New Evidence on Causal Relationships between the Money Supply, Prices and Wages in the UK

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Abstract
The paper re-examines empirically the causal relationship between money stock, prices and wages in the United Kingdom. Using a vector error-correction modelling technique with suitable diagnostics, such as Akaike's FPE statistics and 'F' tests for under-fitting the causal model, the results indicate a feedback relationship between money and prices, prices and wages, and wages and money stock. The results are supportive of the expectations-augmented Phillips-curve view of inflation and the monetary accommodation hypothesis.

1. Introduction

Identification of the nature and direction of a causal relationship between money, prices and wages has been the subject of long-standing debate among researchers and policy-makers. At the heart of the discussion has been the debate between the Post-Keynesian economists and Monetarists regarding the relative importance of monetary versus non-monetary forces in the determination of prices and wages. In a traditional Keynesian model product prices are set as a mark-up over the cost of inputs, such as labour cost. The price mark-up view asserts that the wage-setting behaviour exerts an independent influence on the movement of prices. The original wage-type Phillips-curve model, on the other hand argues that past inflation and the past output gap help to predict the future movement of wages. The expectations-augmented Phillips-curve model, which combines these two views hypothesises that prices are set as a mark-up over productivity-adjusted labour cost while the latter is determined by expected inflation and the degree of demand pressure (Mehra, 1991, p. 931). According to this view, prices and wages are mutually interactive with one another and there is feedback between them.

Despite the varying theoretical propositions, the Post-Keynesian economists, however unequivocally argue that money stock is endogenously determined and thereby rising money income, prices, and wages are accommodated by increases in the money supply. The monetarists' model of inflation, in contrast assigns substantial importance to exogenous monetary forces in the determination of prices. Although short-run variations in the general price level can be attributed to the cost of inputs, such as labour cost, the growth of money supply eventually determines the actual movements of price levels. The monetarists contend that wage and price controls have no lasting effects on prices (Saunders, 1994, p. 46). This issue has profound implications for the conduct of economic policy. The existence of a unidirectional causality from money stock to prices, coupled with a causal independence between prices and wages tends to strengthen the monetarists' proposition that inflation is primarily a monetary phenomenon. Empirical support for the monetarists' view would suggest that policy-makers should emphasise an explicit monetary targeting approach in the conduct of monetary policy. On the other hand, empirical support for Post-Keynesian views of inflation would suggest that policy-makers should emphasise an assortment of economic policies, such as proper price, wage, interest rate and exchange rate policies.

Several empirical studies have investigated the relationship between money stock, prices and wages. Using the U S data, for example Mehra (1977), and Ashenfelter and Card (1982) found a bi-directional relationship between prices and wages which tends to support the expectations-augmented Phillips curve hypothesis of a wage-price spiral. In a recent paper Mehra (1991) found evidence of a common stochastic trend between prices and wages with Granger-causality running from inflation to wage growth. Mehra (1991) interpreted this result to be supportive of the original wage-type Phillips curve model. Gordon (1988), and Darrat (1994), in contrast found that these two variables, i.e., prices and wages are causally independent which tends to strengthen the monetarists' thesis.

In a recent article in this journal, Saunders (1994) investigated the causal relationship between money stock, prices and wages using the quarterly data of the United Kingdom over the period 1970:1-1990:1. The empirical results of Saunder's study suggested that a unidirectional causality runs from the money stock to prices, and a bi-directional causality flows between money and wages, and wages and prices. Saunders (1994, p. 45) interpreted these results to mean that: '...the exogeneity of the money supply is uncovered. The results of this investigation indicate that it is money supply which is causally responsible for changes in both prices and wages. Consequently, this paper provides no empirical support for the existence of cost-push factors, such as wage increases, in the price level determination in the U. K. Additional data analysis indicates that wages are more affected by monetary growth in the short-run, while the impact of monetary growth on prices is more a long-run nature.'

