Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Economics Letters 81 (2003) 389–394
economics letters
www.elsevier.com/locate/econbase

# Recession aversion, output and the Kydland–Prescott Barro–Gordon model

Stefan Gerlach*

*Hong Kong Monetary Authority, Hong Kong Institute for Monetary Research, University of Basel and the CEPR, HKMA, 30th Floor, 3 Garden Road, Central, Hong Kong, China*

Received 31 October 2002; accepted 9 June 2003

**Abstract**

This paper explores the relationship between the Kydland–Prescott Barro–Gordon model and models with asymmetric policy preferences. While both yield an inflation bias, recession aversion dampens the output effects of contractionary supply shocks. Some inflation may, therefore, reflect policy preferences.


*Keywords:* Asymmetric policy reactions; Inflation bias; Reaction functions

*JEL classification:* E31; E50

## 1. Introduction

The sources of the dramatic increase in inflation in many OECD countries in the late 1960s and 1970s remain contentious. Following the analysis of Kydland and Prescott (1977) and Barro and Gordon (1983) (KPBG hereafter), it is commonly believed that this episode resulted from systematic efforts of policymakers to raise output above its steady-state level. While this interpretation of events may be correct, there are theoretical, practical and empirical reasons to doubt the explanatory power of the KPBG hypothesis.

First, McCallum (1997) shows that while the incentive structure studied by KPBG may lead the central bank to attempt to stimulate the economy excessively, this does not on average raise the level of output. Since the expansionary policy leads to no extra benefits, only costs, policymakers could

* Tel.: +852-2878-8800; fax: +852-2878-2280.
*E-mail address:* stefan_gerlach@hkma.gov.hk (S. Gerlach).

0165-1765/$ - see front matter © 2003 Elsevier B.V. All rights reserved.
doi:10.1016/S0165-1765(03)00223-4

simply refrain from playing the game the public expects them to engage in. From a theoretical perspective, there is, thus, no inherent reason why the inflation bias must arise. Second, Blinder (1998), in reviewing central bank practice, argues that policymakers do not systematically attempt to raise output above potential precisely because they know that doing so is inflationary. Third, in formal econometric work, Ireland (1999) shows that while the long-run behaviour of inflation and unemployment in the US is compatible with the KPBG analysis, the short-run dynamic behaviour is not. Thus, the empirical evidence does not appear to support the KPBG explanation for the inflation experienced in the 1970s.

This note presents a competing model for why excessive inflation, as defined below, may arise. I show that the KPBG loss function is isomorphic to the nonlinear loss function for a recession-averse central bank, and that both loss functions lead to a positive average inflation rate.[1] However, the assumption of recession aversion implies that the level of economic activity is higher than in the KPBG analysis in face of large contractionary supply shocks. Depending on their preferences, it may, therefore, be fully rational for policymakers to generate some inflation.

## 2. The KPBG model

Suppressing time subscripts, output, $y$, is given by a traditional Phillips curve:[2]

$$y = \alpha(\pi - E\pi) + u, \tag{1}$$

where $\pi$ denotes inflation, $E\pi$ expected inflation, $\alpha > 0$ and $u$ a supply shock, which we assume is a normally distributed zero-mean random variable. Thus, $Eu = 0$ and $Eu^2 = \sigma^2$. Eq. (1) implies that potential output, defined as the level of output when actual and expected inflation coincide, equals $u$, and that the average output level is zero.

Policymakers minimise the expected loss, which is given by:

$$E\lambda = E[\chi\pi^2 + (y - y^{\mathrm{T}})^2], \tag{2}$$

where $\chi$ measures the relative importance that policymakers attach to stabilising inflation, $y^{\mathrm{T}}$ is the target level for output and where it is assumed for notational simplicity that policymakers' inflation target is zero. In the KPBG analysis, policymakers try systematically to raise output to the level $y^{\mathrm{T}} > 0$ by producing unexpected inflation. Since the public understands policymakers' incentive to inflate, expected inflation also rises. In equilibrium, actual and expected inflation rates are both positive, but the average level of output is zero. With a positive level of inflation but an average output level of zero, it is clear from Eq. (2) that inflation is excessive; that is, there is an inflation bias.

[1] Recently, several authors have demonstrated that an inflation bias could arise as a consequence of asymmetric policy reactions on the part of central banks to economic activity or unemployment (e.g., Cukierman, 2000; Ruge-Murcia, 2000). In contrast to this paper, they do not focus on the relationship to the KPBG model and do not discuss the implications for output.

