



Discussion Paper Series

Inflation Targeting and Inflation Persistence

By

George J. Bratsiotis, Jakob Madsen, Christopher Martin

Centre for Growth and Business Cycle Research, Economic Studies,
University of Manchester, Manchester, M13 9PL, UK

September 2015

Number 211

Download paper from:

<http://www.socialsciences.manchester.ac.uk/cgbcr/discussionpapers/index.html>

ECONOMIC AND POLITICAL STUDIES

VOLUME 3 NUMBER 1 JANUARY 2015

Articles

- 3 Inflation Targeting and Inflation Persistence
George J. Bratsiotis, Jakob Madsen, and Christopher Martin
- 18 The Stabilizing Effect of Industrial Structure Upgrade on Economic Fluctuations in China
Fuqian Fang and Xinyu Zhan
- 42 Combating Corruption in China: The Role of the State and Other Agencies in Comparative Perspective
Leslie Holmes
- 71 Conceptualizing the Nexus between Econocentric Capitalism and Logocentric Radicalism
Xing Li
- 98 China and the EU as Global Actors: Challenges and Opportunities for Joint Cooperation
Emil Kirchner
- 114 The Chinese Are Coming: The Political Implications of the Growing Sino-Israel Economic Ties
Meron Medzini
- 129 Assessing Sino-Indian Economic Relations in an Interdependence Framework: 1992-2008
Joe Thomas Karackattu

ISSN 2095-4816



9 772095 481149



Economic and Political Studies

VOLUME 3 NUMBER 1 JANUARY 2015

VOLUME 3 NUMBER 1 JANUARY 2015

EPS

ECONOMIC AND

POLITICAL
STUDIES

ISSN 2095 - 4816
CN 10 - 1049/C

Economic and Political Studies

Volume 3

Number 1

January 2015

Articles

- 3 Inflation Targeting and Inflation Persistence
George J. Bratsiotis, Jakob Madsen, and Christopher Martin
- 18 The Stabilizing Effect of Industrial Structure Upgrade on Economic Fluctuations in China
Fuqian Fang and Xinyu Zhan
- 42 Combating Corruption in China: The Role of the State and Other Agencies in Comparative Perspective
Leslie Holmes
- 71 Conceptualizing the Nexus between Econocentric Capitalism and Logocentric Radicalism
Xing Li
- 98 China and the EU as Global Actors: Challenges and Opportunities for Joint Cooperation
Emil Kirchner
- 114 The Chinese Are Coming: The Political Implications of the Growing Sino-Israel Economic Ties
Meron Medzini
- 129 Assessing Sino-Indian Economic Relations in an Interdependence Framework: 1992-2008
Joe Thomas Karackattu

Inflation Targeting and Inflation Persistence

GEORGE J. BRATSIOTIS, JAKOB MADSEN,
and CHRISTOPHER MARTIN*

Abstract: This paper argues that the adoption of an inflation target reduces the persistence of inflation. We develop the theoretical literature on inflation persistence by introducing a Taylor Rule for monetary policy into a model of persistence and showing that inflation targets reduce inflation persistence. We investigate changes in the time series properties of inflation in seven countries that introduced inflation targets in the late 1980s or early 1990s. We find that the persistence of inflation is greatly reduced or eliminated following the introduction of inflation targets.

Keywords: Taylor Rule, inflation targeting, Phillips Curve, inflation persistence

I. Introduction

THIS PAPER ARGUES THAT THE persistence of inflation is lower when there is an inflation target. This implies that inflation is more responsive to monetary policy when inflation is the main focus of policy.

The idea that inflation persistence may depend on macroeconomic institutions or policy regimes, of which inflation targets are a recent example, is well established in the literature. Alogoskoufis and Smith (1991) and Alogoskoufis (1992) argue that inflation is less persistent with fixed exchange rates. Other authors, such as Siklos (1999) and Burdekin and Siklos (1999), argue that other factors, such as wars, supply shocks or Central Bank reforms, can also affect inflation persistence.

We extend the theoretical literature by introducing a Taylor-rule representation of monetary policy (Taylor, 1993) into an otherwise standard model of inflation persistence, similar to Taylor (1979), Alogoskoufis and

* George J. Bratsiotis is from the School of Social Sciences, University of Manchester; e-mail: george.j.bratsiotis@manchester.ac.uk. Jakob Madsen is from the Department of Economics, Monash University. Christopher Martin is from the Department of Economics, University of Bath.

Smith (1991), Agenor and Taylor (1992) and Alogoskoufis (1992). We show that inflation persistence is affected by the parameters of the monetary policy rule. An increased weight on the price-level target in the monetary policy rule reduces persistence. As a result, persistence is lower when there is an inflation target.

