Available online at www.sciencedirect.com

SCIENCE DIRECT®

Economics Letters 85 (2004) 271–277

economics letters

www.elsevier.com/locate/econbase

Permanent and temporary inflation uncertainty and investment in the United States

Joseph P. Byrne[a,*], E. Philip Davis[b,c]

[a] *Department of Economics, University of Strathclyde, 100 Cathedral Street, Glasgow G4 0LN, UK*
[b] *Brunel University, Uxbridge, Middlesex, UK*
[c] *National Institute of Economic and Social Research, London, UK*

Received 24 June 2003; received in revised form 20 February 2004; accepted 20 April 2004
Available online 9 August 2004

Abstract

We estimate the impact on US non-residential fixed investment of permanent and temporary inflation uncertainty. We find that while both have a negative effect, temporary uncertainty is more important for investment. This study has implications for monetary policy and applied-econometric practice.
© 2004 Elsevier B.V. All rights reserved.

Keywords: Investment; Permanent and temporary uncertainty; Markov switching

JEL classification: E22

1. Introduction

Given the importance of business investment as a determinant of output growth and contributor to aggregate supply, much recent work has focused on the determinants of investment, and in particular the nature and impact of uncertainty in the economic environment. The theoretical literature concerning the effect of uncertainty on business investment is inconclusive. The traditional literature assuming reversibility of investment suggests a positive impact from uncertainty on business investment (see Hartman, 1972). Other studies, which realistically question the assumption that investment spending is perfectly reversible, propose a cost to committing to an investment project and a benefit to reducing investment in an uncertain environment which can be conceptualised using option theory, see Dixit and Pindyck (1994).

* Corresponding author. Tel.: +44-141-548-3869; fax: +44-141-552-5589.
E-mail address: joseph.byrne@strath.ac.uk (J.P. Byrne).

0165-1765/$ - see front matter © 2004 Elsevier B.V. All rights reserved.
doi:10.1016/j.econlet.2004.04.015

The theoretical stand-off has lead to a burgeoning empirical literature examining the relationship between investment and uncertainty, with recent interest in decomposing uncertainty into permanent and temporary components. Moore and Schaller (2002), for example, find evidence of different effects from permanent and temporary changes in interest rates on US investment behaviour. Chadha and Sarno (2002) report results based on Kalman filtering on the price level, where the transitory component of price volatility has a more substantial impact than the permanent component on the ratio of investment to output for the US. Byrne and Davis (2003) looked at permanent and temporary exchange rate volatility in the G7 using Component GARCH methods and found temporary uncertainty more important for investment determination.

In this paper we decompose inflation uncertainty into permanent and temporary components using the Markov switching model of Kim (1993). Such a model has been used previously to examine the costs associated with inflation. Our decomposition of inflation uncertainty allows us to identify the determinants of investment in greater detail, which is useful for applied econometric practice and the implementation of monetary policy.

2. Modelling permanent and temporary inflation uncertainty

Ball and Cecchetti (1990) studied the relationship between the level of inflation and short-term and long-term inflation uncertainty. In their work, inflation consists of a stationary autoregressive component and a stochastic trend component. However, they omitted policy-regime changes which may be an important source of persistence in the conditional variance of US inflation. Consequently Kim (1993) adopted a similar model but incorporated regime shifts in both the mean and variance structures of inflation uncertainty.[1]

Kim's (1993) model of inflation (π_t) uncertainty is as follows

$$\pi_t = T_t + \mu_2 S_{1t} + \mu_3 S_{2t} + \mu_4 S_{1t} S_{2t} + (h_0 + h_1 S_{2t}) e_t \qquad e_t \sim N(0, 1) \tag{1}$$

$$T_t = T_{t-1} + (Q_0 + Q_1 S_{1t}) v_t \qquad v_t \sim N(0, 1) \tag{2}$$

where T_t is the trend component, and S_{1t} and S_{2t} are unobserved state variables that determine the regime, providing a four state regime specification. This Markov switching model has the advantage that it allows for shifts in both the mean and the variance of inflation and does not presume a smooth transition from one state to another, an attribute which is likely to characterise uncertainty well given it can entail sharp changes in beliefs. Results in Table 1, where inflation is measured as the log first difference of the GDP deflator, suggest μ_4 is insignificantly different from zero, hence μ_2 represents a shift in mean during high permanent-shock variance and μ_3 represents a shift in mean during high transitory-shock variance. Infrequent permanent shocks are responsible for most of the persistence in the series, since Q_0 is much smaller than Q_1. Our measure of temporary uncertainty used below is the probability of a high variance state for the transitory shocks, and works like a dummy variable. Likewise for permanent uncertainty we have the probability of a high variance state for the permanent shocks.

