncertain sign. The mechanism utilized in the so-called 'New Consensus View' on macroeconomics relies on a combination of the

[21] As recognized in Reifschneider and Williams (2000, p. 943), this type of result holds for almost any macroeconomic model in which (1) monetary policymakers influence aggregate demand primarily through changes in real short-term interest rates and (2) inflation displays significant inertia. To avoid a catastrophic collapse in (stochastic) simulation resulting from these deflationary episodes they make allowance in the formation of expectations for the possibility of emergency fiscal stimulus in cases of extremely persistent periods of zero rates. In turn, the stimulus is assumed to be of sufficient magnitude to exactly offset the effect of the ZLB until the economy recovers.

permanent income hypothesis and the largely unrealistic assumption of perfect foresight by individuals to sort this problem out. Alternative mechanisms are available but their efficacy is also open to question. This paper has presented a general theoretical framework for the analysis of the mechanism through which the level of aggregate demand grows in line with potential output in the long run in the absence of any self-regulating mechanism other than the stabilization provided by the central bank through conventional monetary policy actions. We argued that the ability of the central bank to perform this task depends on the economy not being stuck in a zero lower bound trap. An algebraic definition and a distinction between two different types of zero lower bound traps were provided. To analyze this and a number of related problems we developed a small theoretical model for a closed economy without a government sector. The model was then subject to dynamical analysis as well to a non-stochastic numerical simulation exercise that allowed us to calibrate it and obtain a number of additional results.

Several results emerged. First, the analysis revealed that the steady growth real interest rate depends positively on the target rate of inflation and the ‘natural’ rate of growth and negatively on the saving ratio. In turn, this led us to argue that the predictions of the model broadly support the hypothesis that the Japanese economy has been in a zero lower bound trap for the last decade or so. Second, we found that the response coefficient of the central bank policy rule has to be larger than a certain positive threshold if the economy is to be dynamically stable and that, in general, the larger it is the more likely it is that the economy will be so. Lastly, the numerical simulation exercise showed that the ‘neutral’ real interest rate fluctuates as much as the current interest rate thus lending support to empirical studies that have analyzed its volatility.

We believe our results lead to the following conclusions. First, given the high degree of uncertainty that surrounds the value of some of the parameters of the model our results suggest that conventional monetary policy does not guarantee per se that the level of aggregate spending will grow in line with potential output in the long run and that, as a result, counter-cyclical fiscal policy is an indispensable ingredient in any macroeconomic policy framework. Indeed, the fact that we do not observe in the real world the type of deflationary spiral that eventually sets off in our model suggests that the regular workings of fiscal automatic stabilizers and, possibly, the operation of the foreign sector represent a powerful self-adjustment mechanism. Second, the setting of real interest rates by the central bank becomes of paramount importance for the stability of the economy and, in general, the higher is the response of real interest rates to changes in the inflation gap the more stable the economy will be. However, this result presumes that: (i) central banks can always push real interest rates in the right direction and with the right intensity and, (ii) the time-path of potential output is not significantly affected by changes in the level and time-path of aggregate demand. Thus, one possible avenue for future research is to determine how our results are affected if these two assumptions are dropped. Third, the analysis reveals that a high saving ratio and a low 'natural' rate of growth represent dangerous macroeconomic features in a low inflation environment because they increase the probability of the economy getting stuck in a zero lower bound trap. One obvious way to mitigate this danger is to enhance the power of automatic stabilizers. Finally, the most evident way for central banks to reinforce macroeconomic stability is to set inflation targets that are sufficiently far from zero.

Appendix A (Formal dynamical analysis)

We start by obtaining the singular points of the system made up of equations (9), (51) and (53) by setting $\dot{\pi} = \dot{u} = \dot{\bar{u}} = 0$ which yields the two following singular points:

$$u^*_{1,2} = \frac{\bar{f}v - v f_u u^d \pm \sqrt{(-\bar{f}v + v f_u u^d)^2 + 4v f_u g_n}}{-2v f_u}$$

and $$\pi^*_{1,2} = \frac{\bar{f} - \bar{s} + f_u(u - u^d) - s_r r^* + s_r \alpha \pi^d + \dfrac{\psi}{v u^*} - s_{\hat{y}} v\bar{f} u^* - s_{\hat{y}} v f_u u^{*2} + s_{\hat{y}} v f_u u^d u^*}{s_\pi + s_r \alpha}$$

If we assume that the CB correctly estimates the value of the 'steady growth' real interest rate r^* and make $\bar{f} = (g_n / v \cdot u^d)$ then the only singular point with economic meaning is[22]:

$$P^*_1 = (\pi^d, u^d, u^d)$$

Linearizing the system made up of (9), (51) and (53) in a neighborhood of point P^*_1 we obtain the matrix form version of the three-dimensional differential equations system or:

$$\begin{pmatrix} \dot{\pi} \\ \dot{u} \\ \dot{\bar{u}} \end{pmatrix} = \begin{pmatrix} 0 & \phi & -\phi \\ \dfrac{-(s_\pi + \alpha s_r)u^d}{s_{\hat{y}}} & \dfrac{\bar{f} - \bar{s} + f_u \cdot u^d - s_\pi \pi^d - s_r r^*}{s_{\hat{y}}} - 2v\bar{f} u^d - v f_u u^{d^2} & 0 \\ 0 & -\bar{f}v u^d - v f_u u^{d^2} & g_n - \bar{f}v u^d \end{pmatrix} \cdot \begin{pmatrix} \pi - \pi^* \\ u - u^* \\ \bar{u} - \bar{u}^* \end{pmatrix} \quad (59)$$

In turn, we have that:

[22] The second singular point given the values assigned to the parameters and reported in Table 1 above is: $P^*_2 = (-0.36; -2.5; -2.5)$.

