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ABSTRACT

The Inflation Bias Revisited: Theory and Some International Evidence*

The Kydland-Prescott, Barro-Gordon inflation bias result relies on the presumption that policymakers aim at achieving a level of employment above potential. Both academics and policymakers have recently questioned this presumption on the ground of realism. We show that even if policymakers are content with the normal level of employment there is an inflation bias if the central bank is uncertain about the future state of the economy, and is more sensitive to policy misses leading to employment below the normal level than to policy misses leading to employment above it. This new view of the inflation bias implies that there should be a positive association between average inflation and the variance of shocks to output. Cross-sectional empirical evidence from 21 developed economies supports this implication. The Paper also discusses the consequences for the transparency of monetary policy and for central bank reform.

JEL Classification: E31, E52 and E58
Keywords: Barro-Gordon, inflation bias and Kydland-Prescott

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1 Introduction

The twentieth century has been characterized by positive inflation rates in most countries during most time periods. The, by now, standard explanation for this bias is based on a two ways interaction between policymakers and a rational public within the context of the expectations augmented Phillips curve (Kydland and Prescott (1977), Barro and Gordon (1983)). It is based on the notion that monetary policymakers care about both price stability and employment and that their preferred level of employment is higher than the natural level. This is due to either tax distortions (Barro and Gordon (1983)) or to the existence of unions that create excessive unemployment by maintaining the real wage above its market clearing level (chapter 3 of Cukierman (1992)). Under discretion policymakers try to create inflationary surprises in order to push employment above its natural level towards the higher desired level. But individuals understand the temptation of policymakers and correctly forecast inflation, neutralizing any effect of inflation on employment. As a consequence employment remains at its natural level but monetary policy is subject to a suboptimal inflationary bias. This is the well known dynamic inconsistency of monetary policy under discretion.

Some students of monetary policy as well as real life policymakers have recently expressed doubts about the realism of this theory of the inflation bias. McCallum (1995) argues that since they understand the futility of trying to systematically stimulate output by means of inflationary surprises central banks normally refrain from such attempts even under discretion.

Moreover, after a period of service as Vice Chairman of the Federal Reserve Blinder (1998) argued that policymakers at the Fed do not try to systematically maintain employment above the natural level. As a matter of fact he personally felt duty bound to pick monetary policy so as to hit the natural rate when in office (Blinder, Op. Cit. p. 43). In his view even if some policymakers were trying to aim above the natural level of employment one could easily dispose of the consequent inflationary bias by directing them to aim at the natural level. Blinder takes the reduction of inflation in the US during the early eighties as evidence

in favor of the view that it is possible to tame the inflation bias even under discretion. Those doubts cannot be easily dismissed particularly when they come from an economist like Blinder who combines practical monetary policy experience with a solid understanding of formal models. Yet the standard explanation for the existence of an inflation bias has a lot of appeal both because of its simplicity and the persistence and universality of inflation during the second half of the twentieth century.

The fact that such doubts have been raised only recently rather than a few years after the publication of the Kydland-Prescott and Barro-Gordon articles may not be accidental. Central banks today are substantially more independent than they were ten years ago (Cukierman (1998)).[1] When monetary policymaking is dominated by political authorities whose electoral concerns breed short horizons and a strong concern for employment and economic activity the standard inflation bias story seems reasonably realistic. But when, as is currently the case, many central banks have instrument independence and are legally directed to focus solely or mainly on price stability it is more likely that they will recognize the suboptimality of trying to maintain employment and output above their natural levels.[2] Should we conclude that in the current era of enhanced central bank (CB) autonomy the inflation bias is a shadow of the past? We believe the answer is no. Altough the bias producing mechanism may be different when central banks have instrument independence some bias is likely to be present nonetheless.

More precisely, this paper demonstrates that when the central bank is **also** expected to engage in stabilization of employment and output, uncertainty about the future state of the economy and asymmetric concerns about positive and negative output gaps combine to create an inflationary bias. **This result obtains in spite of the fact that the central bank's desired level of economic activity is equal to potential output or normal**

[1]For example, Burns who was Chairman of the Fed during the seventies was more receptive to the wishes of the political establishement than his successors. This might have partly been a matter of different personalities but the general recent trend towards more central bank autonomy and more focus on price stability no doubt played a role.

[2]Many new CB laws grant the bank instrument but not goal independence. The distinction between those two kinds of independence was first drawn by Debelle and Fisher (1994) and Fischer (1995).

employment. In countries such as the US, in which the central bank is directed by law to also maintain a reasonably high level of economic activity this, uncertainty induced, bias is likely to represent (in our view) a particularly realistic scenario. But even in the Euro area in which the law does not explicitly saddle the CB with the task of stabilization policy, decision makers at the CB are not totally indifferent to the real state of the economy.[3]

Conventional wisdom among policymakers and students of monetary policy is that monetary policymaking institutions should be devised so as to enable them to partially offset the effects of non monetary policy induced shocks on output while reducing the Kydland - Prescott inflationary bias. In particular, Rogoff (1985) proposes to improve the consequent "credibility - flexibility" tradeoff by appointing a central banker who is more conservative than society. Persson and Tabellini (1993) and Walsh (1995) suggest optimal incentive contracts for central bankers and Svensson (1997a) shows that, in some cases, such optimal contracts can be implemented by means of a simple inflation target. The basic premise of this literature is that, in the absence of a Kydland - Prescott, Barro - Gordon (KPBG) bias, the use of monetary policy to stabilize shocks to the natural level of employment is socially beneficial.[4] This paper shows that this approach leads to an inflationary bias even if policymakers are content with the permanent or potential level of employment so that the KPBG inflation bias is non existent. It is, therefore, a warning against the dangers inherent in saddling the central bank with the task of stabilizing shocks to the natural level of employment.[5]

Milton Friedman and others have stressed that monetary policy operates with "long and

[3]The Bundesbank who conducted monetary policy in Germany till the end of 1998 also was not required by law to engage in stabilization policy. In spite of this Clarida and Gertler(1997) produce evidence suggesting that, while its rethoric was different than that of the Fed, the Bundesbank did engage in some stabilization of output.