[1] Kim and Nelson (1999) provide a detailed discussion on the implementation of this type of regime switching model.

Table 1
Estimation of the inflation model

Parameters	Coefficients	Standard error
Q_0	0.038	0.019**
Q_1	0.250	0.065**
h_0	0.114	0.018**
h_1	0.074	0.031**
μ_2	0.374	0.194*
μ_3	0.329	0.082**
μ_4	− 0.694	0.451
p_{00}	0.949	0.048**
p_{11}	0.976	0.018**
q_{00}	0.937	0.066**
q_{11}	0.942	0.055**
Log likelihood value = 5.054		

Notes: Sample period 1962Q4–1999Q4. Lag is one. ** and * indicates statistical significance at 5% and 10% level, respectively.

As shown in Fig. 1, inflation itself was high from the mid 1970s to the early 1980s, with intermediate levels in the late 1960s and late 1980s. Increases in the variance of permanent shocks occurred in the 1970s and early 1980s but permanent shocks have been quiescent since then. In Fig. 2 we see that a high variance of temporary shocks was in evidence in the 1960s, through the 1970s, and again in the late 1980s. The 1990s saw a low variance of both permanent and temporary shocks. These patterns may relate partly to the incidence of exogenous shocks, as for example Evans (1991) notes the correlation between increases in the persistence of inflation and the oil-shock period of the 1970s. It can be argued that there is also a relation between these measures and central bank policy, in that uncertainty may be expected to relate inversely to the counter-inflation credibility of the central bank, which builds up gradually as inflation is consistently subdued. When there is low credibility a one-off exogenous shock to prices would tend to set off further inflation volatility and persistence as price and

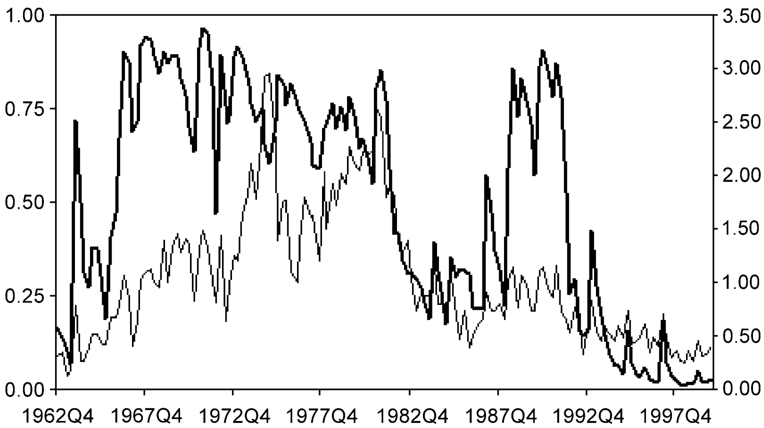

Fig. 1. Inflation rate (—) and probability of a high-variance state for the transitory shocks (—).

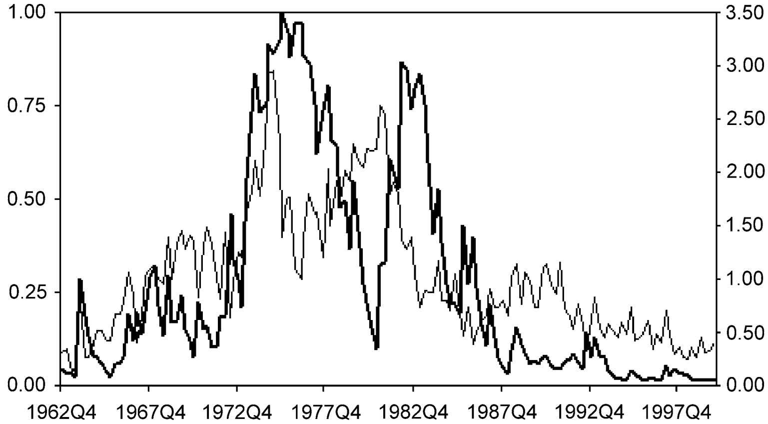

Fig. 2. Inflation rate (—) and probability of a high-variance state for the permanent shocks (—).

wage setters respond, which would not occur if credibility is high. The resurgence of a high variance of temporary shocks in the late 1980s suggests that it was only in the 1990s that credibility was firmly achieved.