The purpose of this paper is to re-examine empirically the causal relationship between money supply, price and wage in an attempt to uncover whether the money-price, price-wage, and money-wage relationship in the United Kingdom lends support to the Post-Keynesian or the Monetarist model of inflation. The study is significantly different from Saunders (1994) temporally, methodologically and theoretically. Firstly, in selecting variables such as money, prices and wages, the study adopts the analytical framework of Saunders, but extends the analysis by incorporating most recent data covering a longer timespan. Secondly, using recent development of cointegration and error correction modelling techniques this paper seeks to capture the short-run and long-run relationship, and causal linkage between these theoretically inferred macro-aggregates. More specifically, this paper utilises the concepts of unit root, cointegration and lag length properly in the context of a vector autoregressive (VAR) model with suitable diagnostics to test for Granger-causality between money, prices and wages. The VAR model is fitted in differenced and vector error-correction forms and sequential causality tests are performed to unveil the direction of Granger-causality. Thirdly, in contrast to the contention of Saunders (1994), this paper finds a feedback relationship between money and prices, prices and wages, and money and wages. The feedback relationship between prices and wages suggest a wage-price spiral process which appears to support the expectations-augmented Phillips curve view of inflation. The feedback relationships between money and prices, and money and wages lend support to the 'monetary accommodation' hypothesis and therefore raises question regarding the exogeneity issue of money supply.

The paper is organised as follows. Section 2 discusses the test methodology; section 3 presents the empirical results and the final section offers a summary and concluding remarks.

2. Methodology

A. Cointegration test

The cointegration and vector error-correction modelling techniques are now well known and widely used in applied econometrics. For detailed methodological exposition, readers are referred to Engle and Granger (1991), Hargreaves (1994) or any standard Econometrics textbook.

The cointegration technique pioneered by Granger (1986), and Engle and Granger (1987) allows long-run components of variables to obey long-run equilibrium relationships with the short-run components having a flexible dynamic specification. This technique seeks to explore whether a set of interrelated variables share a common trend such that the stochastic trend in one variable is related to the stochastic trend in some other variable(s). Granger (1988) has shown that the existence of cointegration also implies the presence of Granger causality between cointegrated variables, at least in one direction. Although the evidence of cointegration indicates the presence of Granger-causality, it does not indicate the direction of causality between variables. The direction of causality can be detected through the vector error correction (VEC) model.

B. Vector ECMs and Granger causality

The idea of error correction implies that a proportion of disequilibrium from one period in a cointegrated system is corrected in the next period. The Granger representation theorem states that once a set of variables are found to be cointegrated, there should exist a corresponding error correction model which relates the change in a dependent variable to past equilibrium error as well as past changes in other explanatory variable(s) (see, Engle and Granger 1987). More specifically, let $z(t) = [m(t), p(t), w(t)]$ represent the discrete time series on money stock, price and wage generated by a linear and covariance stationary trivariate vector autoregressive process of order k; we posit the following testing relationships which constitute the vector error-correction model (VECM):

$$\begin{bmatrix}\Delta m_t\\ \Delta p_t\\ \Delta w_t\end{bmatrix}=\begin{bmatrix}d^k_{11}(L) & d^k_{12}(L) & d^k_{13}(L)\\ d^k_{21}(L) & d^k_{22}(L) & d^k_{23}(L)\\ d^k_{31}(L) & d^k_{32}(L) & d^k_{33}(L)\end{bmatrix}\begin{bmatrix}\Delta m_t\\ \Delta p_t\\ \Delta w_t\end{bmatrix}+\begin{bmatrix}\delta\xi_{mt-1}\\ \delta\xi_{pt-1}\\ \delta\xi_{wt-1}\end{bmatrix}+\begin{bmatrix}v_{1t}\\ v_{2t}\\ v_{3t}\end{bmatrix} \quad (1)$$

where Δ is the difference operator that induces stationarity; the lag polynomial d^k_{ij} represents the k lag coefficients on variable j in equation i; $\delta\xi_{it-1}$ refers to the lagged error-correction term in equation i derived from the long-run cointegration relationship; v_{it} is the serially-uncorrelated random error term in equation i with zero mean. In model (1), the null hypothesis of non-causality from money stock to prices is rejected if either the group of coefficients on the money stock variable, m, in the price equation, $d^k_{21}(L)$ is statistically significant or the coefficient of lagged error-correction term, δ is negative and statistically significant.[2] The statistical significances of $d^*_{21}(L)$ and δ are exposed through joint *F*- and *t*-tests, respectively.