[2] While KPBG study deterministic models (and measure economic activity by unemployment), I follow the rest of the literature and assume that there is a stochastic shock in Eq. (1).

Note that while the KPBG model explains why excessive inflation rates may be observed, it requires policymakers systematically to aim to raise output above what is feasible. Next, we study the determination of inflation in a model of recession aversion.[3]

## 3. Recession aversion

Instead of assuming that the output target is a positive constant, we assume that it is a function of the supply shock.[4] This allows for the possibility that policymakers raise their output target in response to contractionary supply shocks. Specifically, we assume that:

$$y^{\mathrm{T}} = k_0 + k_1 u + k_2(e^{-u} - 1) \tag{3}$$

Eq. (3) nests several plausible loss functions.

- Case 1: If $k_0>0$ and $k_1 = k_2 = 0$, we have the standard KPBG case in which policymakers aim to raise the average level of output above zero, irrespectively of the realisation of the supply shock.
- Case 2: If $k_0 = k_2 = 0$ and $k_1 \neq 0$, policymakers' output target depends linearly on the supply shock. The subcase in which policymakers target potential output, $k_1 = 1$ so that $y^{\mathrm{T}} = u$ is of particular interest and is discussed below.
- Case 3: If $k_0 = k_1 = 0$, and $k_2>0$, policymakers adjust their output target asymmetrically to contractionary supply shocks.

To understand the last case, assume that $k_2 = 1$ and note that $\partial y^{\mathrm{T}}/\partial u = -e^{-u} < 0$. Policymakers consequently attempt to offset the contractionary effects of negative supply shocks ($u<0$) by raising the output target. Note also that $\partial^2 y^{\mathrm{T}}/\partial u^2 = e^{-u}>0$, so that they respond more strongly to large than to small negative $u$ shocks. This specification of the output objective captures recession aversion.

Note that the output target is a random variable since it depends on $u$. Because the public must form expectations of inflation before the $u$ shock is realised, they must compute the expected value of $y^{\mathrm{T}}$. To do so, use a Taylor series approximation to arrive at $e^{-u} - 1 \approx u^2/2 - u$, and take expectations of both sides of Eq. (3). We then have that $Ey^{\mathrm{T}} = k_0 + k_2\sigma^2/2>0$. This establishes that the loss function in the KPBG case is isomorphic to that of the recession aversion case. It follows immediately that excessive inflation can arise either because $k_0>0$ or because $k_2>0$.[5] One way to think of the much criticised assumption of the KPBG analysis that $y^{\mathrm{T}}>0$ is, therefore, that it captures asymmetric policy reactions.

[3] The notions of excessive inflation and recession aversion are defined below.

[4] To understand how this model can explain the high inflation in the 1970s and early 1980s, think of the central bank as minimising Eq. (2), but having a politically determined subsidiary objective given by Eq. (3). The subsequent achievement of price stability can then be seen as a consequence of the introduction of central bank independence which enabled central banks to set their own objective for output.

[5] Note that there is a difference between the two notions of excessive inflation. In the KPBG literature, inflation is excessive in the sense that since aiming to raise output increases $E\pi$ without influencing $Ey$, policymakers should resist the temptation of trying to do the impossible. In the asymmetric reaction case, inflation is excessive in the sense that $E\pi(u)>\pi(Eu)$.

## 4. Solution

Next, we characterise the equilibrium more fully. Solving the first-order condition associated with Eq. (2) for inflation we obtain (using the Taylor series approximation noted above):

$$\pi = \left(\frac{1}{\chi + \alpha^2}\right)\left\{\alpha^2 E\pi + \alpha\left(k_0 + (k_1 - 1)u + k_2\left(\frac{u^2}{2} - u\right)\right)\right\} \tag{4}$$

so that:

$$E\pi = \frac{\alpha}{\chi}\left\{k_0 + k_2\frac{\sigma^2}{2}\right\}. \tag{4'}$$

Eq. (4) states that the expected rate of inflation depends positively on $k_0$ and, for the reasons already discussed, $k_2$ times the variance of supply shocks. Using (4) and (4′), we can then solve for inflation and output:

$$\pi = \frac{\alpha}{\chi + \alpha^2}\left\{\left(\frac{\chi + \alpha^2}{\chi}\right)k_0 + \frac{\alpha^2}{\chi}k_2\frac{\sigma^2}{2} + (k_1 - k_2 - 1)u + k_2\frac{u^2}{2}\right\} \tag{5}$$

$$y = \frac{\alpha^2 k_2}{\chi + \alpha^2}\left(\frac{u^2}{2} - \frac{\sigma^2}{2}\right) + \frac{\alpha^2(k_1 - k_2) + \chi}{\chi + \alpha^2}u. \tag{6}$$

In interpreting the solutions to Eqs. (5) and (6), three cases are particularly interesting.