[4]This premise transcends the recent literature on "strategic monetary policy" as illustrated for example by the earlier work of Fischer (1977) and Taylor (1993).

[5]Friedman (1968) who originally coined the term "natural level of employment" defines it as that level of employment that would be generated by the general equilibrium of the economy in the absence of inflationary surprises. We are using this term in the same sense.

variable lags". As practical central bankers well know, current monetary policy decisions are, therefore, made on the basis of forecasts about the state of the economy rather than on the basis of its actual state.[6] The inflation bias mechanism presented here is based on two presumptions: 1. When current policies are chosen decision makers at the CB are uncertain about the real state of the economy at the time the planned policy is expected to impact the economy and, 2. they possess a precautionary demand for expansions in the sense that they are more concerned about downward deviations of employment from its normal level than about upward deviations. As a consequence monetary policy is chosen so as to make the probability of erring on the side of tightness smaller than the probability of erring on the side of ease.[7] As a consequence planned monetary expansion and inflation are positive on average. Since they understand this tendency of the CB rational individuals expect positive inflation. This pushes policymakers to be even more accomodating and creates, a somewhat higher, permanent inflationary bias. As in the standard model this bias is suboptimal. Although policymakers prefer to err on the side of expansion in order to reduces the probability of the costlier downward deviations of employment from its normal level the positive expecteded inflation neutralizes the effect of this policy on the distribution of employment and output.

Unlike the KPBG bias, the bias producing mechanism in this paper implies that countries with more volatile shocks to output should have, on average, higher rates of inflation. The paper tests this implication of the theory using cross sectional data on a sample of 21 OECD

[6]This is probably the main reason for the extensive forecast effort made by the research departments of the Fed and of the newly formed European Central Bank. Uncertainty about the upcoming state of the economy complicates the task of the CB in trying to achieve employment as well as inflation objectives. The effects of this uncertainty for the operation of inflation targets is examined in Svensson (1997b).

[7]This assumption is obviously realistic for the political establishment. In a world in which the CB is supposed to be, at least partly accountable, to elected officials this asymmetry is likely to permeate, perhaps to a lesser extent, the objectives of the CB. Although central banks today are substantially more independent than ten years ago they are nonetheless expected by many to pay attention to the wishes of political authorities. Stiglitz (1998, p.19), for example, expresses the view that, since monetary policy is a key determinant of macroeconomic performance, removing it from the control of democratically elected officials should at least raise some questions.

countries between 1970 and 2000. The evidence supports the existence of a positive relationship between average inflation and the variance of output growth over this sample. The theory also implies that this relation should be weaker when the effective conservativeness, or independence, of central banks is higher. To test this implcation of the theory the sample period is split into two subperiods: 1971-1985 and 1986-2000. Since both legal and actual CB independence are higher in the second than in the first subperiod the theory implies that the relation between inflation and the variance of shocks to output should be weaker in the second subperiod.[8] The evidence supports this implication as well.

The paper is organized as follows. Using an expectations augmented Phillips curve, Section 2 demonstrates that in the presence of a precautionary demand for expansions and uncertainty about the state of the economy there is an inflation bias even if policymakers target the potential level of output. The section also shows that a qualitatively similar bias arises under instrument uncertainty and that all biases vanish in the absence of a precautionary demand for expansions. Section 3 derives the main testable implication of the theory and tests it empirically using cross sectional data from 21 developed economies. Section 4 discusses some implications for the transparency of monetary policymaking institutions and for central bank reform. This is followed by concluding remarks.

2 The Model

2.1 Basic structure

The supply side of the economy is represented by an expectations augmented Phillips curve

$$Y = Y_n + \alpha(\pi - \pi^e), \tag{1}$$

where Y and Y_n are the actual and the natural levels of output, π and π^e are actual and expected inflation, and α is a positive parameter that characterizes the effect of unanticipated

[8]Evidence in Cukierman (1998) and the discussion in chapter 19 of Cukierman (1992) imply that the effective level of CB conservativeness was substantially higher in the second subperiod.

inflation on employment. The natural level of output is subject to stochastic fluctuations and is given by

$$Y_n = Y_p + \epsilon \tag{2}$$

where Y_p is potential output and $\epsilon = Y_n - Y_p$ is the output gap in the absence of inflationary surprises. For simplicity, ϵ is specified as a zero mean stochastic shock to the natural level of output with distribution function $G(\epsilon)$. Staiger, Stock and Watson (1997) present evidence suggesting that the natural level of employment in the US is subject to substantial uncertainty.[9] Inflation is determined both by the choice of monetary policy as well as by the realization of the shock, ϵ and is given by the following equation :

$$\pi = m - \gamma\epsilon, \tag{3}$$

where m is the rate of inflation planned by the CB (as well as the policy instrument) and γ is a positive parameter that determines the effect of shocks to employment on inflation.[10] Equation (3) states that, given planned inflation, actual inflation is lower the larger is the supply shock to the economy. Provided there is no instrument uncertainty, this formulation is consistent both with cases in which the policy instrument is the interest rate as well as situations in which it is some nominal stock variable.[11]