Given the various theoretical considerations and empirical evidence outlined in the preceding section, several possible hypotheses suggest themselves with regard to the relationship between money, prices and wages. First, the expectations-augmented Phillips-curve view hypothesises a feedback relationship between prices and wages. Second, the traditional Keynesian price mark-up view holds that wage growth causes price rises. Third, the original wage-type Phillips curve model contends that inflation causes wage growth. Fourth, the monetarists' model postulates a causal independence between prices and wages. With regard to the relationship between money stock and prices, two possible causal structures summarise both the Post-Keynesian and monetarist views. First, the monetarists hypothesise that money stock unidirectionally causes prices without any feedback. The monetary accommodation hypothesis argues that money stock is endogenously determined by income, prices and wages and therefore there is a bi-directional relationship between money and prices, and money and wages.

3. Empirical results

In this section, Saunders' analysis is re-performed using the same variables and aforementioned technique. The analysis of causality between money stock, prices and wages is carried out using quarterly data spanning the period 1969:II-1997:IV. The empirical counterparts to the model variables are as follows: monetary aggregates are the M0 measure of the Bank of England. M0 measures the very narrow money stock which is mostly (99 percent) composed of currency holding of the public and banks, plus operational balances at the Bank of England. In order to maintain consistency and enable comparison with Saunders results, the M0 measure of money stock has been used. The price level is proxied by the GDP deflator; wage is represented by the economy-wide wages and salaries per unit of output. All data series are compiled from the 1998 issue of the *Economic Trends Annual Supplement* published by the Office for National Statistics.

The data have been checked for stationarity using the Augmented Dickey Fuller (ADF) unit root test. All variables are expressed in logs. The number of augmentation terms in the ADF regression was determined by examining the significance of the final lag, up to six, and the serial correlation of residuals. The results of the ADF test in table 1 indicate that each of the three variables are non-stationary at the level but stationary in first difference form.

In the next step, the data series have been further checked using the Johansen and Juselius (1990) maximum likelihood procedure to test for cointegration. The main advantage of the Johansen and Juselius method is that it indicates the presence of the number of cointegrating vectors and provides more reliable estimates of the long-run parameters.[3] The Johansen vector autoregressive (VAR) model is specified with an intercept and deterministic trend as there appears to be a linear trend in all the nonstationary series. Moreover, the joint significance of a deterministic trend in each of the equations of the VAR model is tested by a likelihood ratio test. The calculated $\chi^2_{(3)}$ statistic is found to be 31.85 being significant at 1 per cent level, indicating that the hypothesis that the coefficients on the deterministic trends are jointly equal to zero is decisively rejected. Akaike's information criterion (AIC) is used to determine the

Table 1: Unit root and cointegration tests

A. Stationarity test[a]	L		Δ	
Variable	t_μ	t_τ	t_μ	t_τ
m	-1.97 (2.88)	-2.13 (3.45)	-4.18 (2.88)	-4.64 (3.45)
p	-0.448 (2.88)	-0.689 (3.45)	-2.72[b] (2.88)	-3.74 (3.45)
w	-2.41 (2.88)	-0.969 (3.45)	-3.19 (2.88)	-3.93 (3.45)

[a] t_μ and t_τ are the t-statistics based on augmented Dickey-Fuller(ADF) regression with allowance for a constant and trend, respectively. Figures in parentheses are 5% critical values (MacKinnon, 1991). L and Δ signify the level and first difference of a variable respectively. [b] significant at 10% level.

Table 2: Johansen tests for cointegrating relationships between money, prices and wages

		Test statistics		95% critical value	
H_0:	H_1:	Max Eigenvalue	Trace	Max Eigenvalue	Trace
$r = 0$	$r > 0$	33.96*	46.70*	25.42	42.34
$r \leq 1$	$r = 2$	8.58	12.74	19.22	25.77
$r \leq 3$	$r = 3$	4.16	4.16	12.39	12.39

Estimated cointegrating vector (normalised on p); p, m, w, *trend*:- [1.00, 0.614, 0.707, -0.0047] Chi-square test: $\chi^2_{m(1)}$=23.58, $\chi^2_{w(1)}$=25.04.