$$\Delta_1 = Tr(J) = \frac{f_u u^d - \dfrac{\psi}{v u^d}}{s_{\hat{y}}} - g_n - v\, f_u {u^d}^2 \tag{60}$$

$$\Delta_2 = Det(J) = \frac{(s_\pi + \alpha\, s_r)\cdot u^d \phi}{s_{\hat{y}}} \cdot \left(- g_n - v\, f_u {u^d}^2\right) \tag{61}$$

and

$$\Delta_3 = \frac{(s_\pi + \alpha\, s_r)\phi u^d}{s_{\hat{y}}} \tag{62}$$

where J is the jacobian matrix, $Tr(J)$ is the trace of J, $Det(J)$ is the determinant of J and:

$$\Delta_1 = \lambda_1 + \lambda_2 + \lambda_3 = 2\alpha + \lambda_3 \tag{63}$$

$$\Delta_2 = \lambda_1 \cdot \lambda_2 \cdot \lambda_3 = (\alpha^2 + \beta^2)\cdot \lambda_3 \tag{64}$$

$$\Delta_3 = \lambda_1\lambda_2 + \lambda_1\lambda_3 + \lambda_2\lambda_3 = \alpha^2 + \beta^2 + 2\alpha\, \lambda_3 \tag{65}$$

and by Orlando´s formula we have (see Gantmacher, 1954, p. 197):

$$\Delta_4 = -(\lambda_1 + \lambda_2)(\lambda_1 + \lambda_3)(\lambda_2 + \lambda_3) = -2\alpha(\alpha^2 + \beta^2 + 2\alpha\, \lambda_3 + \lambda_3^2) \tag{66}$$

or

$$\Delta_4 = \frac{(s_\pi + s_r \alpha) u^d \phi}{s_{\hat{y}}} \left[\frac{- f_u u^d + \psi / v u^d}{s_{\hat{y}}} \right] \tag{67}$$

where the $\lambda's$ are the eigenvalues of the linearized system, α is the real part of the complex conjugate eigenvalues, $\Delta_3 = J_{11} + J_{22} + J_{33}$ and $\Delta_4 = -\Delta_1\Delta_3 + \Delta_2$. In turn, the J_{ii} are the principal minors (of order 2) of the jacobian matrix, i.e., the determinants of the matrices that are obtained after deleting the i-th row and the i-th column. It is well known that a *necessary* and *sufficient* condition for local stability of the singular point P_1^* is (Gandolfo, 1997):

$$\Delta_1 < 0,\ \ \Delta_2 < 0,\ \Delta_3 > 0 \text{ and } \Delta_4 > 0 \tag{68}$$

Let us go beyond the local stability analysis of system (59). The existence of a pair of pure imaginary eigenvalues requires that (60), (61) and (62) be different from zero and that condition $\Delta_4 = 0$ be fulfilled. This situation highlights the possibility that the implementation of a Taylor-type reaction function by CBs leads to the emergence of self-sustained oscillations. If this were the case the period of the emerging cycles would be equal to $2\pi / \beta_0$ where:

$$\beta_0 = \sqrt{\frac{\Delta_2}{\Delta_1}}$$

It can be shown that the real part of the eigenvalues disappears if the response coefficient of the CB policy rule is equal to:

$$\alpha^* = \frac{-s_\pi}{s_r}$$

However, if $\alpha = \alpha^*$ we have that *Det(J)=0* so that the model will not exhibit self-sustained oscillations around P_1^*. Indeed, if this were the case then singular point P_1^* would disappear since π^* becomes infinite and the stability of the system depends on the initial conditions. Finally, it is important to know how the stability of the system changes when $\alpha \neq \alpha^*$ and α varies. This parameter measures the response of real interest rates to changes in the inflation gap. We have that:

$$\frac{\partial \Delta_2}{\partial \alpha} = \frac{s_r u^d \phi}{s_{\hat{y}}} \cdot \left(-g_n - v f_u {u^d}^2\right) \prec 0 \qquad (69)$$

$$\frac{\partial \Delta_3}{\partial \alpha} = \frac{s_r \phi u^d}{s_{\hat{y}}} \succ 0 \qquad (70)$$

and, for plausible values (see Table 1), we have that:

$$\frac{\partial \Delta_4}{\partial \alpha} = \frac{s_r u^d \phi}{s_{\hat{y}}} \left[\frac{-f_u u^d + \psi / v u^d}{s_{\hat{y}}}\right] \succ 0 \qquad (71)$$

Since the sign of Δ_1 does not depend on the value of α we have that a rise in α actually increases the likelihood that P_1^* is locally asymptotically stable.

Appendix B (numerical simulation)

The numerical simulation was mainly aimed at calibrating the model. In turn, the calibration of the model allowed us to compute a number of multipliers, operators and partial derivatives obtained in previous sections. Table 1 below shows the values of the operators computed for the formal analysis as well as the values for r^*, $\bar{f}$, α^*, $\partial r^* / \partial g_n$, $\partial r^* / \partial \pi^d$, $\partial r^* / \partial \bar{s}$, $\partial r^* / \partial \psi$ and $\partial \Delta_4 / \partial \alpha$. Figures 2 to 9 show the time-path of all the variables in the model for the values of the parameters reported in Table 1. In general, the values were chosen according to the values reported in the empirical literature. The explicit long-run inflation target for many CBs in OECD countries is 2 percent. The empirical literature tends to find that the technical output-capital ratio v is about 0.3. Empirical studies for the U.S. economy suggest that the non-accelerating inflation rate of capacity utilization (NAICU) is about 82 percent (Corrado and Mattey, 1997). The value assigned to ϕ stems from results reported in McElhattan (1978) who found that, for each percentage point that the rate of capacity utilization exceeded 82 percent, inflation accelerated by about 0.15 percentage points. The resulting value for r^* is less than half a percentage point above the average value for the real funds rate over the 1960-1998 period in the United States: 2.55 percent (see Reifschneider and Williams, 2000, p. 950). The values assigned to the parameters in the saving and investment function were the outcome of the calibration process. Finally, for convenience, we set $\bar{f}$ equal to its steady growth value.

