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Price stability and monetary policy: A proposal of a non active policy rule

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Abstract A new type of monetary policy rule designed to achieve both price and output stability has increasingly been recommended during the last business cycle expansion, prior to the 2007 crisis. This type of rule implies "active" reaction functions. Based on the new Keynesian approach to monetary economics, these rules prescribe an active response by the central bank in the face of any shock that shifts prices or output from target, which leads to excessive money creation. Here, a less active type of reaction function is proposed; one in which price stability is the long run target, but permitting prices to respond to changes originating in real disturbances. It is argued that the resulting policy delivers outcomes preferable to currently popular rules.

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Estabilidad de precios y estabilidad monetaria: una propuesta de una regla monetaria no activa

Resumen Durante la última etapa expansiva de la economía, previa a la crisis iniciada en 2007, se propusieron nuevas reglas monetarias dirigidas a estabilizar tanto la inflación como la actividad económica alrededor de ciertos objetivos. Este tipo de reglas implican la intervención frecuente en la economía a través de la aplicación de funciones de reacción activas. Basadas en modelos Neo-Keynesianos, estas funciones de reacción prescriben la intervención activa del banco central para corregir cualquier desviación de la inflación y del output gap de sus objetivos, lo que conduce a un exceso de creación de liquidez en la economía. En su lugar, proponemos en este trabajo una función de reacción menos activa, que tenga un objetivo de estabilidad de precios a medio y largo plazo, pero que permita las variaciones de precios debidas a cambios en la productividad. Concluímos que este tipo de reglas menos activas conducen a mejores resultados que las funciones basadas en la conocida regla de Taylor.

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1. Introduction: activism vs. neutrality of monetary policy

In the 90s there has been a profound change in monetary policy research. Current research in this field is almost dominated by a new Keynesian approach to monetary policy that prescribes an active role for policy-makers in maintaining both (low) inflation and output stability. Central banks are told to follow a so-called "optimal" policy by correcting in advance any expected deviation of inflation from a target level and any expected deviation of output from a target (potential) level (that is, "flexible inflation targeting" [Svensson, 1999]). It is argued here that following this proposal could lead to an active policy with unwanted effects in the long term.

According to the new Keynesian model (Clarida et al., 1999, and Galí, 2008), price rigidities in the short run make it possible to implement an active monetary policy with "persistent real effects" (Galí, 2000, p. 3). According to this model, monetary policy is able to affect the output gap and, thus inflation expectations. As a result, the central bank is able to "fine tune" the economy while maintaining long run price stability as its primary target. Leaving important measurment difficulties aside (related to the estimation of the "proper" or true output gap), the model is short term, designed to exploit those short run rigidities and thus permit the central bank to affect real output. This approach explicitly assigns a role to the central bank in stabilising the economy.

In contrast to shocks generated by the economy, the monetary shocks produced by the central bank in implementing that active policy are not easily monitored and evaluated by the market. They thus become a source of distortions that may affect relative prices and agents' plans. As a result, those rules are a potential source of uncertainty that will affect resource allocation.

In contrast, if a medium and long term perspective is adopted, different and non active policy prescriptions emerge. A truly neutral[1] monetary policy requires "not adding monetary disturbances to real ones" (Castañeda, 2005, p. 61). As it will be explained below, at a more operational level this can be achieved by a policy oriented to maintain the purchasing power of money in the long run, while permitting short run price changes due to real shocks and innovations in markets. The type of policy rule we propose preserves the information given by relative price changes in dynamic and growing economies.

Furthermore, (Clarida et al., 1999, and Galí, 2008) new price and output gap stabilisation rules prescribe monetary policy changes in order to maintain a mild inflation in the long run. However, nominal stability thus defined is not always a necessary target for real stability. In a notable paper, White (2006) emphasized that achieving price stability by targeting a consumer price index may not guarantee stable monetary and financial markets in the long run. Developing the same line of argument, here we will focus on the implicit inflationary trend of current price stabilising rules in the context of growing economies and open markets. In growing economies, such policy would require central bank intervention to counteract and offset price deviations coming from positive productivity shocks. Apart from the problem of measuring the true inflation rate in the economy (see Bryan and Cecchetti, 1994, and Cecchetti and Groshen, 2001), this policy implicitly generates an inflationary trend with visible undesirable effects in the future (Buiter, 2006). This is why we argue that it is in the expansionary phase of the cycle when such price stabilisation rules allow for excessive money creation, thus distorting money growth (and possibly financial markets) in long term basis.

To avoid unwanted effects in terms of output losses, we propose a policy rule that prescribes a different policy reaction in the face of different types of deflations; in particular, productivity-based deflations, associated with growing output and financial stability do not require any offsetting intervention. In fact, this type of fall of prices takes place everyday in the form of relative price changes and will be reflected in the price level index depending on the weight of the sectors involved in that index. In sum, being aware of the potential instability and other real effects associated with the adoption of these new active rules in the context of a growing economy, we propose a different type of *reaction functions* that prescribe a less active policy rule.

The structure of the paper is as follows.

A different *reaction function* is proposed in section one; one by which a nominal income target will allow for different price targets depending on how productivity changes are transmitted to prices in the long run. This leads to the development of a *generalised reaction function* (GRF)). Since the adoption of a nominal income criterion takes account of the joint evolution of productivity and price changes, different price outcomes are possible: in a growing economy with markets tending towards competition in the long run, a nominal income criterion permits the adoption of a disinflationary, and even a mild deflationary target that matches, partially or totally, an increasing output. As a result, a less active monetary policy is needed; resulting in a more stable monetary policy.

In section two, analysis of recent monetary policy in the UK confirms a general trend towards a more market-based and stable strategy. However, there inevitably remains a bias in the Bank of England strategy that prevents the full transmission of productivity changes into prices. As it will be shown, this bias produced an excess of liquidity in the UK economy during the business expansions that can be quantified. That may distort market information and impede efficient resource allocation.

Finally, we propose in section three minor changes in current strategy in order to implement a more neutral monetary policy in the UK and in other developed economies such as the eurozone.

2. Proposal of a new non active rule: *generalised reaction function*

Our proposal aims to follow two principles. First, in order to avoid monetary distortions in the markets, the central

1. See Patinkin (1992) for a survey on the "neutrality of money". There is a consensus on the definition of the neutrality of monetary policy when it only affects nominal variables in the long term. In this regard, our first theoretical approximation to neutrality is more restrictive, since it requires not only long run conventional neutrality, but also not affecting markets in the short term. However, this definition is less operational. We will come back to a more operational definition in later sections.

bank should adopt a monetary target that allows for full market adjustments and the transmission of information in line with relative price changes. Second, in view of the lags in monetary policy, the central bank should set monetary policy and be evaluated on a long run basis. Consequently, monetary policy will be designed and implemented with a long term basis; as a result, nominal rigidities have time to erode and both relative prices and the price level will be able to reflect changes coming from different real shocks.