Casual observations suggest that the political establishement is more sensitive to the costs of recessions than it is content with expansions. Since, in a democratic society, independent, but accountable, central banks are not totally insensitive to the wishes of the

[9] Y, Y_n and Y_p can also be interpreted as the *rates of growth* of the actual, natural and potential levels of output. All the results in this section go through with this reinterpretation. For concreteness the discussion in the paper is in terms of potential output and the output gap. Obviously all the discussion can also be cast in terms of employment or unemployment by mapping potential and actual output into normal and actual employment respectively. The qualitative results are identical.

[10] The positive sign of γ is consistent with the notion that ϵ is a supply shock.

[11] In order to focus on the effects of uncertainty about the state of the economy, we abstract, for simplicity, from instrument uncertainty. The effects of relaxing this assumption are discussed in subsection 2.5.

political establishment some of this asymmetry trickles down into the objective function of the CB as well. This hypothesis is captured here by specifying the loss function of the CB as :

$$\begin{aligned} L &= \frac{A}{2}(Y_p - Y)^2 + \frac{\pi^2}{2} \quad when \;\; Y_p - Y > 0 \\ L &= \frac{\pi^2}{2} \qquad\qquad\qquad\qquad when \;\; Y_p - Y \leq 0. \end{aligned} \tag{4}$$

Equation (4) states that the CB dislikes inflation as well as negative output gaps. But, given inflation, the CB has no interest in deliberately creating positive output gaps. This specification is consistent with and is partly motivated by the observation of a Fed insider that "In most situations the CB will take far more political heat when it tightens preemptively to avoid higher inflation than when it eases preemptively to avoid higher unemployment" (Blinder (1998, pp. 19, 20). In a recent survey on political economy and macroeconomic policy Persson and Tabellini, (1999) also posit a politically motivated asymmetric objective function (section 3). Following recent expressions of doubt about the realism of the assumption that the employment target of policymaker is larger than its potential level, it also builds in the presumption that the target level of employment is equal to its normal or potential level.[12] Hence there is no KPBG bias here. Note that equation (4) is a positive description of CB objectives rather than a social welfare function.

The sequence of events and the structure of information are as follows. First expectations, π^e, are formed and embedded into nominal contracts. In the second stage the CB picks the value of its instrument, m. Finally the stochastic real shock to employment, ϵ, is realized and determines, along with monetary policy, employment and inflation. This sequence is illustrated in Figure 1. A crucial element is that, when it chooses the setting of its instrument, the CB is uncertain about the magnitude of the real shock to employment. This is *a fortiori* true for the public when they form their expectation.

Figure 1 : The Sequence of Events

[12]Besides Blinder such doubts have been voiced also by McCallum (1995) and Vickers (1998).

1. π^e is formed——> **2.** policy, m, chosen——> **3.** ϵ realizes.

The shock, ϵ, affects employment directly, as well as by creating, given monetary policy, unanticipated inflation in a direction that is opposite to the sign of the shock. From equations (1) through (3) the combined marginal impact of the shock on employment is

$$q \equiv 1 - \alpha\gamma. \tag{5}$$

We assume that the direct effect of the shock on employment dominates its indirect effect via unexpected inflation so that q is positive.

2.2 Equilibrium

Using equations (1) through (3) in equation (4) the objective function of the central bank may be rewritten as :

$$\begin{aligned} L &= \frac{A}{2}\left[q\epsilon + \alpha(m - \pi^e)\right]^2 + \frac{1}{2}(m - \gamma\epsilon)^2 \quad for\ \epsilon < \frac{\alpha}{q}(\pi^e - m) \\ L &= \frac{1}{2}(m - \gamma\epsilon)^2 \qquad\qquad\qquad\qquad for\ \epsilon \geq \frac{\alpha}{q}(\pi^e - m) \end{aligned} \tag{6}$$

We proceed now to characterize the (sub game perfect) equilibrium of this game, as usual, by starting from the second stage.[13] At this stage the CB takes expectations as given and chooses the planned rate of inflation, m, so as to minimize the expected value of its loss function. From equation (6) this expected value is

$$\frac{A}{2}\int_{-\infty}^{b(\pi^e - m)} \left[q\epsilon + \alpha(m - \pi^e)\right]^2 dG(\epsilon) + \frac{1}{2}E\left(m - \gamma\varepsilon\right)^2 \tag{7}$$

where E is the expected value operator and

[13]Since only "nature" moves in the third stage the last strategic stage is the second one.

$$b \equiv \frac{\alpha}{q}. \tag{8}$$

Minimization of equation (7) with respect to m yields the following behavioral rule for the monetary authority

$$m = \frac{1}{1 + \alpha^2 AG\left[b(\pi^e - m)\right]} \left[\alpha^2 AG\left[b(\pi^e - m)\right]\pi^e - \alpha Aq \int_{-\infty}^{b(\pi^e - m)} \epsilon dG(\epsilon)\right]. \tag{9}$$

$G\left[b(\pi^e - m)\right]$ is the probability that ϵ is smaller than the threshold $b(\pi^e - m)$ whose value depends on the difference between expected inflation and the level that was planned by the monetary authority.