$f_u = 0.05$	$s_{\hat{y}} = 1.5$	$\alpha = 0.5$	$\bar{u}_0 = 0.8$	$\partial r^* / \partial g_n = 1.0\widehat{7}$
$u^d = 0.8$	$\psi = 0.015$	$\alpha^* = 0.0\widehat{6}$	$\Delta_1 = -0.0412$	$\partial r^* / \partial \pi^d = 0.0\widehat{6}$
$\pi^d = 0.02$	$v = 0.3$	$\bar{f} = 0.125$	$\Delta_2 = -0.00205$	$\partial r^* / \partial \bar{s} = -0.6$
$\bar{s} = 0.1$	$\phi = 0.15$	$r^* = 0.029\widehat{6}$	$\Delta_3 = 0.052$	$\partial r^* / \partial s_r = -0.019\widehat{7}$
$s_\pi = -0.1$	$g_n = 0.03$	$\pi_0 = 0.03$	$\Delta_4 = 0.00078$	$\Pi_0 = 0.0\widehat{6}$
$s_r = 1.5$	$\mu = 0.01$	$u_0 = 0.8$	$\partial \Delta_4 / \partial \alpha = 0.0018$	$\Pi_1 = -0.\widehat{6}$

Table 1: Values of the parameters, initial conditions, operators and partial derivatives