3. Investment behaviour

We use the ARDL approach advocated by Pesaran and Shin (1999), which is robust to the possibility that some of the variables are I(1) and others are I(0), to consider the relationship between investment, output and uncertainty proxies. A dynamic relationship for investment of this kind is also estimated by Darby et al. (1999). We also adopt the bounds test of Pesaran et al. (2001) as this does not require us to pre-test the variables for unit roots, to reject a spurious relationship between our variables. Data are quarterly and seasonally adjusted from 1964Q1 to 1999Q4. Real GDP (*YB*), non-residential fixed investment (*IB*), as well as the real GDP deflator (used as an inflation measure) are from the Bureau of Economic Analysis NIPA Tables. Consequently our model is as follows where lower case indicates logs and Δ is the first difference operator.

$$\Delta ib_t = \alpha_i(ib_{t-1} - \beta_0 - \beta_1 yb_t - \beta_2 \mathrm{PERM}_t - \beta_3 \mathrm{TEMP}_t) - \sum_{j=1}^{p} \delta_j \Delta ib_t - \sum_{j=1}^{q} \varphi_j \Delta yb_t - \sum_{j=1}^{r} \gamma_j \Delta \mathrm{PERM}_t - \sum_{j=1}^{s} \theta_j \Delta \mathrm{TEMP}_t \tag{3}$$

Given inflation uncertainty is latent and proxied by a generated regressor, we utilise the fitted values of an AR(1) process for inflation uncertainty in our investment function. Estimated investment functions are contained in Table 2 and we can be satisfied our model is well specified: our residuals are congruent *niid*; plots of the cumulative sum of recursive residuals and of cumulative sum squares of the recursive residuals, suggest that our ARDL specification is stable and hence

Table 2
Permanent and temporary inflation uncertainty and US investment

	Coefficients	Coefficients	Coefficients
yb_t	1.038 (0.026)**	1.039 (0.030)**	1.034 (0.026)**
$PERM_t$	– 0.236 (0.096)**	– 0.237 (0.098)**	– 0.183 (0.093)*
$TEMP_t$	– 0.309 (0.093)**	– 0.310 (0.097)**	– 0.288 (0.092)**
π_t	0.017 (0.010)*	0.016 (0.012)	0.022 (0.010)**
i_t		– 0.001 (0.011)	
Tobin Q_t			0.145 (0.088)
Δyb_t	1.242 (0.146)**	1.242 (0.147)**	1.225 (0.145)**
Δyb_{t-1}	0.663 (0.144)**	0.663 (0.145)**	0.664 (0.143)**
Δyb_{t-2}	0.562 (0.144)**	0.562 (0.145)**	0.579 (0.143)**
Δyb_{t-3}	0.641 (0.147)**	0.641 (0.147)**	0.641 (0.146)**
$\Delta PERM_t$	– 0.018 (0.005)**	– 0.018 (0.006)**	– 0.014 (0.006)**
$\Delta TEMP_t$	– 0.023 (0.006)**	– 0.023 (0.006)**	– 0.021 (0.006)**
$\Delta\pi_t$	0.001 (0.001)	0.001 (0.001)	0.002 (0.001)**
Δi_t		– 0.001 (0.001)	
ΔTobin Q_t			0.011 (0.006)*
Error correction	– 0.076 (0.018)**	– 0.075 (0.021)**	– 0.075 (0.018)**
$\hat{\sigma}$	0.014	0.014	0.014
$\bar{R}^2$	0.58	0.57	0.58
$\chi^2_{SC}(4)$	0.629 [0.960]	0.631 [0.960]	1.231 [0.873]
$\chi^2_N(2)$	2.804 [0.246]	2.820 [0.244]	3.358 [0.187]
$\chi^2_H(1)$	0.009 [0.923]	0.012 [0.914]	0.121 [0.727]
ARDL	(1, 4, 0, 0, 0)	(1, 4, 0, 0, 0, 0)	(1, 4, 0, 0, 0, 0)
Bounds Test	10.641^{α}	8.802^{α}	9.562^{α}
F-statistic	{2.86, 4.01}	{2.62, 3.79}	{2.62, 3.79}

Notes: The regression is based on Eq. (3) using an ARDL specification chosen by Schwarz's Bayesian Information Criteria with a maximum lag length of four. Dependent variable is business investment. Variables in lower case are in natural logarithms. $\chi^2_{SC}(4)$, $\chi^2_N(2)$ and $\chi^2_H(1)$ denote χ^2 statistics to test for no residual serial correlation, normal errors and homoscedasticity, respectively, with p-values given in [.]. $\hat{\sigma}$ is the standard error of the regression. Sample period 1964Q1–1999Q4. Asymptotic standard errors are given in parenthesis. ** and * indicates significant at 5% and 10% level, respectively. Bounds Test F-statistic examines whether there is a relationship between the levels of the variables, irrespective of whether the regressors are purely I(0), purely I(1) or mutually cointegrated, see Pesaran et al. (2001). Critical values in {.}. Superscript $^{\alpha}$ indicates rejections of null of no evidence of levels relationship.

linear,[2] and the Pesaran et al. (2001) bounds test F-statistic suggests that there is a non-spurious relationship between investment and its determinants. We incorporate the level of inflation in each regression to distinguish any potential impact from the first and second moments of inflation on investment.