We test our model by investigating changes in the time series properties of inflation persistence in seven countries that adopted inflation in the late 1980s or early 1990s (Australia, Canada, Finland, New Zealand, Spain, Sweden and the UK). We find that the persistence of inflation is greatly reduced or even eliminated following the introduction of inflation targets. Using annual and quarterly data between 1946Q2 and 2001Q2, we cannot reject the hypothesis that inflation persistence has been eliminated in any country. Other studies, which examine different countries in more recent periods, including the financial crisis period of the late 2000s, find similar results; for example, for developed countries see Levin, Natalucci and Piger (2004), Benati, (2008), Altansukh *et al.* (2013), and Baxa, Horvath, and Václavek (2014) and for Asia-Pacific countries see de Mendonca and de Guimarães e Souza (2012), and Gerlach and Tillmann (2012).

The paper is structured as follows. Section II describes our theoretical model, Section III contains our empirical results, and Section IV summarizes the findings of this paper.

II. The Model of Inflation Persistence

In this section we present the theoretical model. We begin by considering aggregate demand and then develop the supply side of the model before analyzing inflation persistence.

1. Aggregate Demand

We assume that aggregate demand is given by

$$y_t = \bar{y} - \gamma(i - E_{t-1}p_{t+1} + E_{t-1}p_t) + v_t, \quad (1)$$

where y is the natural logarithm of output, \bar{y} is an exogenous component of demand, i is the nominal interest rate, p is the natural logarithm of the price level, $E_{t-1}p_{t+1}$ is the expected price level in period $(t+1)$ using information available at time $t-1$, v_t is a white noise demand shock and t indexes time.

We assume that monetary policy is conducted through an interest rate Taylor-type rule:

$$i_t = i^* + \phi(p_t - p^*) + \psi(y_t - y^*), \quad (2)$$

where i^* is a constant, p^* is the log of the policymaker's target for the price level and y^* is the log of the policymakers target level of output. The policy parameters ϕ and ψ describe the responsiveness of nominal interest rates to deviations of inflation and output from their respective targets. Our model extends the literature by introducing a familiar Taylor-rule description of monetary policy (Taylor, 1993). In the existing literature, Taylor (1979) assumes that aggregate demand depends on the real money supply and that the nominal money supply is proportional to the price level. Alogoskoufis and Smith (1991), Agenor and Taylor (1992) and Alogoskoufis (1992) use an aggregate demand relationship, similar to (1), but model interest rates using a money demand equation and again assume the nominal money supply is proportional to the price level. In essence, these models are equivalent to $\psi = p^* = y^* = 0$ in (2).

The introduction of a Taylor Rule allows us to analyze various policy regimes. If $\phi \rightarrow \infty$ and $\psi \rightarrow 0$, the over-riding priority of monetary policy is to achieve a price level of p_t^* . This is equivalent to an inflation target of π_t^* , where $p_t^* = \pi_t^* + p_{t-1}$. If $\psi \rightarrow \infty$ and $\phi \rightarrow 0$, there is an output target. If $\psi = \phi$, there is a target for nominal GDP. The parameters of the Taylor Rule affect the extent to which monetary policy accommodates inflation. With an inflation target, policy does not accommodate inflation as real interest rates increase whenever inflation rises above the target. With an output target, changes in the price level do not alter the real interest rate and so monetary policy fully accommodates inflation.

Substituting (2) into (1), we can summarize aggregate demand as

$$y_t = y_c - \frac{\gamma\phi}{1+\gamma\psi} p_t + \frac{\gamma}{1+\gamma\psi} (E_{t-1}p_{t+1} - E_{t-1}p_t) + \frac{v_t}{1+\gamma\psi}, \quad (3)$$

where $y_c = \{\bar{y} - \gamma(i^* - \phi p^* - \psi y^*)\} / (1 + \gamma\psi)$. The slope of this aggregate demand curve depends on the policy regime. The curve is horizontal if there is an inflation target, vertical if there is an output target, and it has a conventional negative slope if there is no target (see Taylor, 1999a).

2. Aggregate Supply

We use a standard model of aggregate supply. We assume that there is a large number of identical monopolistically competitive firms. Each firm's technology is described by a simple production function

$$y_{jt} = \alpha + \ell_{jt} + \xi_t, \quad (4)$$

where ℓ is employment, ξ is a supply shock, α is a constant and j indexes the firm. We follow the literature (e.g. Alogoskoufis, 1992 and Bleaney, 2001) in assuming that the supply shock follows a random walk, $\xi_t = d_\xi + \xi_{t-1} + \varepsilon_t$. The demand for each firm depends positively on aggregate demand and negatively on its relative price:

$$y_{jt} = y_t - \eta(p_{jt} - p), \quad (5)$$

where y_t is given by (3). From a standard profit maximization problem and using Equations (4) and (5), the price chosen by each firm is

$$p_{jt} = \mu + w_{jt} - \alpha - \xi_t, \quad (6)$$

where w_j is the nominal wage and $\mu = (1 - 1/\eta)^{-1}$ is the mark-up of price over marginal cost in firm j .