Figures

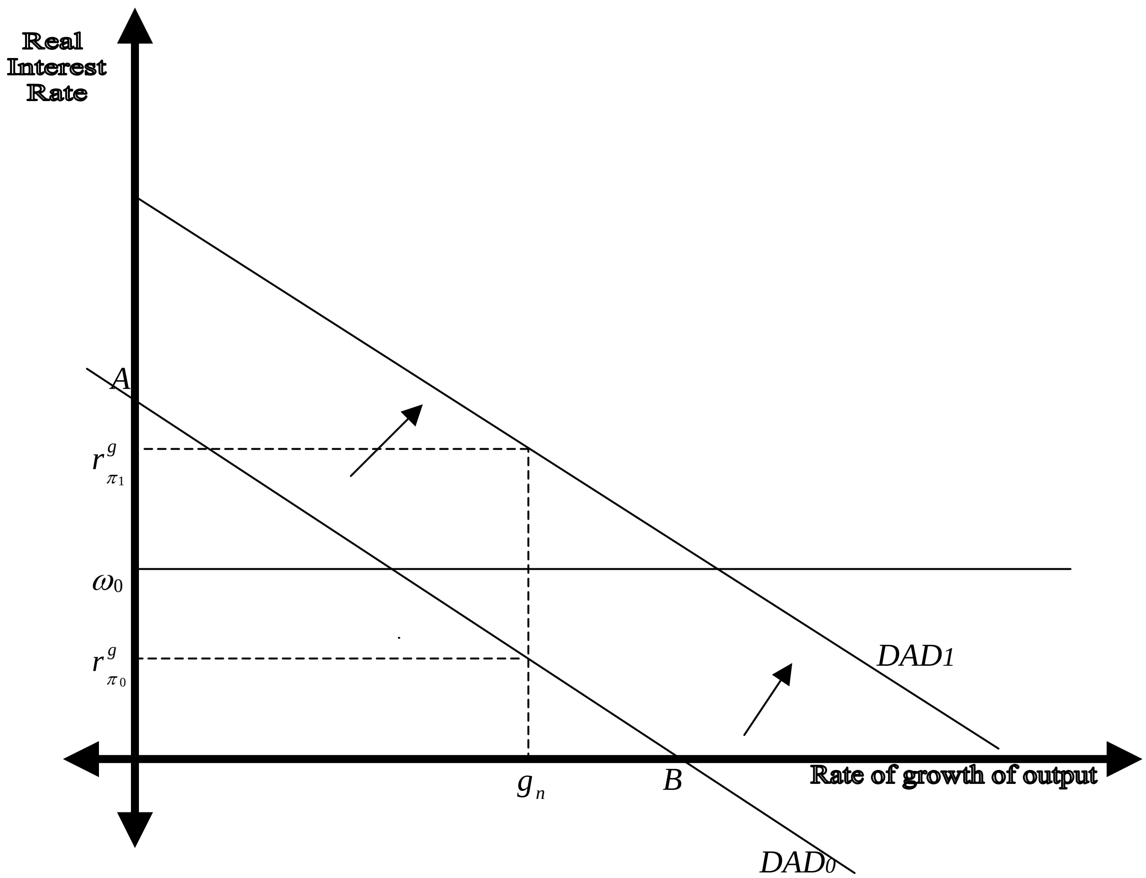

Figure 1: The determination of the 'pseudo-warranted' real interest rate

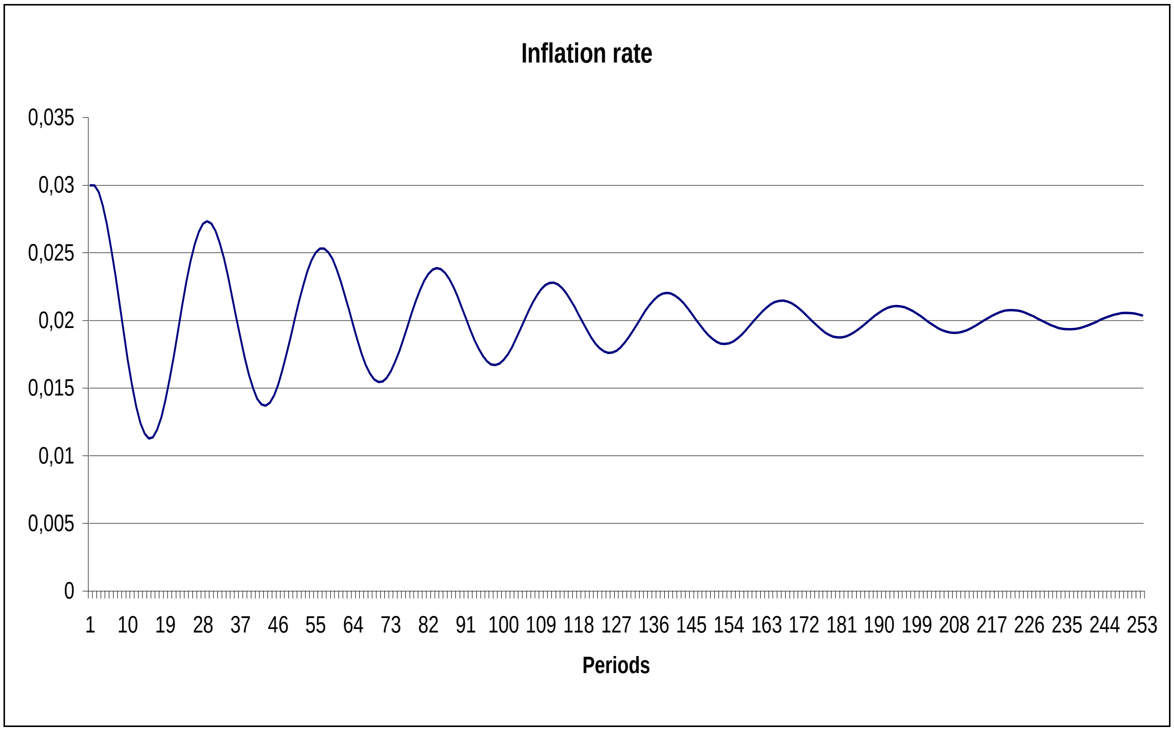

Figure 2: The inflation rate