In particular, in the face of positive productivity shocks in long term open markets, declining prices (either disinflation or mild deflation) will be the expected outcome in a growing economy.[2] In order to deal with different types of deflations and, in particular, productivity-based deflations, our monetary rule will permit a long run transmission of productivity changes into prices.

Instead of price and output gap stability, as part of a "flexible inflation targeting" rule, we argue for a nominal income target that reflects the joint evolution of productivity and prices in the long run. Depending on the central bank's preferences towards inflation, this rule (eq. 1) will permit the adoption of different price targets that take into account the way productivity changes affect prices in the long run. For this reason, it will be considered as a generalisation of the existing functions - the "Generalised Reaction Function" (GRF, Castañeda, 2003).

$$\dot{M}_t^S = \left(\dot{Y}^*_{r,t+i} + \lambda_1 \, \mathrm{Prod}_{r,t+i}\right)^e - \dot{V}^e_{T,t+i} + \lambda_2\left(\dot{Y}_{nom,t+i} - \dot{Y}_{nom,t+j}\right)^e \qquad (1)$$

$$\dot{M}_t^S = \left(\dot{Y}^*_{r,t+i} + \Pi^*_{t+i}\right)^e - \dot{V}^e_{T,t+i} + \lambda_2\left(\dot{Y}_{nom,t+i} - \dot{Y}_{nom,t+j}\right)^e$$

Where:

$\dot{M}_t^S$; Broad monetary aggregate growth rate.

$\dot{Y}^*_{nom,t+i} = \left(\dot{Y}^*_{r,t+i} + \lambda_1 \dot{Y}^*_{r,t+i}\right)^e$; Long term nominal income target.

$\dot{Y}^*_{r,t+i}$; Long term real output growth.

$\mathrm{Prod}_{r,t+i}$; Long term real productivity growth.

$\left(\dot{Y}_{nom,t+j}\right)^e = \mathrm{E}\left(\dot{Y}_{nom,t+j}\right)\big|_t$; Short term expected nominal income "j" periods ahead, with the information set available at "t", where the monetary decision is made. So j < i.

$\dot{V}^e_{T,t+i}$; Long term expected money velocity.

λ_1; *Price stabilisation* coefficient ($-1 \le \lambda_1 \le 1$): where price is not measured by a consumer price index, but by a general price index such as the economy deflator.

$$\lambda_1 \dot{Y}^*_{r,t+i} = \Pi^*_{t+i} \Rightarrow \lambda_1 = \frac{\Pi^*_{t+i}}{\mathrm{Prod}_{r,t+i}}$$

λ_2; Short term activism coefficient: indicates the central bank reaction to short term expected nominal income deviations from target ($\lambda_2 \ge 0$).

According to this rule, the money supply is driven by two main components: a long term one, regarding the evolution of nominal income, and a short term one, regarding the expected deviations of nominal income from its long term target. So, money supply is set to "finance" the long term nominal economy growth and, if required, counteract short term cyclical deviations. Once a nominal income target is set for a pre-determined period (reflecting expected long term output growth and the desired price target), the central bank will only counteract short term nominal income deviations from target if $\lambda_2 > 0$. As a result, if $\lambda_2 = 0$, we will have a truly passive or non reactive version of the rule.

In order to obtain a more operational expression, two different hypotheses are considered (eq. 2): firstly, the *gradualism* hypothesis, to avoid disruptive monetary decision setting (Clarida et al., 1998). And, secondly, *asymmetrical reaction coefficients*, which imply responses of different intensity to different nominal income deviations from target (in case $\lambda_2 > 0$) (Clarida and Gertler, 1997).[3]

$$\dot{M}_t^S = \rho \dot{M}_{t-1}^S + (1-\rho)\left[\left(\dot{Y}^*_{r,t+i} + \lambda_1 \dot{Y}^*_{r,t+i}\right)^e - \dot{V}^e_{T,t+i} + \lambda_2\left(\dot{Y}_{nom,t+i} - \dot{Y}_{nom,t+j}\right)^e\right] \qquad (2)$$

Where:

ρ; *Smoothing parameter*, indicating the interest rate adjustment intensity to the desired value ($0 \le \rho \le 1$).

$\lambda_2 = \int\left(\dot{Y}_{nom,t+j} - \dot{Y}_{nom,t+i}\right)^e$; $\lambda_2 \ge 0$

Finally, by adopting the proposed *reaction function* in the form of a nominal income target we are not giving the central bank any role in stabilising real output. To the contrary, following this *reaction function* the central bank will adopt a price target explicitly related to the long term evolution of productivity.

2.1. Alternative *generalised reaction functions*: mild inflationist, zero inflationist, and mild deflationist rules

Setting the long run nominal income target requires two elements. Once long term real output growth is estimated, the long term inflation target will depend on the value of parameter λ_1, and thus, on the central bank's price stabilisation preferences.

If $-1 < \lambda_1 < 0$, productivity changes are partially transmitted to final prices. This is a distinguishing feature of growing economies with highly competitive goods and services markets. So, the long run nominal income target will be the joint outcome of a growing economy and a long run mild deflationary trend.

If $\lambda_1 = 0$, this situation corresponds to nominal income stabilisation, where economic and productivity growth are not followed by changes in prices. Using conventional *reaction functions*, this may be a special case of an intended zero-inflationist policy that offsets any productivity shocks affecting price stability (i.e. the so called "k%" or "Friedman rule", Friedman, 1959).

If $0 < \lambda_1 < 1$, the central bank adopts a "mild" inflationary target[4], setting a positive lower limit of inflation as a long term target.

2. "In the case of deflation, declining costs due e.g., to technical change will lead to a declining price level as a result of an expansion of real output, without requiring any change in monetary growth or velocity. In other words, cost-push deflation is compatible with the modern quantity theory" (Bordo and Schwartz, 1979, p. 19). See Castañeda and Wood (2011) for a more detailed explaination.

3. In the empirical aplication to the UK monetary policy, we also extend the asymmetrical coeficient hypothesis to λ_1.

4. If $\lambda 1 > 1$, the price target is not set according to market expectations; rather, central bank is fostering money supply as a policy instrument, following an output stabilisation criterion.

In sum, the value of λ_1 will depend on the inflation target adopted by the central bank and, therefore, on the way productivity and economic growth are expected to affect prices in the long term.

Our GRF (eq. 2) allows for different central bank reactions in the face of different types of deflationary pressures.

Adopting a low nominal income target will permit a (mild) downward price trend in the face of a growing supply of goods in the economy. Since this is an expected decline in prices, coming from a growing output, this is a kind of deflation ("good deflation", Bordo and Filardo [2004]) that does not require any central bank offsetting intervention. If, on the contrary, deflation is the signal of a general loss of confidence and lack of activity in the economy, adopting our proposal permits the possibility of counteracting it. This leads to a less active monetary policy, with operational and theoretical advantages. Following Friedman's monetary activism definition (Friedman, 1968), it requires less activism since it reduces central bank interventions during a pre-established time period. In view of the unavoidable lack of information about the "true" model of the economy, this more conservative policy will reduce the potential instability associated with a more active policy.