We turn next to expectation formation which occurs at the first stage of the game. Although individuals do not know the realization of ϵ at this stage, they do know its stochastic structure as well as the structure of the economy and of CB objectives. Taking the expected value of inflation conditioned on this information as the operational proxy for the public's rational expectation of inflation and using equation (3), we obtain

$$E\pi \equiv \pi^e = m = -\alpha Aq \int_{-\infty}^{b(\pi^e - m)} \epsilon dG(\epsilon). \tag{10}$$

The meaning of these expressions is discussed in the following subsection.

2.3 An uncertainty induced inflation bias

In equilibrium equations (9) and (10) must both be satisfied. It follows that $\pi^e - m = 0$ so that equation (10) becomes

$$E\pi \equiv \pi^e = m = -\alpha Aq \int_{-\infty}^{0} \epsilon dG(\epsilon) = -\alpha Aq G(0) E\left[\epsilon \mid \epsilon < 0\right]. \tag{11}$$

$G\left[0\right]$ is the probability of a recession. More precisely it is the probability that the realization of the employment shock, ϵ, is lower than the mean of this shock which is zero. $E\left[\epsilon \mid \epsilon < 0\right]$ is the expected value of ϵ conditioned on the economy being in a recession (ϵ negative). Since the probability of a recession is positive and the expected value of ϵ conditioned on the

economy being in a recession is negative both planned and expected inflation are positive. Furthermore, in spite of its attempt to reduce the size of recessions the CB has no influence on output which remains at its natural level. Had the CB precommitted to a zero rate of monetary expansion output would still be at its natural level. Hence there is an "inflationary bias" on average.

Intuitively this bias arises because the CB does not have perfect information about the state of the economy in conjunction with the fact that it is more sensitive to policy errors in which monetary policy is too tight than to policy errors in which policy is overly expansionary. This in turn is a direct consequence of the fact that policymakers pay a political price that increases with unemployment when unemployment is above a certain threshold but their political benefits do not increase to the same extent when unemployment decreases below that threshold. Both conditions appear to be satisfied in reality. The upshot is that an inflationary bias arises even when policymakers are content with achieving the potential level of output.

As in the KPBG inflation bias story, the bias is an increasing function of the slope of the short run Phillips curve (α) as well of the relative importance attributed by policymakers to employment (A). Hence, as in Rogoff (1985), the more conservative is the CB (the lower A), the lower is the bias. A novel element is that, given those parameters, the bias is positively related to the probability of a recession, and to its expected depth. By the same token, the larger is the average size of the expected recession ($E[\epsilon \mid \epsilon < 0]$ is larger in absolute value) the larger is the bias. That is, other things the same, economies with larger expected recessions suffer from a higher inflationary bias. The broad intuition underlying this result follows. Due to their asymmetric attitude to recessions and to expansions, policymakers tend to relax monetary policies more when the likelihood, and the expected magnitude of a recession is higher. Since the public is aware of that, it adjusts its inflationary expectation accordingly and neutralizes in the process any effects of monetary policy on employment and output. Thus, employment remains at its natural level but the bias is higher due to the stronger incentive of policymakers to inflate.[14]

[14]Preliminary evidence reported in Gerlach (2000) indicates that during the sixties and the seventies

2.4 Symmetric preferences as a benchmark

This subsection highlights the origin of the bias in the absence of a KPBG type bias by showing that when the objective function is symmetric uncertainty alone does not produce excessive inflation. Symmetric preferences imply that the first branch of the loss function in equation (4) holds for the entire range of values of the output gap. That is the CB dislikes any given negative output gap to the same extent that it dislikes a positive output gap of the same size. For this case the reaction function of the CB in equation (9) is replaced by:

$$m = \frac{\alpha^2 A}{1 + \alpha^2 A}\pi^e.$$

Rationality of expectations implies that $E\pi \equiv \pi^e = m$. In conjunction with the CB reaction function this implies that average and expected inflation are both zero. The lesson from this subsection is that in the presence of uncertainty about the future state of the economy asymmetric CB objectives (or a precautionary demand for expansions) are essential for the bias producing mechanism of this paper.

2.5 Instrument uncertainty

For simplicity and focus we have assumed that there is no instrument uncertainty. Had there been additive instrument uncertainty in the model, its effect on the inflationary bias would be qualitatively similar to that of uncertainty about the state of the economy. This point is made in Jordan (2001, chapter 4) for a uniform distribution of the monetary control error but (as demonstrated below) is true for many other distributions as well provided the control error is additive[15]. The more general lesson is that the presence of asymmetries in the CB concern about positive and negative output gaps (additive) uncertainties of **various types** lead to an inflationary bias even if the CB desired level of employment is identical to its potential level.

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interest rate policy in the US responded more strongly to recessions than to expansions.

[15] In chapter 5 Jordan (2001) shows that a multiplicative control error does not lead to a bias.