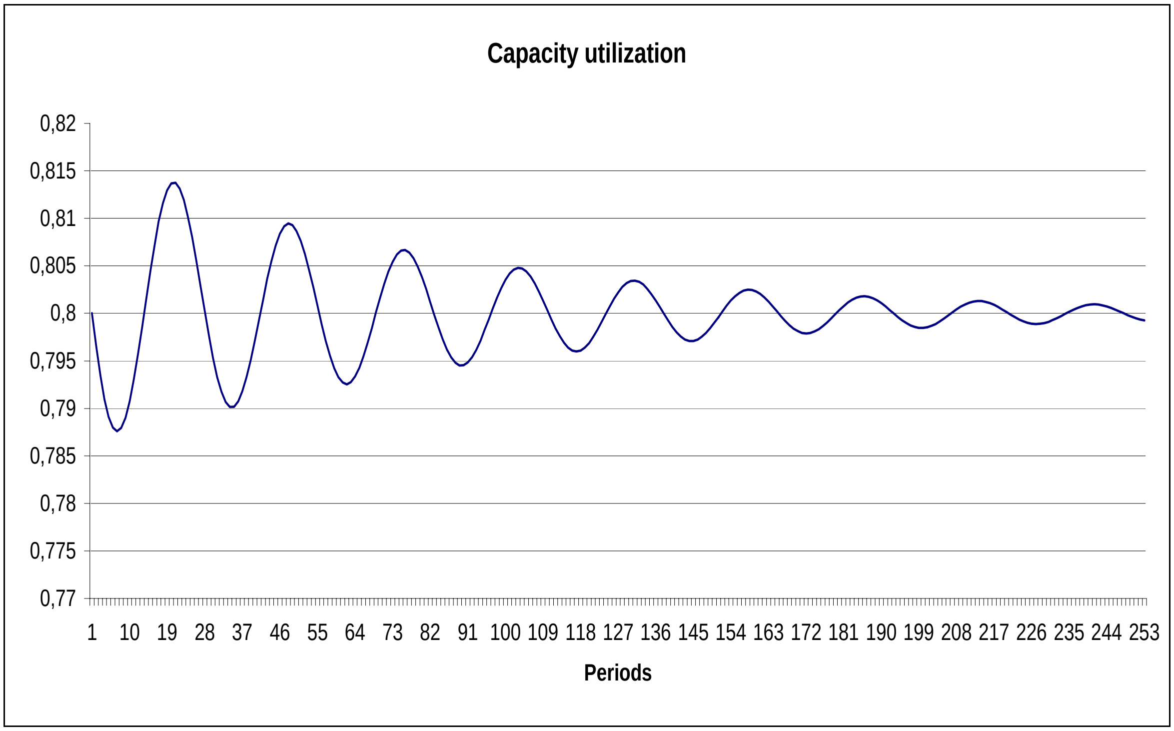

Figure 3: The rate of capacity utilization

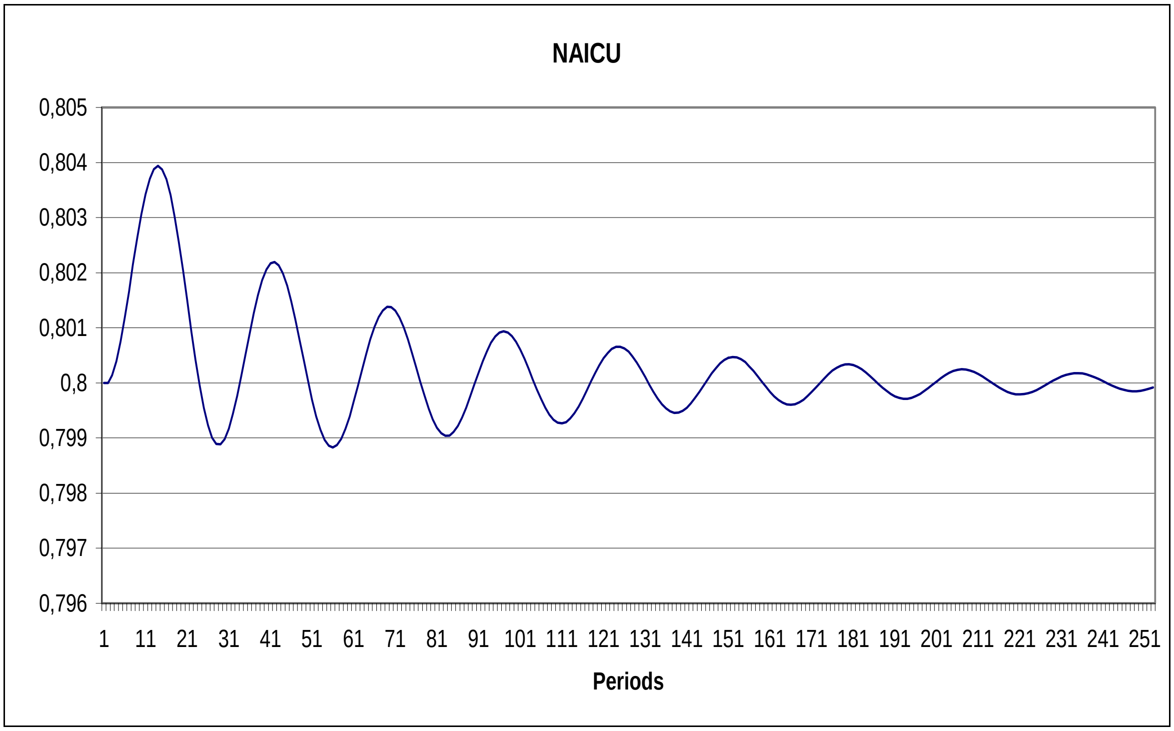

Figure 4: The non-accelerating inflation rate of capacity utilization (NAICU)