Wage adjustment is staggered and described by a discrete time, Calvo-type utility-maximizing wage contract model (Calvo, 1983). At any given time, the wage at each firm has a fixed probability δ of being adjusted and a fixed probability $(1-\delta)$ of remaining fixed at the previous period's wage. In the presence of wage frictions, each union aims to minimize the deviation cost of its wage from its optimal wage, w_t^* . Therefore, each union j adjusting its wage contract at time t will aim to minimize:

$$L_t = \frac{1}{2} E_t \sum_{s=0}^{\infty} (1-\delta)^s \beta^s (w_{j,t+s} - w_{j,t+s}^*)^2, \quad (7)$$

where β is the union's discount factor. From Equation (7) and given that unions are symmetric, all unions adjusting wages at time t choose the same common wage contract

$$\hat{w}_t = [1 - (1-\delta)\beta] \sum_{s=0}^{\infty} (1-\delta)^s \beta^s E w_{t+s}^*. \quad (8)$$

The aggregate wage is given by the sum of all wage contracts still in force. With $\delta(1-\delta)^s$ being the fraction of wage contracts adjusted s periods before t , the aggregate wage is given by

$$w_t = \delta \sum_{s=0}^{\infty} (1-\delta)^s \hat{w}_{t-s} = \delta w_t + (1-\delta)w_{t-1}. \quad (9)$$

From Equation (8), the wage contract chosen when adjustment occurs is forward-looking:

$$\hat{w}_t = [1 - (1-\delta)\beta]w_t^* + (1-\delta)\beta E_t \hat{w}_{t+1}, \quad (10)$$

where w_t^* is the optimal wage common to all union that adjust their wage contracts in period t . We assume that this is given by

$$w_t^* = \omega^* + E_{t-1} p_t + \sigma E_{t-1} (y_t - y^*), \quad (11)$$

where ω^* is desired real wage growth (assumed constant for simplicity), y^* is a reference level of output and σ measures the elasticity of real wages with respect to output. Equation (11) can be derived from almost any model of wage formation.

We then use (9) to express wage contracts in terms of w_t and use (6) to express w_t in terms of prices. This leads to the following equation for the aggregate price level:

$$\begin{aligned} p_t = & \frac{(1-\delta)\hat{\delta}(\omega^* + \mu - \alpha)}{1 + (1-\delta)^2 \beta} + \frac{(1-\delta)}{1 + (1-\delta)^2 \beta} (p_{t-1} + \hat{\delta} E_{t-1} p_t + \beta E_{t-1} p_{t+1}) \\ & + \frac{(1-\delta)\hat{\delta}\sigma}{1 + (1-\delta)^2 \beta} E_{t-1} (y_t - y^*) + \frac{(1-\delta)}{1 + (1-\delta)^2 \beta} (\xi_{t-1} + \beta E_{t-1} \xi_{t+1}) - \xi_t, \end{aligned} \quad (12)$$

where $\hat{\delta} = \delta(1/(1-\delta) - \beta) > 0$ and increasing in δ . Defining inflation as $\pi_t = p_t - p_{t-1}$ and taking expectations, we can summarize the supply side of our model as

$$\begin{aligned} E_{t-1} \pi_t = & \beta E_{t-1} \pi_{t+1} + \hat{\delta}(\omega^* + \mu - \alpha) + \hat{\delta}\sigma E_{t-1} (y_t - y^*) \\ & + \xi_{t-1} - \left(\frac{1 + (1-\delta)^2 \beta}{1-\delta} \right) E_{t-1} \xi_t + \beta E_{t-1} \xi_{t+1}. \end{aligned} \quad (13)$$

This aggregate supply or Phillips Curve is similar to others earlier in the literature such as Taylor (1999b), Mankiw (2000), or Holden and Driscoll (2001).