Both the permanent and temporary component of inflation uncertainty in Table 2 have a significant negative effect on investment in both levels and first differences. The temporary component appears to present stronger evidence with the coefficient being larger and significant at the 1% level. Inflation itself is significant at the 10% level. Additionally the real interest rate, based on the yield on 10 year Federal Reserve Treasury Bills, has a negative and insignificant estimated coefficient. Tobin's Q may be

[2] Available upon request.

important when examining investment and uncertainty since all market information, including the volatility of inflation, may be contained within *Q* (Leahy and Whited, 1996). *Q* is measured by the sum of corporate equities and liabilities, from the Federal Reserve Flow of Funds Accounts, divided by the replacement cost of the capital stock, from the NIPA Tables. *Q* is not statistically significant, although it has the correct sign and statistically the equation remains satisfactory. In this instance permanent uncertainty becomes insignificant at the 5% level whilst the temporary component of inflation uncertainty continues to be more important, suggesting omission of *Q* cannot account for the significance of the latter.

4. Conclusion

There is considerable debate into the nature and impact of uncertainty on business investment. Given recent interest in short- and long-run volatility, we decompose US inflation uncertainty into temporary and permanent components using the Markov switching approach of Kim (1993), which allows for shifts in both the mean and variance of inflation. We find evidence that both permanent and temporary components of inflation uncertainty are important, although the evidence points to the greater importance of the latter, consistent with Chadha and Sarno (2002). This suggests that while a credible counter inflation policy generally is warranted, monetary policy should be most concerned with avoiding protracted periods of temporary uncertainty. Furthermore, it concurs with the growing uncertainty literature that implies that investment functions based on traditional levels variables are subject to omitted variable bias.

Acknowledgements

The authors would like to thank an anonymous referee, Ray Barrell, Darryl Holden, and Ronnie MacDonald for helpful comments. This work was largely completed while both authors were at NIESR under ESRC project L138250122, Fluctuations and Long-Term Prosperity: A study of UK and international economies.

References

Ball, L., Cecchetti, S., 1990. Inflation and uncertainty at short and long horizons. Brookings Papers on Economic Activity I, 215–254.

Byrne, J.P., Davis, E.P., 2001. Panel estimation of the impact of exchange rate uncertainty on investment in the major industrial countries. National Institute Discussion Paper #208.

Chadha, J.S., Sarno, L., 2002. Short- and long-run price level uncertainty under different monetary policy regimes: an international comparison. Oxford Bulletin of Economics and Statistics 64, 183–212.

Darby, J., Hughes Hallett, A., Ireland, J., Piscatelli, L., 1999. The impact of exchange rate uncertainty on the level of investment. Economic Journal 109, C55–C67.

Dixit, A., Pindyck, R.S., 1994. Investment under Uncertainty. Princeton University Press, Princeton.

Evans, M., 1991. Discovering the link between inflation rates and inflation uncertainty. Journal of Money Credit and Banking 23 (2), 169–184.

Hartman, R., 1972. The effect of price and cost uncertainty on investment. Journal of Economic Theory 5, 258–266.

Kim, C.-J., 1993. Unobserved-component time series models with Markov-switching heteroscedasticity: changes in regime and the link between inflation rates and inflation uncertainty. Journal of Business Economics and Statistics 11, 341–350.

Kim, C.-J., Nelson, C.R., 1999. State-space Models with Regime Switching. MIT Press, Cambridge, MA.

Leahy, J., Whited, T., 1996. The effects of uncertainty on investment: some stylised facts. Journal of Money Credit and Banking 28, 64–83.

Moore, B., Schaller, L., 2002. Persistent and transitory shocks, learning and investment dynamics. Journal of Money Credit and Banking 34 (3), 650–677.

Pesaran, M.H., Shin, Y., 1999. An autoregressive distributed lag modelling approach to cointegration analysis. In: Strom, S. (Ed.), Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium. Cambridge University Press, Cambridge.

Pesaran, M.H., Shin, Y., Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics 16, 289–326.