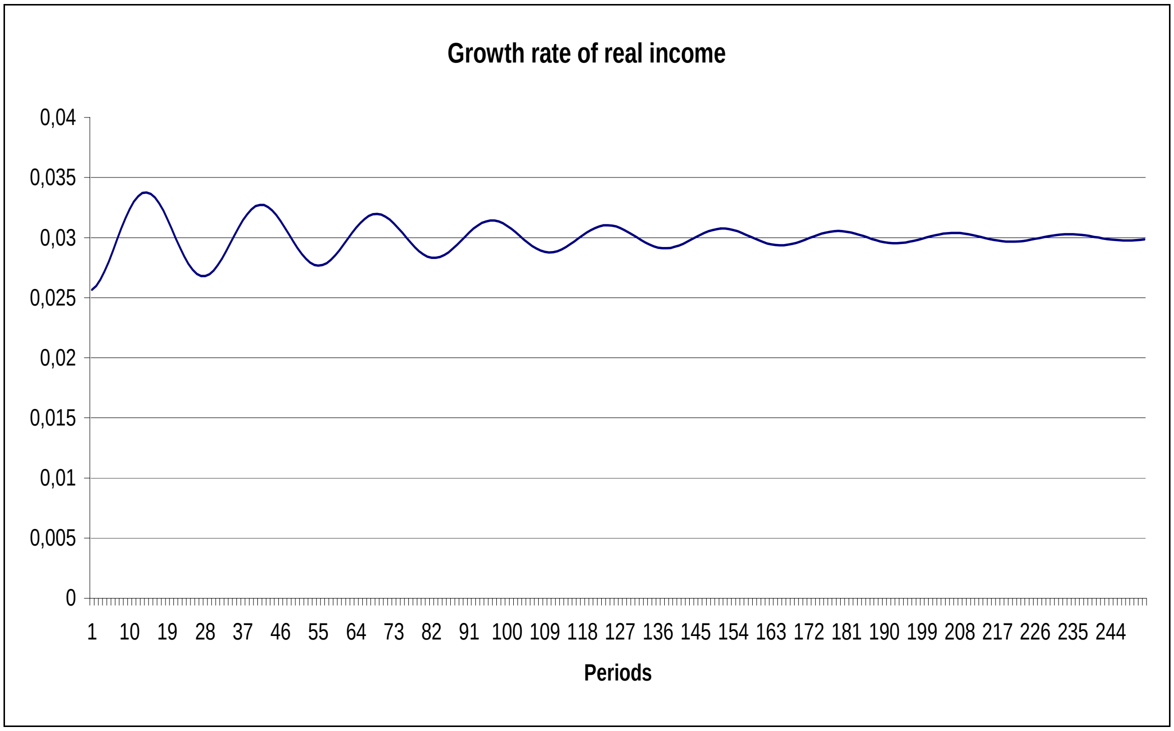

Figure 5: The growth rate of output

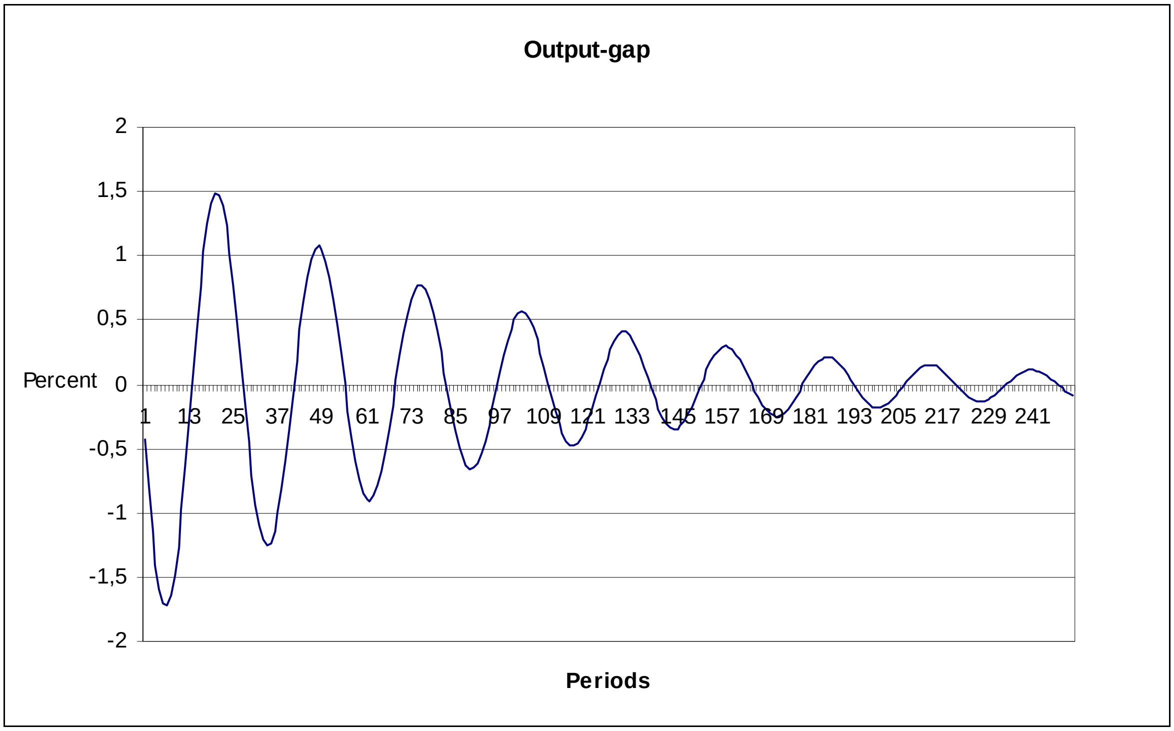

Figure 6: The output-gap

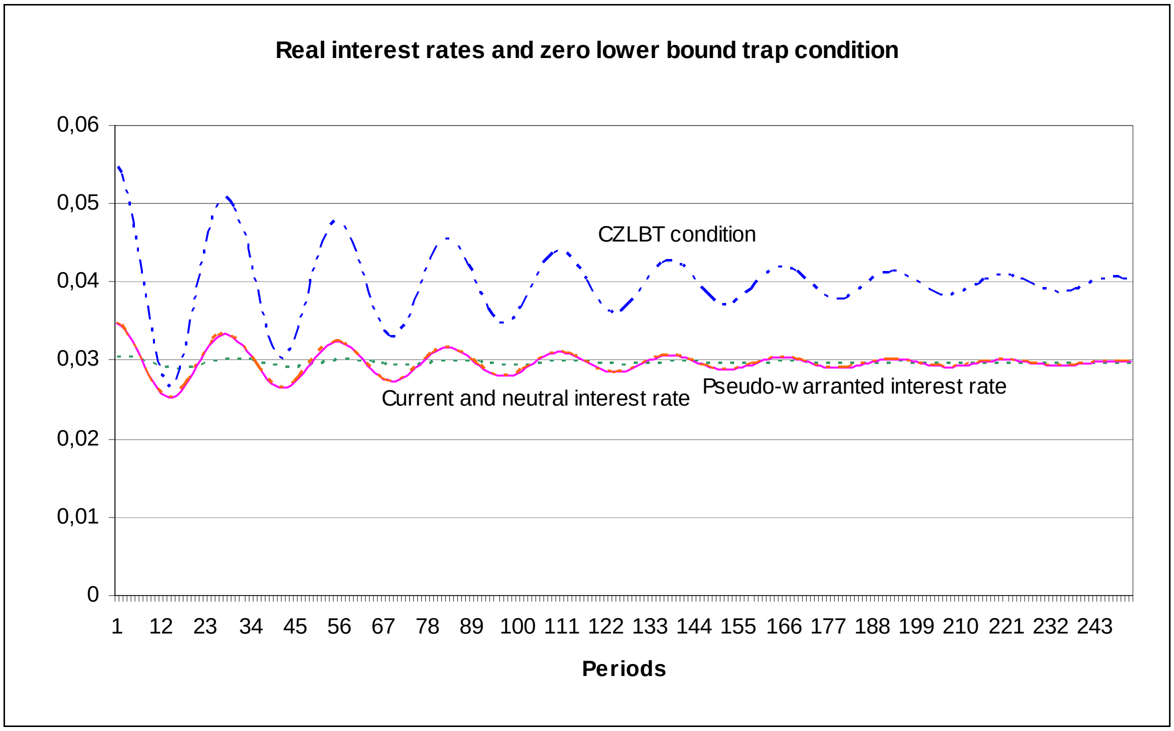

Figure 7: The current, 'neutral' and 'pseudo-warranted' real interest rate and the conventional zero lower bound trap condition ($r^n + \pi - \mu$)