3. Inflation Persistence

We substitute the aggregate demand curve, Equation (3), into the aggregate supply curve, Equation (12), to obtain

$$p_t = \frac{(1-\delta)}{1+\beta(1-\delta)^2} \left(\bar{p} + \left(1 - \frac{\gamma\sigma(1+\phi)}{1+\gamma\psi}\right) \hat{\delta} E_{t-1} p_t + \left(1 + \frac{\gamma\sigma\hat{\delta}}{\beta(1+\gamma\psi)}\right) \beta E_{t-1} p_{t+1} + p_{t-1} + s_t \right), \quad (14)$$

where $\bar{p} = \hat{\delta}(\omega^* + \mu - \alpha + \sigma(y_c - y^*))$ and $s_t = \xi_{t-1} - \left(\frac{1+\beta(1-\delta)^2}{1-\delta}\right) \xi_t + \beta E_{t-1} \xi_{t+1}$.

Forming expectations and rearranging Equation (14) we obtain

$$\begin{aligned} E_{t-1} p_{t+1} - \frac{1}{\theta} \left(\frac{1+\beta(1-\delta)^2}{(1-\delta)} + \hat{\delta} \left(1 - \frac{\gamma\sigma(1+\phi)}{1+\gamma\psi}\right) \right) E_{t-1} p_t + \frac{p_{t-1}}{\theta} \\ = - \frac{(\bar{p} + E_{t-1} s_t)}{\theta}, \end{aligned} \quad (15)$$

where $\theta = \beta + \frac{\gamma\sigma\hat{\delta}}{1+\gamma\psi} > 0$. Equation (15) can be written as

$$\left(F^2 - (\lambda_1 + \lambda_2)F + \lambda_1\lambda_2 \right) L E_{t-1} p_t = -\lambda_1\lambda_2(\bar{p} + E_{t-1} s_t), \quad (16)$$

where λ_1 and λ_2 are the smaller and larger roots respectively of (16), L is the lag operator and F is the forward operator. Expressing (16) as

$$E_{t-1} p_t = \lambda_1 p_{t-1} + \lambda_1 \sum_{i=0}^{\infty} \lambda_2^{-i} (\bar{p} + E_{t-1} s_{t+i}). \quad (17)$$

Substituting (17) into (14) and then taking first differences, we obtain

$$\pi_t = \lambda_1 \pi_{t-1} + \frac{\lambda_1 \beta}{1-\theta\lambda_1} d_\xi + \frac{\lambda_1}{1-\theta\lambda_1} \left(1 - \frac{\theta(1-\delta)}{1+\beta(1-\delta)^2} \right) \varepsilon_{t-1} - \frac{(1-\delta)}{1+\beta(1-\delta)^2} \varepsilon_t, \quad (18)$$

where

$$\lambda_1 = \frac{1}{2\theta} \left(\frac{1 + \beta(1-\delta)^2}{(1-\delta)} - \hat{\delta} \left(1 - \frac{\gamma\sigma(1+\phi)}{1+\gamma\psi} \right) \right) \left(1 - \sqrt{1 - \frac{4\theta(1-\delta)^2}{1 + \beta(1-\delta)^2 - (1-\delta)\hat{\delta} \left(1 - \frac{\gamma\sigma(1+\phi)}{1+\gamma\psi} \right)}} \right). \quad (19)$$

From (19), we can show

$$\frac{d\lambda_1}{d\phi} < 0; \quad \frac{d\lambda_1}{d\psi} > 0. \quad (20)$$

For details see Appendix.

Equations (18)-(20) comprise our model of the persistence of inflation. We find that the parameters of the Taylor Rule for monetary policy affect the persistence of inflation although the targets p^* and y^* do not. Inflation is less persistent when policymakers place a greater emphasis on the price level or a lesser emphasis on output. We therefore predict that inflation will be less persistent with an inflation target.

III. Empirical Evidence

In this section we provide evidence on how the persistence of inflation is affected by inflation targeting. Some evidence is from the OECD economies which adopted inflation targets in the late 1980s or early 1990s. For example, New Zealand adopted inflation targeting in 1989Q3, Australia in 1993Q2, Canada in 1991Q1, Sweden in 1993Q1, and the UK in 1992Q3. Other evidence is from Finland and Spain, which adopted inflation targets in 1993Q1 and 1994Q1 respectively but abandoned the measures upon entering EMU in 1998Q2 (for further institutional details see Bernanke *et al.*, 1999). We use the consumer price index to measure prices throughout and use both annual and quarterly data to ensure our findings are robust.