2.2. Concerns about deflation

Due to the great concerns that were aroused by the 1929 Crisis, and the recent long deflationary period in Japan, deflation remains associated with a recession scenario of high unemployment and great output losses.[5] These are the main concerns regarding deflations (Burdekin and Siklos, 2004):

- Regarding monetary policy: firstly, deflation reduces the effectiveness of monetary policy and, so, reduces central bank ability to develop countercyclical policies. Secondly, it may complicate the design and the understanding of monetary policy, since both central bank and agents are not used to a deflationary environment.
- Fisher's *debt-deflation theory*, which identifies a correlation between growing agents' debts, deflationary trend and, finally, depression episodes.[6]
- The possibility that even a moderate deflation rate may lead to a deflationary self-reinforcing downward price spiral.

In proposing a rule that permits a mild deflation, we do not expect such unwanted effects. A mild deflation coming from productivity gains is totally different from a deflation coming from a general loss of confidence in the economy. Moreover, a mild productivity-based deflation is just the extension of a continuous disinflationary trend in competitive markets; a market phenomenon we have become more used to seeing recently as major components of price indices have fallen due to technical progress (sometimes overseas). This type of decline in prices, is not disruptive, and past experience shows that it can extend to a very wide range of prices.

Misunderstanding the foundations of different types of deflations was one of the most important factors in explaining the origin of price stabilising monetary policy rules (in the face of productivity shocks). Hayek (1928, p. 100) wrote: "*Theory has hitherto scarcely progressed this distinction between the effects of changes in the price level originating on the one hand from the goods side and on the other from the money side. (…) The view advanced here, that changes in the price level coming from the goods side are not detrimental but are even necessary if disturbances of equilibrium are to be avoided, may still appear to many to have something of the air of paradox. (…) because the view that is dominant today, according to which only an invariable price level will ensure an undisturbed course of production, (…)*" and it remains mainly a "paradox" nowadays.

However, recent historical studies have underlined the distinction, both in nature and consequences, between different types of deflations (Bordo et al., 2004; Bordo and Filardo, 2004, and Capie and Wood, 2004). Others, such as Atkeson and Kehoe (2004), find that there is no empirical correlation between deflation and depression. These analyses and findings support the distinction between different origins and consequences of deflations and, therefore, the corresponding distinction between the optimal monetary policy required in each particular case.

Adopting a nominal income criterion through the GRF may generate a mild deflation in a growing economy, since productivity gains are, to an extent which depends on market structure, reflected in prices in the long term. This type of deflation is not a cause for concern. There are several reasons for this.

Firstly, a nominal income rule does not distort resource allocation. It does not prescribe continuous central bank interventions to offset deflationary pressures that affect price settings and agents' expectations; rather, it permits the heterogeneous transmission of the price signals in different markets. As a consequence, it preserves valuable market information for agents' decision-making-process, and reduces the number of monetary shocks affecting agents' expectations (Castañeda, 2005).

Secondly, most of the costs associated with deflations are the consequences of demand-side deflationary episodes. In this case, a significant and persistent downward demand shift may lead to a general lost of confidence[7] (Svensson, 2003) and, thus, to an "*ugly deflation*" (Bordo and Filardo, 2004). But a mild deflation coming from increases in productivity is the expected outcome in a flexible and competitive market. In this case, a truly neutral policy should not react to offset that outcome, which is the ordinary and expected result

5. "*A mild but continuous deflation could be a cause of concern, however, as it may increase economic uncertainties, distort resource allocation, entail distributional consequences, and lead to subpar growth performance*". Kumar et al. (2003, p. 3).

6. See Capie and Wood (2004) for a more detailed analysis.

7. "*Prolonged deflation can have severe negative consequences. The real value of nominal debt rises, which may cause bankrupties (…). Commercial banks' balance sheet deteriorate when collateral loses value and loans turn bad, and financial instability may threaten. Unemployment may rise, and if nominal wages are rigid downwards, deflation means that real wages do not fall but increase, further increasing unemployment. All this contribute to a further fall in aggregate demand (…) and bring prices and economy down in a deflationary spiral.*" Svensson (2003, p. 2-3).

in the market. Deflations are not inevitably linked with depressions and negative expectations.

Furthermore, increases in productivity will be followed by increases in the equilibrium real interest rate (Wicksell, 1907, and Mises, 1912), keeping the economy away from the so-called zero bound of nominal interest rates and the ineffectiveness of monetary policy (or "liquidity trap", Keynes, 1936).

Thirdly, some of the costs (mentioned above) that are said to be associated with deflation are not consistent with a *Rational Expectations Hypothesis*. In fact, both agents and the central bank can learn how to analyse markets' evolution in a mild deflationary scenario in the context of a nominal income rule.

Finally, regarding the spiral effects of deflations, Capie and Wood (2004) and Bordo and Filardo (2004) provide evidence which suggests that only in very specific and limited situations can deflation be linked to financial instability and depression (e.g. 1929). Furthermore, these situations were mainly determinated by a vast demand-side deflation, following and followed by an inappropriate monetary policy, which undermined agents' expectations about economic recovery (Svensson, 2003).

2.3. A more realistic, but not a mechanical, rule

Unlike the original *Taylor Rule* (Taylor, 1993a and 1993b), this *reaction function* (eqs. 1, 2) is set according to real time information availability. The central bank is supposed to make monetary decisions according to expected variables (the rule is forward looking), but using currently available indicators. So, monetary decisions are made in period "t", with regard to medium term expected variables "t+i" periods ahead, using information of "t−z" periods behind. In this setting, the central bank has the possibility of using all relevant (and available) information to foresee medium term inflation and output.

However, a *reaction function* cannot be used as a straightforward operational tool to run monetary policy (Blinder, 1998, and King, 2005), since personal judgements and other sources of relevant information play an important role in the monetary decision-making-process. The function is far from being a complete description of the monetary decision-making-process; rather it is a credible anchor to explain and communicate monetary policy decisions.

In this sense, the *reaction function* is just the final outcome of the monetary strategy of the central bank; which includes the definition of the central bank target, the hypotheses of the model (or rationale) used to analyse the economy indicators, the instruments used to implement policy decisions and, finally, its communication policy with the market. Consequently, the *reaction function* proposed is a way to explain policy decisions and the expected path of monetary policy, according to the model and information used by the central bank.

Finally, the GRF is the generalised expression of well-known money supply-based *instrument rules*[8]:

If $\lambda_1 = 0$; $\lambda_2 = 0$, it is the fixed (non reactive) rule proposed by Friedman (1959); which implies, by definition, the adoption of a zero inflation target.

If $\lambda_1 = 0$; $\lambda_2 > 0$, it is McCallum's nominal income rule (McCallum, 1987) It is an active rule, which adopts a price stability objective, and permits interventions to correct cyclical nominal income deviations from target.