Notes: r indicates the number of cointegrating relationships. * indicates rejection at the 95% critical values. The chi-square statistics $\chi^2_{m(1)}$, $\chi^2_{w(1)}$ test the restriction that money and wage variables in the cointegrating vector individually are statistically significant.

optimal lag length of the Johansen VAR system. The optimal lag length is the one which yields highest AIC:

$$AIC = L_n(\theta) - p$$

where $L_n(\theta)$ is the maximised value of the log-likelihood function of the model; p is the number of freely estimated parameters. Use of the AIC criterion suggests a lag length of 6. Moreover, as Hargreaves (1994) has suggested that Johansen's maximum likelihood procedure provides relatively robust results with an overparameterised model, the lag optimal length of the VAR model was chosen to be six.

Results of Johansen's eigenvalue and trace tests are presented in table 2, and indicate that there exists at least one cointegrating relationship in the trivariate VAR system since the calculated test statistics exceed the 95 per cent critical values which hypothesised the existence of a zero cointegrating vector. The results tend to suggest that there exists at least one stationary relationship between money stock, prices and wages.[4]

Table 3: The optimum lag of the variables and the FPEs of model 2

Controlled variable	First manipulated variable	Second manipulated variable	FPE
M0 (k=12)			.00006498
M0 (k=12)	*W (k=7)*		.000059337*
M0 (k=12)	*W (k=7)*	*P (k=1)*	.000057824**
P (k=4)			.000108798
P (k=4)	*W (k=2)*		.000095042*
P (K=4)	*W (k=2)*	*M0 (k=1)*	.000094474**
W (k=2)			.000195801
W (k=2)	*P (k=6)*		.000181033*
W (k=2)	*P (k=6)*	*M0 (k=10)*	.000165036**

The figures in parentheses adjacent to variables are the optimal lag length. * and ** imply the reduction of FPE corresponding to preceding FPE.

Given that there are (n-r) common trends within the system, we can conclude that there exist two common trends within the vector. The estimated cointegrating vector is reported beneath the tests for cointegration after normalising on variable *p*. We have tested the zero loading restrictions on the coefficients of the vector with the aid of likelihood ratio tests. The likelihood ratio tests indicate that money stock and wage variables enter significantly in the cointegrating vector normalised on prices.

The finding of cointegration among these macroeconomic variables has several implications. First, consistent with the economic theory this finding indicates that money, wages and prices have a long-run equilibrium relationship which may be exploited by the monetary authorities in the formulation of monetary policy. Second, the evidence of cointegration also rules out the possibility of spurious correlations and Granger noncausality between money, price and wage variables.

Following the Granger representation theorem, the above unit root and cointegration test results also imply that the dynamic modelling of money, price and wage variables has a valid error-correction representation with a cointegrating constraint embedded in them. The vector error-correction model estimates provide important information about the short-run relationship among wages, prices and the money supply in the UK. The optimal error-correction model is specified using a hybrid of Granger-Akaike synthesis (see, Hisao 1981) and Engle-Granger's (1987) vector error correction (VEC) modelling strategy. We specify variables and lag lengths in each equation in the VEC model through a stepwise regression procedure combining Akaike's (1969) final prediction error and Granger's (1969) notion of incremental predictability augmented with the error correction term implied by our cointegrating restrictions.[5] The detailed estimation procedure is not discussed here but interested readers are referred to Engle and Granger (1987), and Hisao (1981). Table 3 reports minimum FPE at various univariate, bivariate and trivariate autoregressions.

Careful examination of various FPEs and specific gravity criteria (see, Caines *et al* 1981) leads to the following tentative specification of the VEC model:

$$\begin{bmatrix}\Delta\log m_t\\ \Delta\log p_t\\ \Delta\log w_t\end{bmatrix}=\begin{bmatrix}d_{11}^{12}(L) & d_{12}^{1}(L) & d_{13}^{7}(L)\\ d_{21}^{1}(L) & d_{22}^{4}(L) & d_{23}^{2}(L)\\ d_{31}^{10}(L) & d_{32}^{6}(L) & d_{33}^{2}(L)\end{bmatrix}\begin{bmatrix}\Delta\log m_t\\ \Delta\log p_t\\ \Delta\log w_t\end{bmatrix} \quad (2)$$

$$+\begin{bmatrix}\delta\xi_{mt-1}\\ \delta\xi_{pt-1}\\ \delta\xi_{wt-1}\end{bmatrix}+\begin{bmatrix}b_1\\ b_2\\ b_3\end{bmatrix}+\begin{bmatrix}v_{1t}\\ v_{2t}\\ v_{3t}\end{bmatrix}$$

where the v's are the disturbance terms, the error-correction term ξ's are the residuals obtained from the cointegrating regressions; b_i's are constants.