The effect of a control error can easily be added to the conceptual framework of this paper by respecifying the inflation equation as

$$\pi = m - \gamma\epsilon + \psi \equiv m + \delta \tag{12}$$

where ψ is a zero mean stochastic variable that represents the control error. The stochastic variable δ combines both the uncertainty about the state of the economy and the uncertainty due to imperfect control of the monetary instrument. From a formal point of view, δ plays the same role that ϵ did in the model with no control error, and like ϵ it has a zero mean. Hence in the presence of both types of uncertainty, the inflation bias in equation (11) is replaced by

$$E\pi \equiv \pi^e = m = -\alpha Aq \int_{-\infty}^{0} \epsilon dG(\epsilon) = -\alpha AqF(0)E\left[\delta \mid \delta < 0\right] \tag{13}$$

where $F(.)$ is the distribution of the stochastic variable δ that combines the uncertainty about the state of the economy with instrument uncertainty.

Although each type of uncertainty alone creates an upward bias, their combination does not necessarily raise the bias. Whether it does or not depends on the relative skewness properties of the distributions $G(.)$ and $F(.)$ in equations (11) and (13).

3 An Empirical Test of the New Inflation Bias Hypothesis

3.1 A testable implication

The preceding section has shown that when policymakers possess a precautionary demand for expansions there is an inflation bias even if the target and the potential levels of output (and of employment) are equal. This section provides a cross sectional empirical test of the mechanism responsible for the inflation bias under such circumstances. In order to discriminate between the KPBG inflation bias story and the one presented here the test is

based on an implication of the new theory that is not shared with the KPBG theory. In particular, provided the distribution of the supply shock, ϵ, is normal, the new inflation bias theory implies that there should be a positive relation between average inflation in a country and the variance of shocks to output.

This can be seen from equation (11) which states that the average rate of inflation depends on the average expected magnitude of recessions which is given by the absolute value of the (negative) term, $E[\epsilon \mid \epsilon < 0]$. Assuming that the distribution of ϵ is normal with mean 0 and variance σ^2 equation (11) implies that the average rate of inflation is proportional to the mean of a normally distributed variable truncated from above at zero. Theorem 22.2 in Greene (1997, p. 951), implies that

$$E[\epsilon \mid \epsilon < 0] = -\sigma\phi(0)/\Phi(0) = -2\sigma\phi(0). \tag{14}$$

where $\phi(\epsilon)$ and $\Phi(\varepsilon)$ are respectively the probability density and the distribution function of a standard normal variate. Equation (14) states that the mean of a normally distributed random variable truncated from above at zero depends inversely on the standard deviation of the variable. Intuitively, the greater the standard deviation, the more likely it is that the variable will assume a large negative value, and consequently the more negative is the expected value of the truncated distribution.[16]

Inserting equation (14) in equation (11) we obtain

$$E\pi \equiv 2\alpha Aq\phi(0)\sigma. \tag{15}$$

The key implication of equation (15) is that the average rate of inflation depends positively on the standard deviation of the supply shock. Intuitively, the larger is σ, the more likely it is that large contractionary shocks will occur. As a consequence the interaction between the precautionary demand of policymakers for expansions and uncertainty about supply shocks

[16]Although we use the normal distribution for concreteness, this intuition suggests that the positive association between the expected depth of recessions and the variability of the supply shock extends to all symmetric distributions with a zero mean. Furthermore, symmetry is a sufficient but not necesssary condition for this association.

induces a stronger inflationary reaction when the variability of shocks is higher. Since the public is familiar with this tendency of policymakers, inflationary expectations are therefore also positively related to σ.

The new inflation bias mechanism implies that the slope parameter in a regression of average inflation on the standard deviation of the supply shock should be positive. By contrast, the traditional KPBG inflation bias story does not imply that such a relation should exist. It is therefore possible to perform a first pass test of the new mechanism by examining whether there is such a relation in the data. It also follows from equation (11) that this implication should hold only if the CB is not too conservative (A is not too small). As a matter of fact the theory predicts that, when central banks are highly independent and concerned mainly with inflation so that A is small, the positive relation between inflation and the variance of shocks to output should weaken and may even dissapear. The next subsection provides cross sectional evidence that supports these implications.

3.2 Empirical implementation of the test

We think of the theory as relevant for explaining average inflation rates over an extended time period, say a decade, in highly developed economies. To test it we use annual data spanning the period 1971-2000 for a sample of 21 OECD countries: Australia, Austria, Belgium, Canada, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the UK and the US.[17] Ideally, to test the theory one would need an estimate of the standard deviation of the supply shock, that is, the disturbance to the Phillips curve equation. For simplicity, we use the standard deviation of the growth rate of real GDP as a proxy for σ. The rationale for using this proxy is that, in the absence of anticyclical policy, the varability in the rate of growth of real GDP and the variance of shocks to GDP are positively and strongly related. Although stabilization policy may weaken this relation it is unlikely that it destroys it for at least two reasons. First, due to imperfect knowledge about the economy stabilization policy is only

[17]The source of the data is the July 2002 IFS CD-Rom.

partially successfull. Second, since policymakers are also concerned about other objectives like inflation the stabilization of shocks to output is partial even in the absence of uncertainty.

3.2.1 Regression results

For each country i we calculate the average inflation rate, $\overline{\pi}_i$, using the GDP deflator and the standard deviation of real GDP growth, $\widehat{\sigma}_i$. Since inflation rates declined substantially between the 1970s and the 1990s, we also compute $\widehat{\sigma}_i$ and $\overline{\pi}_i$ for the subperiods 1971-1985 and 1986-2000.