We first examine the time series properties of our data, testing for unit roots. For our quarterly data, we test for seasonal unit roots, using the HEGY test (Hylleberg *et al.*, 1990). The HEGY test identifies the precise nature of seasonal integration and allows us to model any seasonal unit roots accordingly. The following auxiliary regression is undertaken:

$$\phi(L)z_{4t} = \pi_1 z_{1,t-1} + \pi_2 z_{2,t-1} + \pi_3 z_{3,t-2} + \pi_4 z_{3,t-1} + \varepsilon_t, \quad (21)$$

where $\phi(L) = 1 - \sum_{j=1}^n \phi_j L^j$ is a stationary autoregressive polynomial of order n in L . Deterministic variables are left out of the equation for simplicity but are included in the empirical estimates. The z -variables are given by

$$\begin{cases} z_{1t} = (1 + L + L^2 + L^3)p_t \\ z_{2t} = -(1 - L + L^2 - L^3)p_t, \\ z_{3t} = -(1 - L^2)p_t \\ z_{4t} = (1 - L^4)p_t \end{cases}$$

where p is the log of consumer prices. One-period lags of the dependent variable are included in the tests.

The results of the HEGY tests are presented in Table 1. The null hypotheses of $\pi_2 = 0$, and $\pi_3 \cap \pi_4 = 0$ are rejected at the 5% level for all countries. This implies the absence of semiannual, complex and annual unit roots. However, the null hypothesis of $\pi_1 = 0$ cannot be rejected at the 5% level for any of the countries. This suggests that consumer prices in quarterly data contain a zero-frequency unit root and therefore that first-difference is the appropriate filter for making the series stationary. By examining the time series properties of our annual data using simple ADF tests, we found that prices were clearly I(1) in each country.¹ We therefore define the rate of inflation using both annual and quarterly data as $\pi_t = p_t - p_{t-1}$, where p is the log of the consumer price index.

TABLE 1
HEGY Unit Root Tests

	$t(\hat{\pi}_1)$	$t(\hat{\pi}_2)$	$F(\hat{\pi}_3, \hat{\pi}_4)$
Canada	-3.31	-7.91	38.17
Australia	-2.45	-4.75	42.93
New Zeal.	-0.07	-6.49	47.42
Finland	-1.22	-5.32	55.33
Spain	-1.71	-5.42	50.91
Sweden	-2.30	-5.91	55.37
UK	-2.07	-5.44	36.95

¹ In order to save space, the results are not presented in details but available from the authors upon request.

Note: A time-trend, constant term, seasonal dummies and a lagged dependent variable are included in the estimates. Estimation period: 1946Q2-2001Q2, which yields 220 observations. Critical values for $T = 200$ at the 5% level are: $t(\pi_1) = -3.49$, $t(\pi_2) = -2.91$, and $F(\pi_3, \pi_4) = 6.57$ (see Hylleberg *et al.*, 1990).

To examine the impact of inflation targets on inflation persistence, we consider simple regression models of the form

$$\pi_t = \alpha + (\beta_1 + \beta_2 FX_t + \beta_3 IT_t) \pi_{t-1} + u_t, \quad (22)$$

where FX is an indicator variable that equals unity during periods of fixed exchange rates and equals zero in other periods; IT is an indicator variable that equals unity during periods where an inflation target was in operation and equals zero in other periods and u is an error term. We use the White (1980) procedure to correct our estimated standard errors for heteroskedasticity and the Newey and West (1987) estimator to adjust standard errors for serial correlation.

Equation (22) is similar to other models in the literature on inflation persistence. These models typically interact lagged inflation with indicators of institutional presence or economic events. For example, Alogoskoufis and Smith (1991), Alogoskoufis (1992) and Bleaney (2001) use indicators of fixed exchange rates, corresponding to $\beta_3 = 0$ in (22). Other authors, e.g., Burdekin and Siklos (1999), also include indicators of other events, for example oil shocks and structural changes at Central Banks.

Estimates of (22) are presented in Table 2. In every country, the estimate of β_3 is negative and significantly different from zero using both annual and quarterly data. Indeed, we can only reject the hypothesis that inflation targets have eliminated inflation persistence ($H_0: \beta_1 + \beta_3 = 0$) in the case of the UK using quarterly data and cannot reject the hypothesis for any country when using annual data. These findings provide strong evidence in favor of our hypothesis that adopting an inflation target will reduce the persistence of inflation. The only other evidence on this is in Siklos (1999), who finds more ambiguous results using data up to 1997. This may be because we have more observations from the inflation targeting regime.