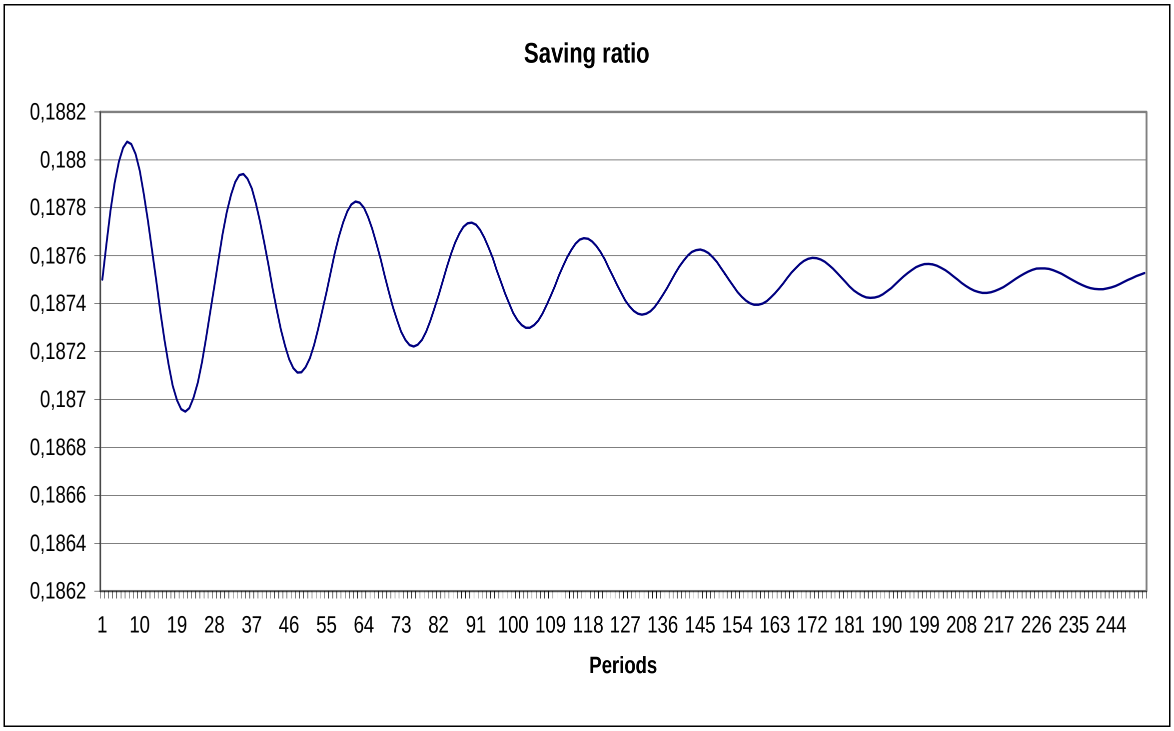

Figure 8: The saving ratio

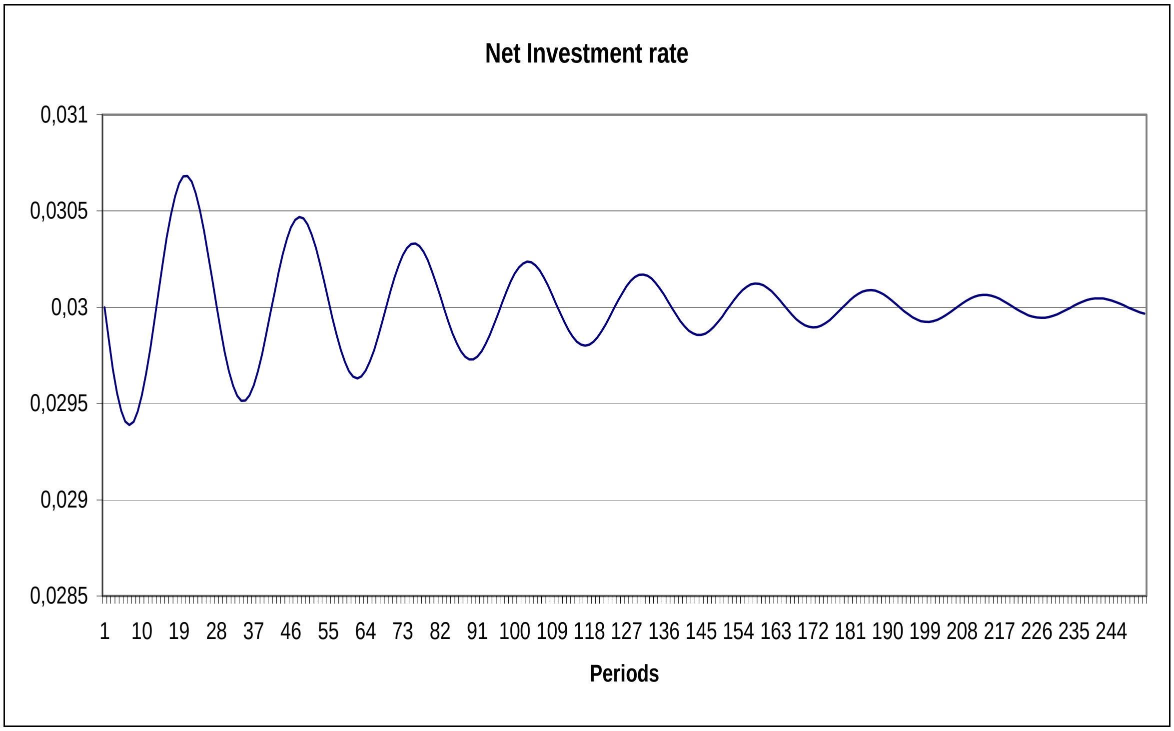

Figure 9: The net investment rate

References

Arestis, P. and M.C. Sawyer (2005); 'The Nature and Role of Monetary Policy when Money is Endogenous', *Cambridge Journal of Economics*, forthcoming.

Bernanke, B.S. (1981); 'Bankrutcy, Liquidity, and Recession', *American Economic Review*, Papers and Proceedings, 71(2), May, pp. 155-59.

Blinder, A.S. (2000); 'Monetary Policy at the Zero Lower Bound: Balancing the Risks', *Journal of Money, Credit and Banking*, 32(4), November, pp. 1093-1099.

Bryant, R. C. (2000); 'Comment on Overcoming the Zero Lower Bound on Interest Rate Policy', *Journal of Money, Credit and Banking*, 32(4), Part 2, pp. 1036-50.

Buiter, W.H. (2003); 'Deflation: Prevention and Cure', *National Bureau of Economic Research*, Working Paper no. 9623, April.

Cargill, T., M. Hutchison and T. Ito (1997); *The Political Economy of Japanese Monetary Policy*, Cambridge (MA): MIT Press.

Clarida, R., J. Galí and M.Gertler (1998); 'Monetary Policy Rules in Practice: Some International Evidence', *European Economic Review*, 42, pp. 1033-1067..

Clarida, R., J. Galí and M.Gertler (1999); 'The Science of Monetary Policy: A New Keynesian Perspective', *Journal of Economic Literature*, 37, December, pp. 1661-1707.

Clouse, J., D. Henderson, A. Orphanides, D. Small and P. Tinsley (2000); 'Monetary Policy When the Nominal Short-Term Interest Rate is Zero', Board of Governors of the Federal Reserve System, November.

Corrado, C. and J. Mattey (1997); 'Capacity Utilization', *Journal of Economic Perspectives*, 11(1), Winter, pp. 151-67.

De Long, J.B. (1999); 'Should We Fear Deflation?', *Brookings Papers on Economic Activity*, 1, pp. 225-252.

Eggertsson, G. B. and M. Woodford (2003); 'The Zero Bound on Interest Rates and Optimal Monetary Policy', *Brookings Papers on Economic Activity*, 1, pp. 139-233.

Filardo, A.J. (1998); 'New Evidence on the Output cost of Fighting Inflation', *Federal Reserve of Kansas City Economic Review*, 83(3), pp. 33-62.

Freedman, C. (2000); 'Comment on Overcoming the Zero Lower Bound on Interest Rate Policy', *Journal of Money, Credit and Banking*, 32(4), November, pp. 1051-1057.

Fuhrer, J.C. and B. F. Madigan (1997); 'Monetary Policy When Interest Rates are Bounded at Zero', *Review of Economics and Statistics*, 79(4), November, pp. 573-585.

Gandolfo, G. (1997); *Economic Dynamics*, Heidelberg: Springer-Verlag.

Gantmacher, F.R. (1954); *Theory of Matrices*, New York: Interscience Publishers.

Goodfriend, M. (2000); ‘Overcoming the Zero Bound on Interest Rate Policy’, *Journal of Money, Credit and Banking*, 32(2), November, pp. 1007-1035.