If $\lambda_1 = -1$; $\lambda_2 = 0$, it is the fixed (non reactive) money supply rule proposed by Hayek (1928). Unlike Friedman's proposal, a long term deflation target consistent with productivity growth is the target, not zero inflation.[9]

3. An empirical application: Is the Bank of England following an inflationary rule?

Next we analyse the workings of our proposed rule during the last business cycle expansions in the UK data, using UK[10] from 1960 to 2004) (eq. 3). In this analysis, the evaluation of the parameter λ_1 will be our main objective: it can be considered as a "rough" measure of how central banks are reacting to price deviations coming from productivity changes and thus a measure of central bank price stabilisation preference. The changing value of this parameter will capture the Bank of England's preferences: the bigger "λ_1", the more *activist* is monetary policy.

$$\dot{M}_t^S = \left(Trend\dot{Y}_{r,t}^* + \lambda_1 Trend\,\mathrm{Pr}od_{r,t}\right) - Trend\dot{V}_{T,t} + \lambda_2\left(Trend\dot{Y}_{nom,t} - Trend\dot{Y}_{nom,t-1}\right) \quad (3)$$

This GRF allows for testing different price target strategies (see Table 1 below), by using different nominal income targets (and thus, different "λ_1"). As a result, we will be able to compare the recent Bank of England monetary policy with ones coming from the adoption of those different targets[11]:

If it has adopted a *mild inflationary policy*, the central bank will have chosen an inflationary target in the long run, by which inflation cannot fall under a certain positive value. So, under this target, in the case of a growing economy, prices may fall in the long run but only to certain limit; corresponding to that positive inflation target. This corresponds to the adoption of a positive and greater than one "λ_1" (with a different value in the face of increasing (1.0) or decreasing (1.5) productivity growth).

If adopting a *fully* disinflationary policy, the central bank would have allowed prices to reflect changes in productivity. In the case of a growing economy, productivity

8. According to Svensson's (1999) definitions, *instrument rules* are *ad hoc* functions that prescribe monetary policy according to predetermined variables. In contrast, *optimal rules* are the mathematical outcome of optimising an objective (or a loss) function, restricted to a set of equations that describe the economy.

9. For this reason, it has also been named as a *productivity norm* (Selgin, 1997).

10. All the variables are Hodrick-Prescott trends of (interanual variation rates):
- Productivity: as output per worker for the whole economy (Office of National Statistics).
- Real GDP: Office of National Statistics.
- GDP Deflator: Office of National Statistics.
- M4: As a proxy for broad money supply (Bank of England).

11. Since we focus on determining the inflationary bias of monetary policy, the three GRF specifications are benchmarks to study the long term bias of monetary policy. As a result, all GRFs are calculated using trends and they are all non *reactive reaction functions* ($\lambda_2 = 0$, see eq. 3).

Table 1 *Generalised reaction functions*: different policy options

$$\dot{M}_t^s = \rho\dot{M}_{t-1}^s + (1-\rho)[Trend\ (\dot{Y}_{r,t}^* + \lambda_1\ \mathrm{Pr}\ od_{r,t}^*) - Trend\dot{V}_t + \lambda_2\ (Trend\dot{Y}_{nom,t}^* - \dot{Y}_{nom,t-1})]$$

Policy rules	$\lambda_1 = \left(\frac{\Pi}{\mathrm{Pr}\ od}\right)$		λ_2	Inertia parameter: ρ
	If ↑ Prod. growth	If ↓ Prod. growth		
Mild inflationist	1.0	1.5	0	0.9
Disinflationist	0.1	0.5	0	0.9
Mild deflationist	−0.5	−0.1	0	0.9

growth is transmitted in the long run to falling prices but, since this disinflationary policy avoids deflation, a lower inflation bound is set at zero. So, in contrast to the "mild inflationary" policy, a fully disinflationary policy permits disinflation until zero inflation is achieved. This corresponds to the adoption of a positive and less than one "λ_1" (with a different value in the face of increasing (0.1) or decreasing (0.5) productivity growth).

If adopting a "*mild deflationary*" policy, the central bank would have allowed prices fully to reflect productivity changes. In the case of a growing economy, productivity growth is transmitted in the long run to a falling price target. This corresponds to the adoption of a negative "λ_1" (with a different value in the face of increasing (−0.5) or decreasing (−0.1) productivity growth).

3.1. Underlying assumptions

We have tested three assumptions needed to asses the feasibility and usefulness of those GRF as tools to study UK monetary policy: First, since it is a money supply-based *reaction function*, we have tested the existence of a long run relationship between money growth and price changes. Secondly, adopting a forward looking rule such as the GRF requires the use either of expected variables or leading indicators. As it is a crucial variable for our GRF, we test if productivity is a good leading indicator of GDP. Finally, following our proposal, the price target is set according to productivity changes. So, we examine the joint evolution of those variables and test if prices follow different paths in the face of increases or decreases in productivity.

A. Inflation as a monetary phenomenon

As it can be seen in Figure 1, money growth and inflation have shared a common trend since the sixties, except for the period of the early eighties, a period characterised by significant financial deregulation and innovation. In order to analyse the cyclical evolution of money and prices in more detail, we have calculated the first difference of the trends of the deflator and M_4 (see Figure 2). Using García Ferrer and Bujosa (2000) criterion to identify common cyclical patterns, the turning points of the first difference of both trends may provide useful information about their cyclical evolution. Since the mid eighties, turning points of money growth (see Figure 2, points A, B, C and D) anticipate, several quarters ahead, turning points of prices (Figure 2, vertical lines). As a result, we can consider money growth as a leading indicator of price changes.

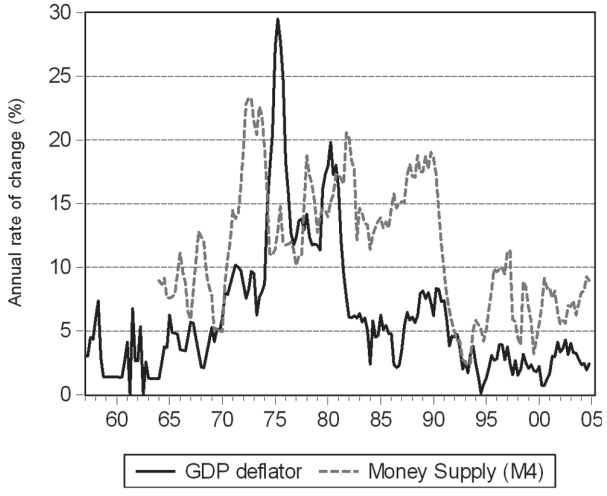

Figure 1 Prices and money supply in the UK. Data: Bank of England and National Statistics Office.