TABLE 2
Parameter Estimates of Inflation Persistence

$$\pi_t = \alpha + \beta_1 + \beta_2 FX_t + \beta_3 IT_t + \pi_{t-1} + u_t$$

(a) Quarterly Data Sample 1945Q1-2001Q2

	π_{t-1}	$\pi_{t-1}FX_t$	$\pi_{t-1}IT_t$	DW	R^2	HET	RES	SC	$H_0: (\beta_1 = \beta_3)$
Canada	0.69(13.0)	-0.40(5.10)	-0.56(3.60)	2.17	0.46	4.79	1.19	1.41	0.79
Australia	0.65(9.15)	0.03(0.44)	-0.47(2.68)	2.42	0.49	19.5	0.58	2.61	1.71
New Zeal.	0.57(3.83)	0.14(0.95)	-0.40(2.44)	2.25	0.48	21.4	1.51	1.15	2.48
Finland	0.51(6.18)	-0.06(0.46)	-0.76(3.19)	2.29	0.26	18.2	1.41	3.24	2.11
Spain	0.61(9.16)	-0.31(3.49)	-0.79(4.41)	2.25	0.42	19.2	0.20	2.38	0.61
Sweden	0.37(4.83)	-0.05(0.49)	-0.43(3.25)	2.21	0.21	12.7	0.40	2.46	0.11
UK	0.68(6.09)	-0.42(3.30)	-0.30(2.06)	2.20	0.55	63.3	0.18	1.22	7.32

(b) Annual Data Sample 1946-2001

	π_{t-1}	$\pi_{t-1}FX_t$	$\pi_{t-1}IT_t$	DW	R^2	HET	RES	SC	$H_0: (\beta_1 = \beta_3)$
Canada	0.88(5.38)	-0.45(3.14)	-0.57(2.34)	1.85	0.52	6.64	1.14		0.20
Australia	0.79(11.1)	-0.19(0.99)	-0.50(2.06)	1.71	0.54	11.4	0.14		1.32
New Zeal.	0.77(10.0)	-0.12(0.91)	-0.54(2.71)	2.10	0.54	6.84	1.13		1.24
Finland	0.63(4.32)	-0.34(1.86)	-1.90(2.93)	2.01	0.41	8.78	1.55		3.35
Spain	0.72(10.3)	-0.24(1.83)	-0.63(3.42)	1.77	0.54	3.42	0.22		0.17
Sweden	0.68(7.48)	-0.28(2.93)	-0.68(2.64)	1.99	0.47	1.14	1.40		0.00
UK	0.77(8.46)	-0.44(3.16)	-0.50(3.34)	1.77	0.68	15.1	0.14		2.34

Note: The numbers in parentheses are absolute t -statistics. Constants and seasonal dummies are included in the estimates but not shown. The t -values are based on White's heteroscedasticity consistent covariance matrix. Estimation period: 1946.Q2-2001.Q2. DW = Durbin-Watson test for first order serial correlation; HET = Breusch-Pagan LM test for heteroscedasticity, and is distributed as $\chi^2(6)$ under the null hypothesis of no heteroscedasticity; RES is Ramsey's RESET test with the predicted value squared as additional regressor and is distributed as $F(1,213)$ under the null hypothesis of no functional form problems; and SC is a LM test for 1 - 4 order serial correlation and is distributed as $t(217)$ under the null hypothesis of No 1 - 4 order serial correlation. $H_0: (\beta_1 = \beta_3)$ is a test of the null hypothesis $\beta_1 = \beta_3$, and is distributed as $\chi^2(6)$ under the null.

The impact of exchange rate regimes on inflation persistence is less clear. We find a significantly lower rate of persistence during fixed exchange rates for Spain and the UK, which is consistent with Alogoskoufis and Smith (1991) and Alogoskoufis (1992), but no significantly consistent effect in Australia, New Zealand, Finland and Sweden. This is broadly consistent with the results in Burdekin and Siklos (1999), who argue that wars, oil shocks or changes in Central Bank statutes have at least as great an impact on inflation

persistence as exchange rates regimes.

TABLE 3
Pooled Parameter Estimates of Inflation Persistence

$$\pi_{it} = \alpha + \beta_1 + \beta_2 FX_{it} + \beta_3 IT_{it} \pi_{it-1} + u_{it}$$

(a) Quarterly Data Sample 1945Q1-2001Q2

π_{t-1}	$\pi_{t-1}FX_t$	$\pi_{t-1}IT_t$	<i>DW</i>	R^2	$H_0: (\beta_1 = \beta_3)$
0.62(27.0)	-0.22(6.70)	-0.41(4.85)	2.15	0.64	6.08

(b) Annual Data Sample 1946-2001

π_{t-1}	$\pi_{t-1}FX_t$	$\pi_{t-1}IT_t$	<i>DW</i>	R^2	$H_0: (\beta_1 = \beta_3)$
0.54(15.01)	-0.39(6.17)	-0.38(2.48)	1.96	0.62	1.05

Note: (a) see Table 2. (b) R^2 is based on Buse's raw-moment R^2 .