The empirical work is based on fitting the regression

$$\overline{\pi}_i = \phi_0 + \phi_1 \widehat{\sigma}_i + \eta_i, \tag{16}$$

where η_i is a residual.[18] In Table 1 we present the results of OLS estimates of (16), using the estimates of $\overline{\pi}_i$ and $\widehat{\sigma}_i$ from the full sample and the two subsamples. Since a White test reject the hypothesis of homoscedasticity, Panel A reports t-statistics that are based on White standard errors.

Several aspects of the results are of interest. First, ϕ_1 is positive and highly significant in regressions for the full sample and for the first subsample. This finding provides support for the basic implication of the model discussed above. Second, the estimate of ϕ_1 in the first subsample is larger than that for the full period and highly significant. Third, ϕ_1 is not significantly different from zero in the second subsample. The last two findings are consistent with the view that the new bias was important in the first part of the period when CBI was low and A high. But when, due to substantial increases in central bank independence during the second half of the period, A declined the positive relationship between average inflation and the variance of shocks to output weakened substantially.[19]

Since plots of the squared residuals from the regressions in Panel A suggest that the

[18] Since we use $\widehat{\sigma}_i$ rather than σ_i in fitting (16), the estimates are subject to an errors-in-variables problem. This will bias the estimate of ϕ_1 towards zero and make it more difficult to reject the null hypothesis that $\phi_1 = 0$ (see, for instance, Greene (1997, p. 437). We return to this issue below.

[19] The world wide increase in CB independence during the nineties is discussed in Cukierman (1998).

Table 1: Regressions

$$\overline{\pi}_i = \phi_0 + \phi_1 \widehat{\sigma}_i + \eta_i$$

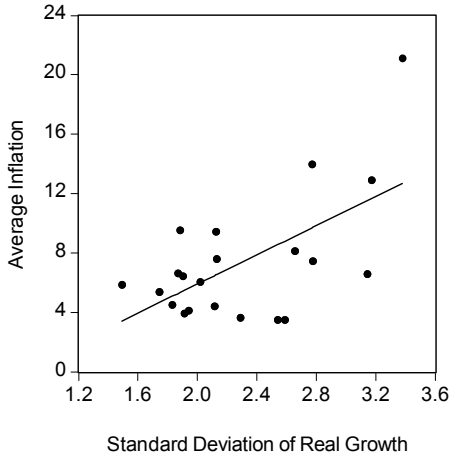
Panel A: OLS Estimates (White standard errors)			
Sample	ϕ_0	ϕ_1	R^2
1971-2000	-3.88 (0.89)	4.89** (2.10)	0.36
1971-1985	-2.47 (5.30)	5.25** (2.43)	0.28
1986-2000	3.37* (1.67)	0.46 (0.84)	0.01
Panel B: WLS Estimates			
Sample	ϕ_0	ϕ_1	R^2
1971-2000	-0.97 (3.06)	3.60** (1.42)	0.33
1971-1985	0.54 (4.13)	4.01** (1.78)	0.27
1986-2000	2.07 (2.02)	1.16 (1.20)	-0.01

Notes: Significance at the 10% / 5% level is denoted by * / **. Standard errors appear in parenthesis under the coefficients. For the WLS estimates, $\widehat{\sigma}_i$ was used as weights. For the WLS regressions the reported R^2 is computed using the unweighted data to maintain comparability with Panel A.

variances of the errors depend on the squared regressors (a conclusion that is supported by unreported OLS regression of the squared errors $\widehat{\eta}_i^2$ on $\widehat{\sigma}_i^2$), we reestimated the model with WLS, using $\widehat{\sigma}_i$ as weights. The results are summarized in Panel B of the table. Since the main features of the results in Panel B are similar to those in Panel A we do not discuss them.

To explore the relationship between the variables more informally, Graphs 1-3 contain scatterplots of $\overline{\pi}_i$ versus $\widehat{\sigma}_i$ for the entire sample period and the two subperiods. The graphs reveal that there is a clear positive relationship between the two variables in the full sample and the pre-1986 subsample but not for the post-1985 sample. The fact that the relationships in the two subsamples differ is clear from the fact that while the mean of $\widehat{\sigma}_i$ is roughly the same in the two subsamples, the mean of $\overline{\pi}_i$ falls sharply.[20]

Figure 1: Average Inflation and Standard Deviation of Real GDP Growth, 1971 - 2000



[20]The average standard deviation of output growth in the first sample is 2.50 (with a standard deviation of 0.61) while in the second subsample it is 1.97 (0.72). For inflation the mean falls from 10.68 (6.06) to 4.29 (3.15).

Figure 2: Average Inflation and Standard Deviation of Real GDP Growth, 1971 - 1985

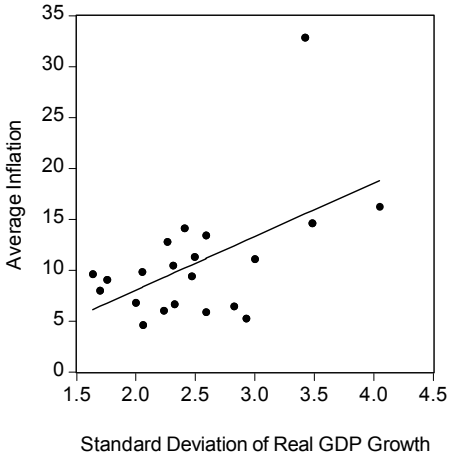
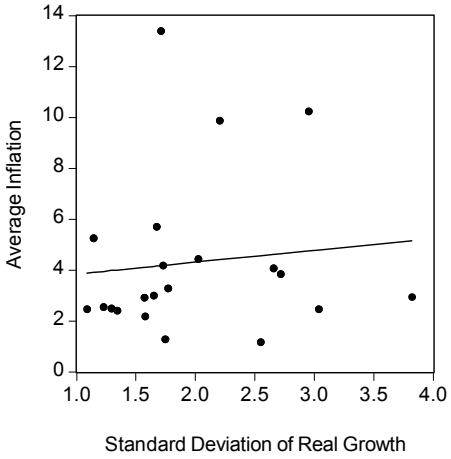