The equations are estimated using ordinary least squares. The results of estimations of the trivariate VEC model are reported in table 4.[6] The coefficients of the error-correction terms both in money and price equations have the correct sign and are statistically significant. The small size of the coefficients indicate that the speed of adjustment is rather slow for the equations to return to their equilibrium level once they have been shocked. The causality implications and adequacy of specification are checked by carrying out a sequence of F-tests (see table 5). The lagged error correction term as well as the F-values relating to price and wage variables are statistically significant in the money equation. The lagged error-correction term as well as the wage and money stock variables are significant in the price equation. Although the lagged error correction term is statistically insignificant, the F-values relating to money stock and price variables are significant in the wage equation. These results indicate a feedback relationship between money and prices, prices and wages, and wages and money stock. The finding of a bi-directional relationship between money and prices is in contrast with Saunders (1994) which suggests that M0 unidirectionally causes significant changes in prices. The evidence of a bi-directional relationship between prices and wages accords well with Ashenfelter and Card (1982), Mehra (1977), and Saunders (1994), but is in contrast with Darrat (1994). Finally, the evidence of a bi-directional relationship between money stock and wages is consistent with the finding of Saunders (1994).

We can now analyse the economic implications embodied in the Granger-causal inferences of system (2). First, the existence of a feedback relationship between prices and wages appears to support the expectations-augmented Phillips curve view which hypothesises that the two variables are jointly determined through a price-wage spiral process. Second, the results of bi-directional relationships between M0 and prices, and M0 and wages provide evidence of monetary accommodation with respect to prices and output changes in the United Kingdom (see, Gordon 1977, Willet and Laney 1978) and therefore raises question regarding the exogeneity property of the money stock. The issue of endogeneity of the money stock in the UK is well documented in the literature (see, Arestis 1992, Barnhart and Wallace 1994, Mixon *et al* 1980, Williams *et al* 1976). In elaborating the view of endogenous money, Arestis (1992) contends that money comes into existence in three ways in the financial system. Firstly, money arises because of a lag between production and sale of output. The purchase of inputs has to be financed prior to the sale of output. In a monetary production economy, credit is generated in order to bridge this gap. Secondly, money is introduced into the system via fiscal and

Table 4: Parameter estimates of the trivariate VEC model

Coefficient on lag of	Dependent variable Δm	Δp	Δw
ξ_{t-1}	.049(-4.402)	-0.0064(-2.195)	-0.047(-1.293)
Δm_{t-1}	.158(1.568)	.128(1.577)	.193(1.121)
Δm_{t-2}	.055(.548)		.041(.246)
Δm_{t-3}	.253(2.673)		-0.120(-0.758)
Δm_{t-4}	.108(-1.108)		.199(1.464)
Δm_{t-5}	.159(1.659)		-0.051(-0.377)
Δm_{t-6}	.024(.303)		.069(.523)
Δm_{t-7}	-0.340(4.197)		.399(3.145)
Δm_{t-8}	-0:021(-0.266)		-0.347(-2.566)
Δm_{t-9}	.033(.390)		.208(1.476)
Δm_{t-10}	-0.013(-0.165)		.159(1.140)
Δm_{t-11}	.103(1.125)		
Δm_{t-12}	-0.029(-0.386)		
Δp_{t-1}	.172(1.971)	.074(.690)	.292(1.914)
Δp_{t-2}		.035(.334)	-0.141(-0.931)
Δp_{t-3}		.172(1.806)	.131(.934)
Δp_{t-4}		-0.007(-0.080)	.195(-1.455)
Δp_{t-4}			.149(1.120)
Δp_{t-4}			-0.389(-3.119)
Δw_{t-1}	-0.070(-1.152)	.281(3.887)	.343(3.112)
Δw_{t-2}	-0.119(-1.867)	.145(1.875)	.169(1.393)
Δw_{t-3}	-0.005(-0.084)		
Δw_{t-4}	.025(.418)		
Δw_{t-5}	-0.051(-0.869)		
Δw_{t-6}	-0.057(-1.029)		
Δw_{t-7}	-0.164(2.999)		
R^2	.596	.636	.607
DW	1.99	1.99	1.99
SE	.0068	.0092	.0119
F	8.10	25.54	9.40

Figures in parentheses next to coefficients are the *t*-ratios; DW, SE and F are the Durbin-Watson statistic, standard error of the regression and the regression F-statistic, respectively.