Goodfriend, M. (2001); ‘Financial Stability, Deflation, and Monetary Policy’, *Monetary and Economic Studies*, 19(S-1), February, Bank of Japan, pp. 143-167.

Goodwin, R.M. (1967); ‘A growth cycle’, in C.H. Feinstein (ed.) *Socialism, Capitalism and Growth*, Cambridge: Cambridge University Press.

Greenwald, B.C. and J.E. Stiglitz (1993); ‘New and Old Keynesians’, *Journal of Economic Perspectives*, 7(1), Winter, pp. 23-44.

Gurley, J. G. and E.S. Shaw (1957); ‘The Growth of Debt and Money in the United States, 1800-1950: A Suggested Interpretation’, *Review of Economics and Statistics*, 39, August, pp. 250-62.

Ito, T. and F.S. Mishkin (2004); ‘Two decades of Japanese monetary policy and the deflation problem’, *National Bureau of Economic Research*, Working Paper no. 10878, October.

Krugman, P. (1998); ‘It’s Baaack: Japan’s Slump and the Return of the Liquidity Trap’, *Brookings Papers on Economic Activity*, 2, pp. 137-205.

Laidler, D. (2004); ‘Monetary Policy after Bubbles Burst: the Zero Lower Bound, the Liquidity Trap and the Credit Deadlock’, mimeo.

Laubach, T. and J.C. Williams (2001); ‘Measuring the Natural Rate of Interest’, Board of Governors of the Federal Reserve System, November.

McCallum, B.T. (2000); ‘Theoretical Analysis Regarding a Zero Lower Bound on Nominal Interest Rates’, *Journal of Money, Credit and Banking*, 32(4), Part 2, November, pp. 870-904.

McElhattan, R. (1985); ‘Inflation, Supply Shocks and the Stable-Inflation Rate of Capacity Utilization’, *Federal Reserve Bank of San Francisco Economic Review*, Winter, 1, pp. 45-63.

Modigliani, F. and R. Brumberg (1980); ‘Utility Analysis and Aggregate Consumption Functions: An Attempt at Integration’, in A. Abel (ed.) *Collected Papers of Franco Modigliani*, vol. 2, Cambridge: MIT Press.

Modigliani, F. (1986); ‘Life Cycle, individual Thrift, and the Wealth of Nations’, *American Economic Review*, 76(3), June, pp. 297-313.

Mourougane, A. and H. Ibaragi (2004); 'Is There a Change in the Trade-off Between Output and Inflation at Low or Stable Inflation Rates?. Some Evidence in the Case of Japan', *Economics Department Working Paper* No. 379, February, Organization for Economic Cooperation and Development.

Mussa, M. (2000); 'Reflections on Monetary Policy of Low inflation', *Journal of Money, Credit and Banking*, 32(4), November, pp. 1100-1106.

Nakatani, T. and P. Skott (2005); 'Japanese growth and stagnation: a Keynesian perspective', mimeo.

Oda, N. and K. Ueda (2005); 'The Effects of the Bank of Japan´s Zero Interest Rate Commitment and Quantitative Monetary Easing on the Yield Curve: A Macro-Finance Approach', http://www.e.u-tokyo.ac.jp/cirje/research/03research02dp.html, Discussion Paper, CIRJE-F-336.

Orphanides, A. and V. Wieland (1998); 'Price Stability and Monetary Policy Effectiveness When Nominal Interest Rates are Bounded at Zero', Board of Governors of the Federal Reserve System, June.

Orphanides, A. (2004); 'Monetary policy in deflation: the liquidity trap in history and practice', *North American Journal of Economics and Finance*, 15, pp. 101-124.

Palacio-Vera, A. (2005); 'The 'Modern' View of Macroeconomics: Some Critical Reflections', *Cambridge Journal of Economics*, 29(5), pp. 747-767.

Palley, T.I. (2004); 'The Economics of Deflation', mimeo.

Pollin, R. (1985); 'Stability and Instability in the Debt-Income Relationship', *American Economic Review*, Papers and Proceedings, 75(2), May, pp. 344-350.

Richardson, P., L. Boone, C. Giorno, M. Meacci, D. Rae, and D. Turner (2000); 'The Concept, Policy Use and Measurement of Structural Unemployment: Estimating a Time Varying NAIRU Across 21 OECD Countries', Economics Department Working Paper No. 250, OECD, ECO/WKP(2000)23.

Reifschneider, D. and J.C. Williams (2000); 'Three Lessons for Monetary Policy in a Low-Inflation Era', *Journal of Money, Credit and Banking*, 32(4), November, pp. 936-966.

Sims, C.A. (2000); 'Comment on Three Lessons for Monetary Policy in a Low-inflation Era', *Journal of Money, Credit and Banking*, 32(4), November, pp. 967-972.

Skott, P. (1989); *Conflict and effective demand in economic growth*, Cambridge: Cambridge University Press.

Svensson, L.E.O (2001); ‘The Zero Bound in an Open-Economy: A Foolproof Way of Escaping from a Liquidity Trap’, *Monetary and Economic Studies* 19 (S-1), February, Bank of Japan, 277-312.

Taylor, J.B. (1999); ‘A Historical Analysis of Monetary Policy Rules’, in J.B. Taylor (ed.) *Monetary Policy Rules*, pp. 319-347, National Bureau of Economic Research, The University of Chicago Press.

Taylor, J.B. (2000); ‘Teaching Modern Macroeconomics at the Principles Level’, *American Economic Review*, Papers and Proceedings, 90(2), May, pp. 90-94.

Tobin, J. (1975); ‘Keynesian Models of Recession and Depression’, *American Economic Review*, 65(2), pp. 195-202.

Ueda, K. (2000); ‘ Japan’s Experience with Zero Interest Rates’, *Journal of Money, Credit and Banking*, 32(4), November, pp. 1107-1109.

Woodford, M. (2003); *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton, NJ, Princeton University Press.

Yates, T. (2002); ‘Monetary Policy and the Zero Bound to Interest Rates: A Review’, Working Paper No. 190, October, European Central Bank.

Yellen, J. L. and G.A. Akerlof (2004); ‘Stabilization Policy: A Reconsideration’, mimeo.

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