Figure 3: Average Inflation and Standard Deviation of Real GDP Growth, 1986 - 2000



4 Implications for Transparency and for CB Reform

4.1 Implications for transparency

In comparison to past decades there is nowadays substantially more transparency about the main objective of monetary policy. In most contemporary central banks the main legal objective of monetary policy is price stability and all other objectives are either non existent (as is nearly the case in the charter of the ECB) or relegated to being (at least legally) a distant second priority (as is the case with the growth and employment objectives in the 1997 charter of the Bank of England). This is a substantial increase in transparency in comparison to the eighties and previous decades during which most CB charters featured several conflicting objectives with no clear specification of priorities.

In spite of those advances there still is substantial opaqueness about the output gap segment of the loss function of modern central banks as well as about the relative importance attributed to stabilization of output versus stabilization of inflation (the parameter A). Following Svensson (1997b) we shall sometimes refer to A as the "flexibility parameter" since it determines the degree of flexibility in targeting inflation. There is little doubt that all central banks are quite opaque about the flexibility parameter. This is admitted quite candidly by Vickers (1998) in a review of recent UK monetary policy. Vickers openly recognizes that the MPC's remit is silent on the magnitude of this parameter. Furthermore, no CB has ever come close to disclosing any minimal amount of information about the shape of its loss function for alternative levels of the output gap.[21]

Our inflation bias story implies that when $A = 0$ murkiness about the output gap segment of the loss function does not matter for inflation. No matter what is the shape of losses from non zero output gaps there is no inflation bias in this case. But when A is positive, equation (11) implies that the larger it is, the higher is the inflation bias even when policymakers aim at potential output. As a consequence, a flexible inflation targeter with a non negligible flexibility parameter has good reason to try to appear to be less flexible than he really is.

[21] A more detailed discussion of those issues and additional documentation appears in Cukierman (2002).

This may have underlied the traditional historical public position of the Bundesbank, according to which it was not concerned about fluctuations in output, as well as a recent observation by Mervyn King from the Bank of England. King's argument is that it is difficult to distinguish, in practice, between strict and flexible inflation targeters since both raise interest rates when inflation and output are above target. We doubt that a strict inflation targeter would have made such a statement. As a matter of fact, central banks with asymmetric output gap concerns have, in view of the new inflation bias result presented here, a credibility reason for **not** highlighting this fact. By contrast, simple monetary policy games with signalling imply that a strict inflation targeter would like to send messages that would make his identity clear to the public.[22] Such a "type" is unlikely to claim that it is not possible to distinguish flexible from strict inflation targeters.

One consequence of those observations is that, even if they possess precautionary demands for expansions, central bankers are unlikely to openly admit that. This suggests that the main source of future information about possible asymmetries in the loss functions of central banks is likely to come from empirical work which tries to use actual data in order to infer whether central banks do or do not possess precautionary demands for expansions. The previous section is one such attempt and its findings are consistent with the view that an uncertainty induced inflation bias was present between 1971 and 1985. The concluding section features a brief description of other recent empirical work on this issue.

4.2 Implications for central bank reform

The recent flurry of reform in CB laws raised the issue of whether the only objective of the central bank should be price stability or whether the law should also require the bank to take into consideration the state of the real economy. Since there are different views on this question among professional central bankers and academics it is interesting to examine

[22]This is in the spirit of formal models of monetary policy games with private information like Vickers (1986). Within the context of inflation targets, Cukierman (2000a) shows that a policymaker that is more seriously committed to low inflation has a stronger incentive to reveal his identity.

whether it is possible to rank those two alternative institutional arrangement from a welfare point of view. The equilibrium described in section 2 corresponds to the case in which the law charges the CB with the dual task of "price stability" and a "sufficiently high level of economic activity and employment" implying that the CB is expected to also engage in anticyclical policy. In the case in which the bank is directed to achieve **only** price stability, the first term in equation (7) vanishes. Maximization of the remaining expression yields the policy rule

$$m = 0, \tag{17}$$

which implies that the average inflationary bias is zero. Equation (3) and rational expectations imply that, if the law is strictly observed by the CB, expected inflation is zero as well. From equations (1) and (2) this implies that economic activity is at its (fluctuating) natural level

$$Y_n = Y_p + \epsilon. \tag{18}$$

Consider now the behavior of output in the case in which the CB is charged by law with the dual task of price stability and stabilization of employment as is the case for example in the US. In this case the equilibrium in equation (11) is relevant , $m = \pi^e$, and economic activity is therefore given again by equation (18). Thus, given the realization of the shock ϵ, economic activity is the same in the two cases but average inflation is higher in the case in which the CB is also directed to choose its policy so as to maintain a "reasonable" level of economic activity. Thus, in the presence of uncertainty about the state of the economy and asymmetric losses from positive and from negative output gaps, the requirement that the CB should partially offset recessions produces a suboptimal inflationary bias even in the absence of a systematic divergence between potential and desired output.