Table 5: Temporal causality results based on vector error-correction model

Dependent variable	*F*-statistics (marginal significance level)			*t*-statistics
	ΔM0	ΔP	ΔW	ξ_{t-1}
ΔM0	-	3.887(.052103)	3.526(.00237)	-4.402*(.000032)
ΔP	2.487(.117787)	-	9.32(.000187)	-2.195(.030324)
ΔW	2.643(.007483)	3.528(.003656)	-	-1.293(.199486)

Figures in parentheses are the marginal significance level of *t* and *F*-statistics

Table 6: *F*-statistics using model (3) as the maintained hypothesis

Hypotheses	*F*-statistics	Degrees of freedom	Causality results
A. Imposing zero restrictions on the non-zero elements			
1. $d_{12}{}^{1}(L) = 0$	4.146(.04504067)	(1, 80)	$P \Rightarrow$ M0
2. $d_{13}{}^{7}(L) = 0$	2.824(.01106517)	(7, 80)	$W \Rightarrow$ M0
3. $d_{21}{}^{1}(L) = 0$	3.025(.08492805)	(1, 104)	M0 $\Rightarrow P$
4. $d_{23}{}^{2}(L) = 0$	9.651(.00014296)	(2, 104)	$W \Rightarrow P$
5. $d_{31}{}^{10}(L) = 0$	3.093(.00213638)	(10, 84)	M0 $\Rightarrow W$
6. $d_{32}{}^{6}(L) = 0$	5.076(.00017308)	(6, 84)	$P \Rightarrow W$

Figures in parentheses are the marginal significance level *F*-statistics

open-market operations initiated by the monetary authorities. Thirdly, the overseas financial flows are responsible for the creation or destruction of money in an open economy. Under this scenario, money is an output of the financial system with its endogenous behaviour governed by the borrowing needs of firms, households and the government and the portfolio behaviour of the financial institutions and of the personal sector. The monetary authorities accommodate rising prices, wages and output by increasing the money supply. This phenomenon gains momentum when the monetary authorities aim to regulate the structure of interest rates.

To further check on the robustness of the results and compare with the specification of Saunders (1994), we have also examined the relationship between money stock, prices and wages in a differenced VAR:

$$\begin{bmatrix} \Delta \log m_t \\ \Delta \log p_t \\ \Delta \log w_t \end{bmatrix} = \begin{bmatrix} d_{11}^{12}(L) & d_{12}^{1}(L) & d_{13}^{7}(L) \\ d_{21}^{1}(L) & d_{22}^{4}(L) & d_{23}^{2}(L) \\ d_{31}^{10}(L) & d_{32}^{6}(L) & d_{33}^{2}(L) \end{bmatrix} \begin{bmatrix} \Delta \log m_t \\ \Delta \log p_t \\ \Delta \log w_t \end{bmatrix} + \begin{bmatrix} t_1 \\ t_2 \\ t_3 \end{bmatrix} + \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \quad (3)$$

where the ε's are the disturbance terms; b_i's are constants; t_i is a time trend in the i-th equation.

Table 6 reports the results of the asymptotic '*F*' tests applied on the differenced VAR model.[7] In Table 6, test (1) through (6) impose zero restrictions on the non-zero lag polynomials. The *F*-tests results suggest that the specified system is adequate as all the zero restrictions are rejected at the conventional significance level. We can now analyse the Granger-causal inferences embodied in system (3). In system (3), feedback occurs between money and prices (see, tests 1 and 3). Tests (4) and (6) indicate a feedback relationship between prices and wages. Tests (2) and (5) again indicate a bi-directional relationship between money stock and wages. Overall, the existence of a bi-directional causality between prices and wages, money stock and prices, as well as between money stock and wages are robust across alternative specifications.