*Targeting potential output*, $y^T = u$. Thus, the solutions for inflation and output are $\pi = 0$ and $y = u$, that is, policymakers hold inflation constant and let output fluctuate in response to supply shocks.

The *KPBG case*, $y^T = k_0 > 0$. The solutions in this case are given by:

$$\pi = \frac{\alpha}{\chi + \alpha^2}\left\{\left(\frac{\chi + \alpha^2}{\chi}\right)k_0 - u\right\} \tag{7a}$$

$$y = \frac{\chi}{\chi + \alpha^2}u. \tag{7b}$$

As is well known, supply shocks elicit smaller output responses than when policymakers target potential output. Thus, there is stabilisation bias. By contrast, inflation responds by more than when the central bank targets potential output. Furthermore, policymakers' desire to raise output leads to an inflation bias, which is proportional to $k_0$, but does not influence the average level of output. The attempts to expand economic activity, thus, lead to increased inflation, which is welfare reducing, without influencing output.

*Recession aversion*, $y^T = k_2(e^{-u} - 1)$. In this case, policymakers respond more to contractionary than to expansionary disturbances. The solutions for inflation and output are given by:

$$\pi = \frac{\alpha}{\chi + \alpha^2}\left\{\frac{\alpha^2 k_2}{\chi}\frac{\sigma^2}{2} - (1 + k_2)u + k_2\frac{u^2}{2}\right\}. \tag{8a}$$

$$y = \frac{\alpha^2 k_2}{\chi + \alpha^2}\left\{\left(\frac{u^2}{2} - \frac{\sigma^2}{2}\right)\right\} + \frac{u}{\chi + \alpha^2}(\chi - \alpha^2 k_2). \tag{8b}$$

These expressions warrant two comments. First, note that inflation is on average positive. The reason for this is that the public expects policymakers on average to have a positive output target despite the fact that the output target is zero when the supply shock is at its expected value (that is, $Ey^T(u) > y^T(Eu) = 0$). Second, for large contractionary supply shocks (defined such that $u < -\sigma$), output will be higher when policymakers respond asymmetrically. The asymmetric behaviour, thus, leads to greater economic activity in bad states at the cost of higher inflation on average. In contrast to KPBG models, there is a trade-off between average inflation and the behaviour of output, which implies that a positive average inflation rate may simply reflect policymakers' preferences.

## 5. Conclusions

This paper has shown that there is a relationship between the KPBG analysis of the inflation bias and the literature of asymmetric policy reactions. In particular, the central assumption of the KPBG analysis that $y^T > 0$ can be thought of as capturing asymmetric policy reactions. However, the assumption of recession aversion implies that the level of economic activity is higher than in the KPBG model in the face of large contractionary supply shocks. Depending on their preferences, it may, therefore, be fully rational for policymakers to generate an on average positive inflation rate.

## Acknowledgements

The views expressed in this paper are my own and not necessarily those of the HKMA and HKIMR. I thank Jeffery Amato, Vitor Gaspar, Hans Genberg, Petra Gerlach, Philip Lowe, Srichander Ramaswamy, Nouriel Roubini, Frank Smets and Lars Svensson for helpful discussions.

## References

Barro, R.J., Gordon, D.R., 1983. A positive theory of monetary policy in a natural rate model. Journal of Political Economy 91, 589–610.

Blinder, A.S., 1998. Central Banking in Theory and Practice. MIT Press, Cambridge, MA.

Cukierman, A., 2000. The inflation bias result revisited. Unpublished paper, Tel-Aviv University.

Kydland, F.E., Prescott, E.C., 1977. Rules rather than discretion: the inconsistency of optimal plans. Journal of Political Economy 85, 473–492.

Ireland, P.N., 1999. Does the time-consistency problem explain the behaviour of inflation in the United States? Journal of Monetary Economics 44, 279–291.
McCallum, B.T., 1997. Crucial issues concerning central bank independence. Journal of Monetary Economics 39, 99–112.
Ruge-Murcia, F.J., 2000. The inflation bias when the central bank targets the natural rate of unemployment. Unpublished paper, CRDE, Université de Montréal.