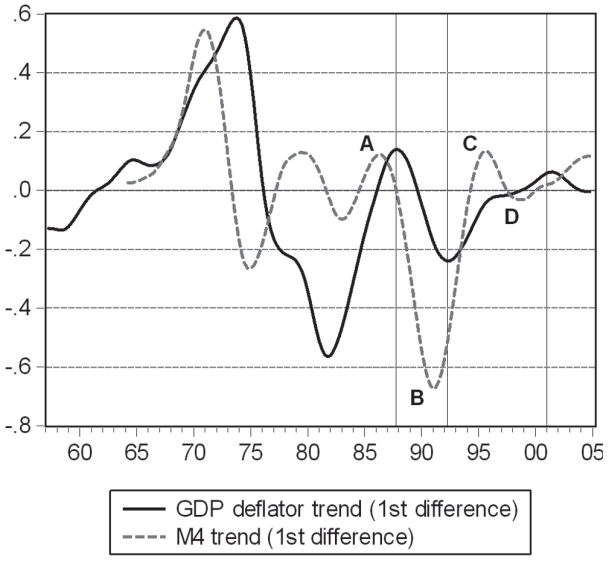

Figure 2 Money supply and prices in the UK: long term leading indicator. All trends are calculated using the Hodrick-Prescott filter (HP). Data: Bank of England and National Statistics Office.

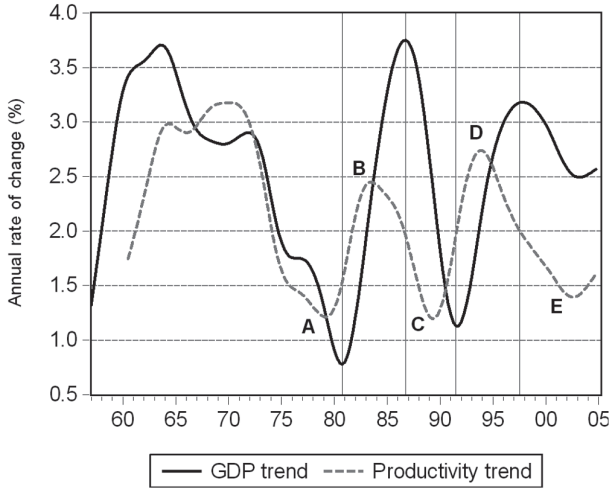

Figure 3 Productivity as a leading indicator of GDP in the UK. All trends are calculated using the Hodrick-Prescott filter (HP). Data: National Statistics Office.

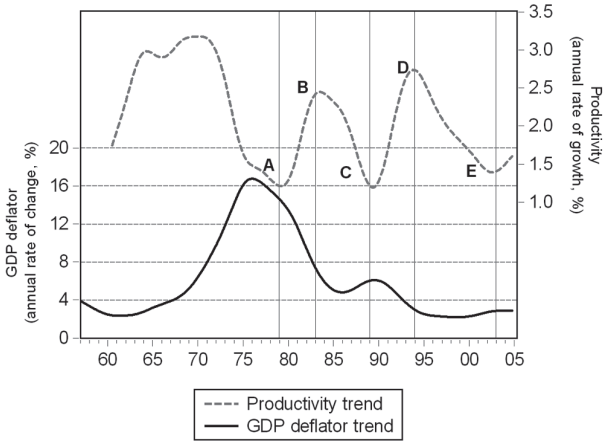

Figure 5 Prices and productivity trends in the UK: identification of changing points. All trends are calculated using the Hodrick-Prescott filter (HP). Data: National Statistics Office.

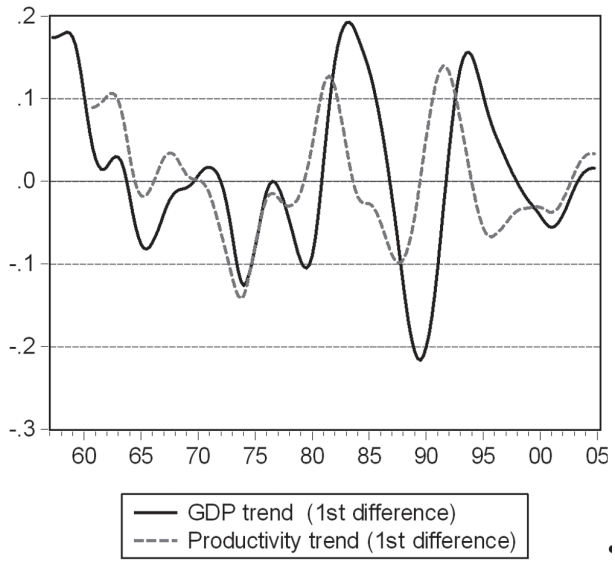

Figure 4 Productivity changes: leading indicator of GDP changes in the UK. All trends are calculated using the Hodrick-Prescott filter (HP). Data: National Statistics Office.

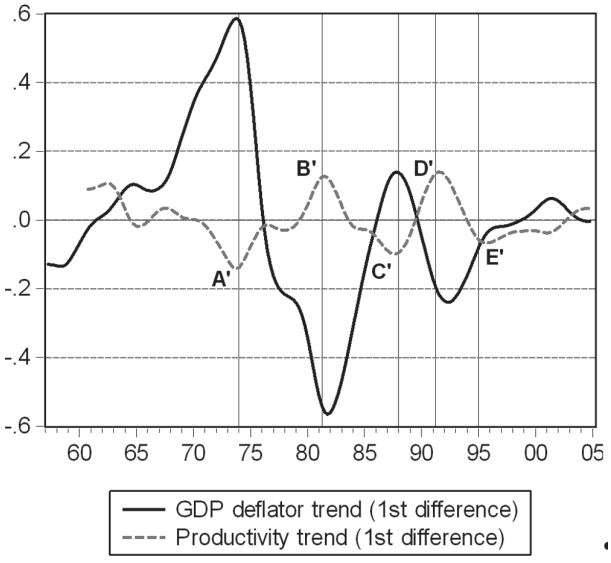

Figure 6 Prices and productivity changes in the UK: identification of changing points. All trends are calculated using the Hodrick-Prescott filter (HP). Data: National Statistics Office.

B. Productivity as a leading indicator of GDP

Using the same criterion, we have analysed GDP and productivity trends. As can be seen in Figure 3, turning points of productivity systematically lead turning points of GDP (see points A, B, C, D and E). This result is reinforced after analysing the first difference of the trends (see Figure 4). In this case, a clear leading pattern across the whole sample arises. This empirical analysis supports the adoption of productivity as a leading indicator of GDP.

C. Productivity and prices

The GDP deflator in the UK follows a path associated with productivity changes since 1960. Though productivity growth has always been positive in this period of around fifty years, there are two different patterns: There are periods of increasing productivity growth (see A-B, C-D, Figure 5) and periods of decreasing productivity growth (see B-C, D-E, Figure 5). Prices vary in a different way in these two different productivity scenarios.