4. Summary: conclusions and policy implications

This paper has re-examined the relationship between money stock, prices and wages to test the expectations-augmented Phillips-curve view vis-à-vis the monetarist theory of inflation in the UK using cointegration and vector error-correction modelling techniques. The Johansen's cointegration tests indicate that long-run movements of money stock, prices and wages are correlated over time. The results derived from the VEC and differenced VAR models indicate that a bi-directional relationship exists between prices and wages, money stock and prices, and money stock and wages. The feedback relationship between prices and wages appears to support the expectations-augmented Phillips-curve view of inflation while the feedback relationship between money stock and prices tends to support the monetary accommodation hypothesis. Overall, the results broadly conform with the Post-Keynesian views of inflation and monetary accommodation.

The results have important implications for the conduct of monetary policy. First, with the adherence to monetarism during the late 1970s and early 1980s, monetary targeting became an explicit element of monetary policy in the UK and several measures of monetary aggregates have been targeted as intermediate and informational variables over time. However, as Bernanke and Mishkin (1997) contend, using an intermediate target approach such as money growth is feasible in an optimal framework only if the intermediate target contains all information relevant to forecasting the goal variable. If any variable other than the intermediate target contains marginal information about the future values of the goal variable, then targeting the goal variable, such as inflation forecast, should strictly dominate a monetary targeting strategy. Furthermore, if a reverse causality flows from goal variable to intermediate target variable, no improvement is available by using an intermediate target framework. As, Barnhart and Darrat (1992) have noted, it would be hard to predict or control the intermediate target variable because it becomes unclear whether movements in the intermediate target emanate from policy actions, from changes in the ultimate goal variable, or perhaps from both. Second, in recent years, financial market innovation and deregulation were held to be largely responsible for the breakdown in the statistical relationships between various monetary aggregates on the one hand and the ultimate goal variables such as stable prices, output and interest rates on the other (see, Goodhart 1989). Arestis (1992) has contended that financial innovations have affected the endogeneity of the money supply as banks are now able to accommodate changes in the demand for loans with less frequent use of central bank panel facilities for reserves. Financial innovations coupled with endogenous money have made it increasingly difficult for the monetary authorities to monitor developments in financial markets. These pieces of evidences, taken together, therefore suggest a reduced effectiveness of monetary targeting strategy as a stabilisation tool. Given the limited information content and the forecasting value of any particular indicators, such as monetary aggregates, monetary authorities and policy-makers should focus on an assortment of mutually interactive economic variables such as money, prices and wages in the formulation of monetary policy.

Endnotes

1. Sheffield Hallam University.

2. Despite the usual misgivings associated with the notion and tests of Granger causality (see, for example Conway, *et al* 1984), this approach in recent years has found wide ranging applications in hypothesis testing, hypothesis searching and the investigation of causal relationships. Moreover, our study is limited to the concept of temporal precedence, information and predictive content of interrelated variables as embodied in these tests.

3. Gonzalo 1994, Hargreaves 1994, Cheung and Lai 1993, Luintel and Pudyal 1998 provide good discussions on the desirable properties of Johansen's estimators.

4. In order to examine the sensitivity of the results to the choice of lag length, we have also experimented with alternative lag lengths of 1 through 5. Interestingly, Johansen's trace and eigenvalue tests indicate overwhelming evidence of cointegration under alternative lag specifications. The results are available from the author upon request.

5. The maximum lag length was set at 12. Econometrically, the choice of maximum lag is designed to avoid a possible bias due to the exclusion of important lags, as well as the fragility of inefficient parameter estimates induced by an over-specified lag order. For a discussion on the consequences of under-specification and over-specification of lag length, see Hisao (1981). Theoretically, the choice of 12 quarters lag would allow for the complete realization of impacts due to a given monetary disturbance. For example, see Fromm and Klein (1973).

6. Sims (1980) has urged great caution when interpreting the autoregressive parameter estimates because of the reduced form nature of the model and they are the coefficients of the filtered data.

7. Hisao (1981), and Lutkepohl and Reimers (1992) have noted that the standard Wald, likelihood ratio and *F*-tests for causality are all asymptotically valid as (χ2 for model (3).

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