This result would seem to imply that price stability should be the only legal objective of the CB. But the matter is not as clear cut as may appear to be the case at first blush. For simplicity and focus we have assumed that the information sets of the public and of

the CB are identical. This assumption rules out socially beneficial stabilization policy. But, if at the time it sets monetary policy the CB has more information about the state of the real economy than what the public had when they formed expectations, there is room for beneficial stabilization policy. The model could be extended to allow for the existence of beneficial stabilization policy by introducing some persistence in the employment shock and by allowing the monetary authority to have more (although not fully) precise information on its future value than the public had when it formed its expectation.[23]

In such an extended framework there will be, a familar (as in Rogoff (1985) and Lohmann (1992)) trade-off between the credibility needed to reduce the inflationary bias and the flexibility required to enable the CB to engage in stabilization policy. Although the precise investigation of the extended framework is beyond the scope of this paper it is easy to see that leaving the door open for some stabilization of the real economy (by not totally excluding employment from the objectives of the CB) may in this case be socially beneficial. The higher is the information advantage of the central bank in comparison to the extent to which it is uncertain about the future, the more likely it is that requiring some stabilization of output by the CB will be beneficial.

5 Concluding Remarks

The standard Kydland-Prescott, Barro-Gordon (KPBG) inflationary bias hypothesis has enriched our understanding of the possible reasons for persistent and widespread inflation under discretion. This conceptual framework heavily relies on the presumption that policymakers use monetary policy to raise employment above its normal level. This presumption has been questionned by policymakers as well as some academics on the ground of realism.

Using a natural rate model this paper shows that, the conjunction of forecasting uncertainty and asymmetric attitudes of the CB to positive and to negative retrospective monetary

[23]Note that this does not necessarily imply that the monetary authority is better informed about the state of the economy at the **same** point in time. All that it requires is that the CB choose policy after some additional persistent information, that was not available at the time of expectation formation, is revealed.

policy errors implies that there is a bias **even if the desired level of employment is identical to its normal level**.[24] This bias arises because the CB is more sensitive to policy errors that lead to negative output gaps than to policy errors that lead to positive output gaps. Such precautionary demand for expansions leads to more expansionary monetary policies which (since they are perfectly anticipated by nominal contract setters) lead, in turn, to positive inflationary expectations and to a modifed form of the original KPBG bias.[25] But in the absence of asymmetries in the loss function of the CB there is no precautionary demand for expansions and no bias.

The potential existence of a precautionary motive for expansionary monetary policy leads to two implication. The first is that in the presence of such a motive there should be a positive relation between average inflation and the variance of output shocks. The second is that this association should be weaker the more effectively conservative are the central banks. The first implication is supported by cross sectional evidence from a sample of 21 developed economies in the thirty years' period ending in 2000. To test the second implication the sample period has been divided into two subperiods. Since the effective levels of CB independence, and therefore of conservativeness, are both larger in the second subperiod our theory predicts that the cross sectional association between average inflation and the variance of shocks to output should be weaker in the second subperiod. This implication of the theory is also supported by the data.

Although the empirical work in the paper is simple the results are sufficiently strong and clear cut to warrant the conclusion that, at least until 1985, the view that the central banks of (most if not all) developed economies possessed precautionary demands for expansions cannot be easily dismissed. Due to the substantial increase in CB independence during the nineties such a sweeping conclusion is likely to be less appropriate today. But this still

[24]Most of the literature on endogenous monetary policy abstracts from such a possibility by postulating quadratic loss functions. Cukierman (2002) argues that the quadratic form is postulated mostly for analytical convenience rather than because of its descriptive realism.

[25]Section V of that paper shows that a similar bias arises under similar circumstances with a New Keynesian transmission mechanism.

leaves the door open for the possibility that individual central banks possess precautionary demands for expansions.

There is time series evidence within individual countries which supports the existence of precautionary demands for expansions in some countries but not in others. Using a natural rate model and a Linex function to allow for possible asymmetries in the loss function Ruge - Murcia (2001) provides evidence supporting the view that the US and French central banks possess precautionary demands for expansions but that the central banks of the UK and of Japan do not. Using a New Keynesian framework Cukierman and Muscatelli (2002) develop a procedure for the detection of a precautionary demand for expansions from interest rate reaction functions of the type used by Clarida, Gali and Gertler (2000). They find evidence supporting the existence of a precautionary motive for expansions during the second half of the eighties and the nineties in the US but not in Germany, Japan and the UK.

For sceptics like McCallum (1995), who argue that the KPBG inflation bias story is not a good explanation of inflation even prior to Volcker's disinflation in the US, this paper provides an alternative, more realistic, hypothesis that is supported by cross sectional evidence from 21 developed economies. This raises the possibility that the "new inflation bias" hypothesis proposed here provides, for the period in which most of the developed economies suffered from relatively high inflation, a more believable alternative to the KPBG bias hypothesis. More definitive judgement on this issue must await further work. But the fact that there was, in the pre-1985 period, a strong positive relation between inflation and the variability of output growth - - which is consistent with the new bias hypothesis but not with the KPBG hypothesis - - raises the possibility that, for developed economies, the "new bias" hypothesis is a serious contender to the standard one.

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