First, when productivity growth is increasing, inflation always falls. Secondly, when productivity growth is positive but falling, inflation either increases (see B-C subperiod, Figure 5) or remains stable (subperiod D-E, Figure 5). In designing a GRF, this empirical result suggests the adoption of different price targets in the face of different productivity patterns; adopting an asymmetrical GRF, or a time changing "λ_1". This inverse relationship between prices and productivity is confirmed after analysing the first difference of both trends (see Figure 6): periods where the first difference of productivity decreases are almost

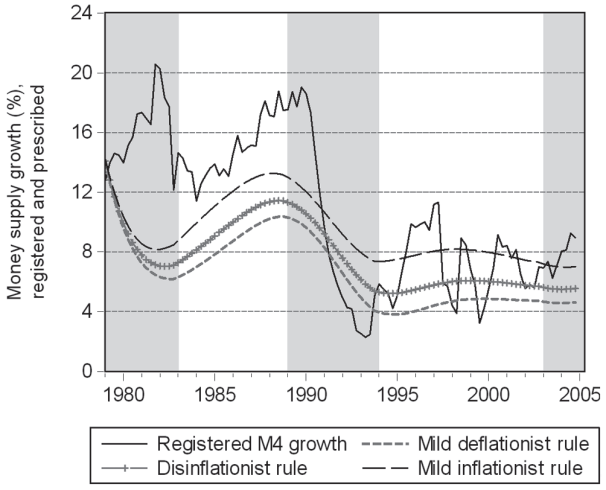

Figure 7 Generalised reaction function: mild inflationist, disinflationist, mild deflationist rules. All trends are calculated using the Hodrick-Prescott filter (HP). Data: M4 from the Bank of England. Shaded areas correspond to periods of increasing productivity growth. See Table 1 for equations and parameters used.

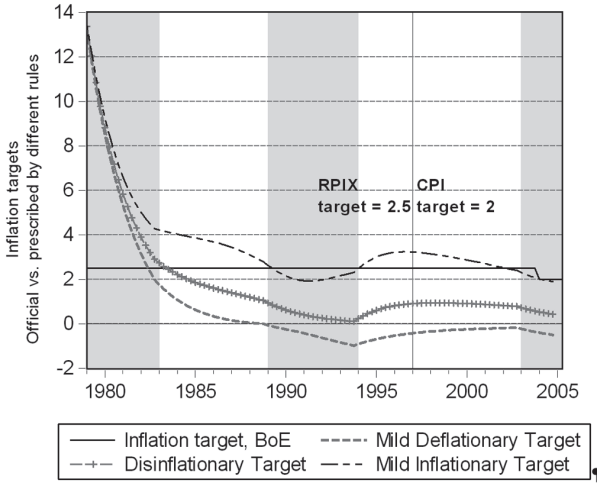

Figure 8 Alternative inflation targets: mild inflationary, disinflationary and mild deflationary. All trends are calculated using the Hodrick-Prescott filter (HP). Shaded areas correspond to periods of increasing productivity growth. See Table 1 for equations and parameters used: $\Pi^* = \lambda_1 \times$ *Trend* Pr *od*

perfectly matched by periods of increases of the first difference of inflation, and vice versa.

3.2. Main results

As Figure 7 shows, the three GRF specifications (mild inflationary, fully disinflationary and mild deflationary rules) prescribe increasing money supply growth in the face of falling productivity growth; and decreasing money supply growth in the face of increasing productivity growth. This is because in the case of an increase of productivity growth, the nominal income target is the joint result of growth of the economy and a fall of the price target: allowing for a certain disinflation, zero inflation and a mild deflation (respectively). When productivity growth falls, inflation either falls (from 1983 to 1989) (but less than proportionally), or increases in all the cases from 1994 to 2003 (see Figure 8).

Money supply growth in the UK, and thus inflation, has been above the money supply growth implied by our mild inflationist GRF for more than ten years (1980-1992). From 1992 onwards, comparing to the three inflation targets proposed, the bias of UK monetary policy corresponds to the adoption of a mild inflationary target (setting a positive inflation value as a bottom line, see Figures 8 and 9). However, taken 1997 as the beginning of the new monetary strategy of the Bank of England, the average growth of money supply in the UK from 1997 to 2004 (7%) is close but even smaller than the resulting from the mild inflationist rule specification (7.6%).

The adoption of a fully disinflationary target during these years would have permitted further falls of inflation, in the presence of continuous productivity growth and a notably smaller growth of money supply. As Figure 7 and Table 2 show, from 1997 to 2004 the money supply in the UK has increased more than necessary to achieve strict price stability (more than 1% points in excess on average).

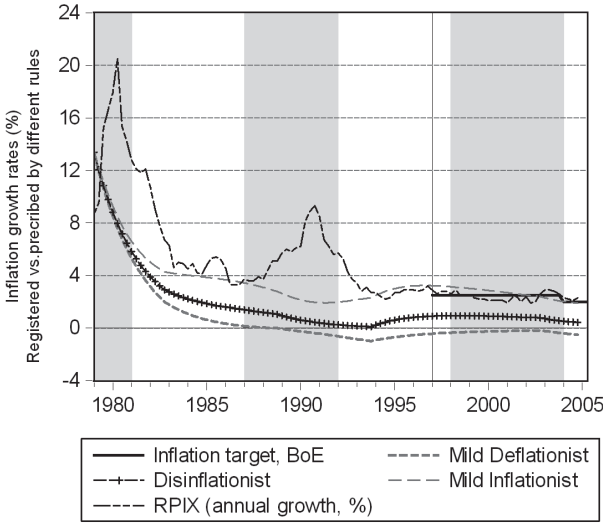

Figure 9 Analysis of recent UK inflation target: identification of a mild inflationary bias. All trends are calculated using the Hodrick-Prescott filter (HP). Data: Office of National Statistics. Shade areas correspond to periods of decreasing GDP growth. See Table 1 for equations and parameters used: $\Pi^* = \lambda_1 \times$ *Trend* Pr *od*

As a result, having adopted a mild inflationary target as a baseline for monetary policy-making, the Bank of England has been increasing the money supply in the face of clear productivity growth during the last business expansion, thus implementing an inflation stabilising policy that creates inflation.

Secondly, the conduct of monetary policy in the UK in recent years is consistent with a trend towards a more market-based monetary strategy; that is, one in which a price target is set not to achieve an output or

Table 2 Average growth of money supply in the UK (1997-2004) coming from different policy options

Registered M4 growth	Inflationist rules		Disinflationist rules			Deflationist	
	Taylor rule	GRF: Mild inflationist	McCallum rule	Friedman rule	GRF: Disinflationist	Hayek rule	GRF: Mild deflation
7.0%	7.3%	7.6%	5.5%	5.0%	5.8%	3.1%	4.7%

unemployment target, but rather to achieve monetary stability. Comparing the last two periods of falls of GDP growth in the UK prior to the 2007 crisis, (1987-1992 and 1998-2003, see Figure 9, shaded areas), UK monetary policy followed a different path: in the first one, highly influenced by the crisis of the ERM, a genuine inflationary pattern; and, in the second, the Bank of England has maintained inflation around the target.