We investigate the robustness of these findings in several ways.² First, we use alternative measures of inflation. We estimate (22) where inflation is defined as $\pi_t = p_t - p_{t-2}$ and $\pi_t = p_t - p_{t-4}$. We find broadly similar results. In particular, there is a large and significant reduction in inflation following the introduction of inflation target. Secondly, we estimate an augmented model that allows the intercept to vary between policy regimes and allow for changes in the equilibrium inflation rate between regimes (Bleaney, 2001). We also find that the persistence of inflation is lower when there is an inflation target, although an effect on estimates for the fixed exchange rate regime, similar to Bleaney (2001). Thirdly, we include the measures of oil shocks and changes in Central Bank statutes that are identified as significant by Burdekin and Siklos (1999) and Siklos (1999). We further find that the adoption of inflation targets leads to a reduction in inflation persistence, although most our estimates again become less well determined. Fourthly, we assess the importance of misspecification apparent in the estimates in Table 2. Such misspecification is not surprising as we estimate a very simple model. Similar findings are reported in the existent literature, such as Burdekin and Siklos (1999). Our use of the White (1980) and Newey and West (1987) corrections should ensure that our estimates are robust to this. This allows us to eliminate misspecification by including both more lags of the dependent

² The results of these lengthy experiments are not reported but are available from the authors upon request.

variable and dummies for time periods associated with marked volatility. We again continue to find that inflation targets are associated with less inflation persistence. Lastly, we estimate the model $\pi_t = \alpha_t + \beta_t \pi_{t-1} + u_t$ using both Kalman Filter and rolling window techniques. Although our estimates are not as precise as those reported in Table 2, we detect that inflation persistence is lower in the 1990s than in the preceding two decades. Overall, it seems that our conclusions are robust.

Finally, we summarize our findings by presenting estimates of the pooled model

$$\pi_{it} = \alpha + (\beta_1 + \beta_2 FX_{it} + \beta_3 IT_{it}) \pi_{it-1} + u_{it}, \quad (23)$$

where i indexes the country and t indexes time. Our estimates, presented in Table 3, confirm the results of the country-by-country estimates in Table 2. The introduction of inflation targets leads to a large reduction in the persistence of inflation. Using annual data, the persistence of inflation falls from 0.54 to 0.16 following the introduction of inflation targets. We cannot reject the hypothesis that the persistence of inflation is eliminated. Using quarterly data, the persistence of inflation falls from 0.62 to 0.21, although in this case we can reject the hypothesis that inflation persistence is eliminated.

IV. Conclusion

This paper argues that the persistence of inflation is lower when there is an inflation target, so inflation is more responsive to monetary policy when inflation is the main focus of policy. We have presented a model in which inflation targeting reduces inflation persistence by reducing the extent to which monetary policy accommodates inflation. We then presented evidence from seven countries that adopted inflation targets in the late 1980s and early 1990s and showed that the persistence of inflation did indeed fall sharply after the introduction of an inflation target.

More importantly, the way in which the monetary policy parameters enter endogenously the coefficient of persistence in the model allows us to explain analytically how changes in monetary policy preferences affected the degree of persistence. In that sense, unlike many structural models, our model is not subject to Lucas' critique, something that has recently been pointed out, as a major weakness in many structural models that try to assess the role of inflation targeting and monetary policy in general (see Benati, 2008).

APPENDIX

Derivation of Equation (20)

From Equation (19) and using the definitions of $\lambda_1\lambda_2$ and $\lambda_1 + \lambda_2$, we can show that

$$\frac{d\lambda_1}{d\phi} = -\frac{1}{2\theta} \left(\frac{\hat{\delta}\sigma\gamma}{1 + \gamma\psi} \right) \left(\frac{\lambda_1 + \lambda_2}{\lambda_2 - \lambda_1} - 1 \right) < 0. \quad (\text{A1})$$

Since $\lambda_2 > \lambda_1$ and $\lambda_1 + \lambda_2 > \lambda_2 - \lambda_1$ we also have $\frac{\lambda_1 + \lambda_2}{\lambda_2 - \lambda_1} > 1$. Therefore, for any value of $\delta < 1$, we obtain $\theta, \hat{\delta} > 0$, and hence, $\frac{d\lambda_1}{d\phi} < 0$ and so inflation targeting reduces inflation persistence.

Conversely, we can show that the effect of output stabilisation on inflation persistence is positive:

$$\frac{d\lambda_1}{d\psi} = \left(\frac{\hat{\delta}\sigma\gamma^2}{(1 + \beta\psi)^2} \right) \left(\frac{\lambda_1(1 - \lambda_1 + \phi)}{(\lambda_2 - \lambda_1)(\lambda_1 + \lambda_2)^2} \right) > 0. \quad (\text{A2})$$

Since for convergence the small root of the dynamic equation is required to be less than unit $\lambda_1 < 1$ then $1 - \lambda_1 + \phi > 0$ and so given $\lambda_2 > \lambda_1$ for any value of $\delta < 1$, $\frac{d\lambda_1}{d\psi} > 0$.