This general trend towards more stability is also reflected in the changing value of parameter λ_1 in recent decades. From very high levels in the seventies (indicating a clear inflationary policy), this parameter has been falling from the beginning of the eighties, approaching to a mild inflationary

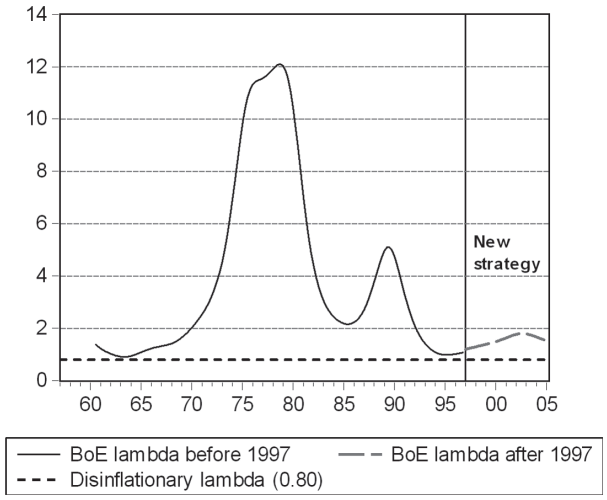

Figure 10 Evolution of UK monetary policy: towards a market-based policy. All trends are calculated using the Hodrick-Prescott filter (HP). Note: $\lambda_1 = \left(\frac{\Pi^*}{Trend\ \Pr od}\right)$

policy in the nineties (see Figure 10). In sum, monetary policy in the UK has converged to a more market-based strategy; by adopting a price target related to productivity changes that permits disinflation, but setting a positive inflation target as a bottom line.

Finally, taking other money supply rules as benchmarks, the GRF is a generalised expression of other conventional money based rules; so, we have compared recent UK monetary policy to the ones resulting from these rules: specifically, McCallum's, Friedman's, and Hayek's rules (see Table 3).The former is an active rule ($\lambda_2 > 0$) and the latter are non active rules ($\lambda_2 = 0$). They imply different price targets: strict price stabilisation in Friedman's and McCallum's rules ($\lambda_1 = 0$), and nominal income stabilisation in the Hayek's rule ($\lambda_1 = -1$). We have also extended this analysis to compare the implications of a version of the Taylor rule. This is an inflationist rule with more activism in reacting to cyclical deviations from target.

Following the same approach Taylor's (2009) applies to explain the byas of the Fed during the last business cycle, we have also made several simulations regarding the Bank of England. If a strict price stabilisation policy, such as Friedman's rule, had been adopted, money supply would have followed a different path in the UK:, money supply growth would have been slower; and, secondly, under this rule, the central bank does not have any scope to counteract short term deviations from target. As a result, there is a much smoother money supply growth in the sample (see Figure 11). Though since the early nineties, the gap between the Friedman's rule and UK monetary policy has narrowed, the remaining divergence confirms the adoption in the UK in the recent years of a price stabilisation policy around a mild positive inflation target. This price stabilisation policy around a mild inflation target is better explained by the Taylor-based rule; however, on average, money growth in the UK in recent years (7%) has been somewhat smaller than

Table 3 Conventional policy rules in terms of the GRF

		λ_1	λ_2	ρ
Taylor-based rule	$\dot{M}_t^s = 0.9\dot{M}_{t-1}^s + 0.1\left[\begin{matrix} Trend\dot{Y}_r + Trend\ \Pr od - Trend\dot{V} + \\ 1.5(TrendRPIX - RPIX)\vert_{t-1} + 0.5(Trend\dot{Y}_r - \dot{Y}_r)\vert_{t-1} \end{matrix}\right]$	1	–	0.9
Friedman rule	$\dot{M}_t^s = 0.9\dot{M}_{t-1}^s + 0.1\left[(Trend\dot{Y}_r^* + 0) - Trend\dot{V}\right]$	0	0	0.9
McCallum rule	$\dot{M}_t^s = 0.9\dot{M}_{t-1}^s + 0.1\left[(Trend\dot{Y}_r^* + 0) - Trend\dot{V} + 0.5(Trend\dot{Y}_{nom}^* - \dot{Y}_{nom}^*)\vert_{t-1}\right]$	0	0.5	0.9
Hayek rule	$\dot{M}_t^s = 0.9\dot{M}_{t-1}^s + 0.1\left[(Trend\dot{Y}_r^* - Trend\ \Pr od) - Trend\dot{V}\right]$	–1	0	0.9

All trends are calculated using the Hodrick-Prescott filter (HP).

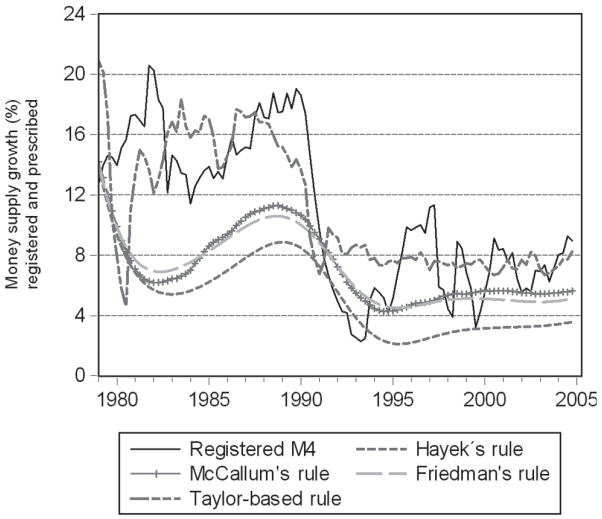

Figure 11 Generalised reaction function: analysis of conventional rules. All trends are calculated using the Hodrick-Prescott filter (HP). Data: M4 from the Bank of England. See Table 3 for equations and parameters used.

that which would have resulted from the adoption of the Taylor based rule (see Table 2, 7.3%).

Similarly, had Hayek's rule been adopted, since under it long run price targets closely reflect increases of productivity, money supply growth would have been modest; permitting a long run mild deflationary trend associated with a growing economy.

4. Final remarks and policy implications

Since inflation and deflation are in the long run monetary phenomena, money-based monetary rules and *reaction functions*, such as the GRF, are useful tools to analyse and prescribe monetary policy. But not as mechanistic intervention tools, rather as benchmarks for long run monetary policy setting. In this vein, the proposed *reaction function* is not considered as an active tool to "manage" the economy, but as an important element of the communication of a market compatible monetary policy - one by which the central bank is able to explain the expected path of monetary decisions. Consequently, agents will have both reliable information and the rationale used by the central bank to set monetary policy on a long run basis.

Secondly, in contrast to the assumptions of the New Keynesian model and the optimal active rules associated with it (such as the forward-looking *Taylor Rule*), the running of the GRF does not prescribe an automatic reaction to *any* price deviation. The central bank will react only to *monetary* shocks affecting prices. As a result, real productivity shocks affecting markets will be allowed to have the expected impact on prices and will be compatible with maintaining the purchasing power of money in the long run. Further, since this rule sets the long run target in terms of nominal income, a growing output may be matched by disinflation or, even mild deflation. As a result, it generates a less active monetary policy.

Finally, the Bank of England has successfully adopted in recent years a new monetary strategy, leading to quite low and stable inflation. However, there is still an inflation bias in the conduct of a mild inflation-stabilising monetary policy. As we have seen, this bias has generated an excess of money supply growth (1-1.5% pa) during the last UK business expansion, and thus an underlying monetary inflation in the economy. If a fully disinflationary target were adopted in the las business expansion, genuine price stability would be achieved with smaller money growth and without generating frequent money supply shocks that may affect market expectations and resource allocation. This would be a minor change to current strategy and in line with its underlying statute, since that disinflationary target in the long term would be compatible with the mandate of preserving price stability. It would, however, require a change in the instruction given by the Chancellor to the Bank.

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We want to thank the participants of the seminars at *Cass Business School* (London) and *CEU* (Madrid) for their helpful comments. This paper was developed whilst Juan Castañeda was a visiting scholar in *Cass Business School* and received financial support from *Fundación Caja de Madrid* and *UNED*. Juan Castañeda also wants to thank Pedro Schwartz's early comments on the topic addressed in the paper.

References

Atkeson, A., Kehoe, P., 2004. Deflation and depression: is there a link? American Economic Review 94, 93-103.

Blinder, A.S., 1998. Central banking in theory and practice. Ed. The MIT Press, Cambridge.

Bordo, M., Filardo, A., 2004. Deflation and monetary policy in historical perspective: remembering the past or being condemned to repeat it? Presented at the 40th Panel Meeting of Economic Policy. Amsterdam. October.

Bordo, M., Lane, J., Redish, A., 2004. Good versus bad deflation: lessons from the gold standard era. NBER Working Paper Series 10329. February.

Bordo, M., Schwartz, A., 1979. Money and prices in the nineteenth century: was Thomas Tooke right? Carleton Economic Papers. Carleton University.

Bryan, M., Cecchetti, S., 1994. Measuring core inflation. In: Mankiw N. (Ed.), Monetary policy. Chicago University Press. NBER.

Buiter, W., 2006. Rethinking inflation targetingand the central bank independence. Background paper for the Inaugural Lecture for the Chair of European Political Economy. European Institute. LSE. 26th November 2006. London.

Burdekin, R., Siklos, P., 2004. Fears of deflation and the role of monetary policy. In: Burdekin, Siklos (Eds.), Deflation. Current and historical perspectives. Cambridge University Press. p. 1-27.

Capie, F., Wood, G., 2004. Price change, financial stability and the British economy, 1870-1939. Ed. Burdekin and Siklos. Deflation. Current and historical perspectives. Cambridge University Press. p. 61-90.

Castañeda, J., 2003. Propuesta de una regla de emisión para el Banco Central Europeo: de la estabilidad de precios a la estabilidad monetaria. Colección de Tesis Doctorales. Ed. Universidad Autónoma de Madrid.

Castañeda, J., 2005. Towards a more neutral monetary policy. Proposal of a nominal income rule. In: Economic Affairs 25, 61-67.

Castañeda, J., Wood, G., 2011. Optimal monetary rules: a critique. Draft version. Unpublished.

Cecchetti, S., Groshen, E., 2001. Understanding inflation. Implications for monetary policy. In: Advances in macroeconomic theory. Ed. P. Dreze, Palgrave, p. 113-135.

Clarida, R., Galí, J., Gertler, M., 1998. Monetary policy rules in practice. Some international evidence. European Economic Review 42, 1033-1067.

Clarida, R., Galí, J., Gertler, M., 1999. The science of monetary policy: a new keynesian perspective. Journal of Economic Literature XXXVII, 1661-1707.

Clarida, R., Gertler, M., 1997. How the Bundesbank conducts monetary policy. Reducing inflation. Motivation and strategy. Ed. C. D. Romer and D. H. Romer. University of Chicago Press, Chicago, p. 363-412.

Friedman, M., 1959. A program for monetary stability. Fordham University Press. New York.

Friedman, M., 1968. The role of monetary policy. American Economic Review 58, 1-17.

Galí, J., 2000. The conduct of monetary policy in the face of technological change: theory and postwar US evidence. Presented at the conference on Stabilization and Monetary Policy. Mexico. Nov., 14-15th.

Galí, J., 2008. Monetary policy, inflation and the business cycle. Princeton University Press, Princeton.

García Ferrer, A., Bujosa, M., 2000. Forecasting OECD industrial turning points using unobserved components models with business survey data. International Journal of Forecasting 16, 207-227.

Hayek, F.A.V., 1928. Intertemporal price equilibrium and movements in the value of money. In: Money, capital and fluctuations. Ed. R. McCloughry. Routledge and Keagan Paul. p. 71-117.

Keynes, J. M., 1936. The General theory of employment, interest and money. Ed. Harvest Harcourt Brace, San Diego, New York and London.

King, M., 2005. Monetary policy: practice ahead of theory. Conference at Cass Business School (Mais Lecture). 17 May, London.

Kumar, M., Baig, T., Decressing, J., Faulkner-McDonagh, C., Feyzioglu, T., 2003. Deflation. Determinants, risksand policy options. Ed. IMF.

McCallum, B.T., 1987. The case for rules in the conduct of monetary policy: a concrete example. Federal Reserve Bank of Richmond Economic Review 73, 10-18.

Mises, L.V., 1912. The theory of money and credit. Liberty Classics (1980). Indianapolis.

Patinkin, D., 1992. Neutrality of money. In: Newman, P., Milgate, M., Eatwell, J. (Eds.), The new palgrave dictionary of money and finance. Vol. II. Macmillan, London. p. 16-24.

Selgin, G., 1997. Less than zero. The case for a falling price level in a growing economy. Ed. Institute of Economic Affairs, London.

Svensson, L.E.O., 1999. Monetary policy issues for the eurosystem. International Macroeconomics. CEPR 2197. (August).

Svensson, L.E.O., 2003. Escaping from a liquidity trap: the foolproof way and others. Journal of Economic Perspectives 17, 145-166.

Taylor, J.B., 1993a. Macroeconomic policy in a world economy. From econometric design to practical operation. Ed. Norton & Company, New York, London.

Taylor, J. B., 1993b. Discretion versus policy rules in practice. Carnegie-Rochester Conference Series on Public Policy. No. 39. Ed. North-Holland, Amsterdam. p. 195-214.

Taylor, J.B., 2009. Getting off track: how government actions and interventions caused, prolonged and worsened the financial crisis. Ed. The Hoover Institution, San Francisco.

White, L., 2006. Is price stability enough? BIS Working Paper 205 (April).

Wicksell, K., 1907. The influence of the rate of interest on prices. In: Foundations of monetary economics. Vol. 2. Ed. D. Laidler. Edgar Elgar, Cheltenham. p. 1-10.