REFERENCES

- Agenor, Pierre-Richard and Mark P. Taylor. 1992. "Testing for Credibility Effects." *IMF Staff Papers*, 39: 545-571.
- Alogoskoufis, George. 1992. "Monetary Accommodation, Exchange Rate Regimes and Inflation Persistence." *Economic Journal*, 102(412): 461-480.
- Alogoskoufis, George and Ron Smith. 1991. "The Phillips Curve, the Persistence of Inflation and the Lucas Critique: Evidence from Exchange Rate Regimes." *American Economic Review*, 81(5): 1254-1275.
- Altansukh, Gantungalag, Ralf Becker, George J. Bratsiotis, and Denise R. Osborn. 2013. "What Is the Globalization of Inflation?" Paper presented at the European Economic Association & Econometric Society, February 2013. Available at http://www.eea-esem.com/files/papers/eea-esem/2013/1007/ESEM-EEA_Feb2013.pdf (accessed: June 6,

- 2014).
- Baxa, Jaromir, Roman Horvath, and Borek Vasicek. 2014. "How Does Monetary Policy Change? Evidence on Inflation Targeting Countries." *Macroeconomic Dynamics*, 18(3): 593-630.
- Benati, Luca. 2008. "Investigating Inflation Persistence across Monetary Regimes." *Quarterly Journal of Economics*, 123(3): 1005-1060.
- Bernanke, Ben, Thomas Laubach, Frederic Mishkin, and Adam Posen. 1999. *Inflation Targeting: Lessons from the International Experience*. New Jersey: Princeton University Press.
- Bleaney, Michael. 2001. "Exchange Rate Regimes and Inflation Persistence." *IMF Staff Papers*, 47: 387-402.
- Burdekin, Richard and Pierre Siklos. 1999. "Exchange Rate Regimes and Shifts in Inflation Persistence: Does Nothing Else Matter?" *Journal of Money Credit and Banking*, 31(2): 235-247.
- Calvo, Guillermo. 1983. "Staggered Contracts in a Utility-maximizing Framework." *Journal of Monetary Economics*, 12: 383-398.
- De Mendonça, Helder Ferreira and Gustavo José de Guimarães e Souza. 2012. "Is Inflation Targeting a Good Remedy to Control Inflation?" *Journal of Development Economics*, 98(2): 178-191.
- Gerlach, Stefan and Peter Tillmann. 2012. "Inflation Targeting and Inflation Persistence in Asia-Pacific." *Journal of Asian Economics*, 23(4): 360-373.
- Holden, Steinar and John Driscoll. 2001. "A Note on Inflation Persistence." NBER Working Paper, 8690.
- Hylleberg, Svend, Robert Engle, Clive Granger, and Byung Yoo. 1990. "Seasonal Integration and Cointegration." *Journal of Econometrics*, 44(11-12): 159-176.
- Levin, Andrew Theo, Fabio M. Natalucci, and Jeremy M. Piger. 2004. "The Macroeconomic Effects of Inflation Targeting." *Federal Reserve Bank of St. Louis Review*, 86(4): 51-80.
- Mankiw, Gregory. 2000. "The Inexorable and Mysterious Tradeoff between Inflation and Unemployment." *Economic Journal*, 111(May): C45-C61.
- Newey, Whitney and Kenneth West. 1987. "A Simple Positive Semi-definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica*, 55(3): 703-708.
- Siklos, Pierre. 1999. "Inflation-Target Design: Changing Inflation Performance and Persistence in Industrial Countries." *Federal Reserve Bank of St Louis Review*, 81(2): 47-58.
- Taylor, John B. 1979. "Staggered Wage-setting in a Macro Model." *American Economic Review*, 69(2): 108-113.
- . 1993. "Discretion versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy*, 39(1): 195-214.

- . 1999a. “The Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank.” *Journal of Monetary Economics*, 43(3): 655-679.
- . 1999b. “Staggered Price and Wage Setting in Macroeconomics.” In *Handbook of Macroeconomics*, Vol. 1, Part B, edited by John B. Taylor and Michael Woodford, 1009-1050. North Holland: Elsevier.
- White, Halbert. 1980. “A Heteroskedasticity-consistent Covariance Estimator and a Direct Test for Heteroskedasticity.” *Econometrica*, 48(4): 817-838.