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The Dynamics of Currency Substitution: Evidence from UK Foreign Currency Balances

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Abstract

This study evaluates the magnitude of the permanent and the transitory components of currency substitution in the UK. The results indicate that the permanent component, the ratchet effect, accounted only for a small share while the aggregate temporary component, speculation, whose impact lasts about one month, was responsible for most of the dynamics of UK currency substitution. The findings thus lend support to the view that at worst currency substitution would only cause short-run problems for the UK economy.

Key words: currency substitution; speculation; decomposition

JEL classification: E42; F36; F41

1. Introduction

The dynamics of currency substitution are not fully understood. This study examines the dynamics of currency substitution in the UK economy by disentangling the permanent and transitory components of shocks on currency substitution. Our approach differs from those of earlier studies on currency substitution in the UK economy, such as Deutsche Bundesbank (1995) and Seitz and Reimers (1999). Our study is also different from those which have examined the role of sterling in currency substitution outside the UK economy; see Mizen and Pentecost (1994) and Milner et al. (1996).

Mizen and Pentecost (1996) argue that currency substitution is only a short-run disequilibrium process. When financial portfolios have been re-adjusted, the ratio of foreign currency balances to domestic currency balances is constant and there is no currency substitution. Such a definition confines currency substitution to short-run portfolio adjustment only. However, in principle the determination, level, and dynamics of foreign currency balances with respect to domestic money stem from two types of factors: long-run and short-run. Some factors, such as transaction demand or the ratchet effect, have a rather long-run impact while other factors, such

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as speculation, have only a short-run impact. Short-run speculation in currency balances is generated through expectations of changes in exchange rates. A portfolio shift from the devaluing currency into the appreciating currency makes cash balances an interest-yielding asset. However, occasionally short-run speculation may have permanent impacts due to the ratchet effect, which proposes that an increase in the opportunity cost of holding domestic money will cause an increase in the demand for foreign currency, while a decrease in the opportunity cost will not decrease foreign currency balances to the same extent. This kind of ratchet effect has been reported in several studies; see Kamin and Ericsson (1993) and Melnick (1990) for Argentina, Clemenz and Schwarz (1992) for Bolivia, Mogardini and Mueller (1999) for Kyrgyz Republic, and Piterman (1988) for Israel, Argentina, Chile, Uruguay, Brazil, Japan, and the UK.

In effect, the upper threshold level of foreign currency balances will have permanently increased. This kind of irreversibility in currency holdings emerges from the fixed costs in switching from using the local to using foreign currency; see Guidotti and Rodriquez (1992). The vehicle currency phenomenon could strengthen the persistence of this phenomenon; see Krugman (1980) and Black (1991). Furthermore, the network externalities stemming from wide use of the vehicle currency are also expected to generate some persistence; see Dowd and Greenway (1993).

The previous econometric foundations and interpretations of the long-run nature of currency substitution are mainly based on two approaches: first, on the estimation of cointegrating vectors using either the Engle-Granger (1987) approach, as in Bana and Handa (1990), or the Johansen and Juselius (1990) VAR approach, as in McNown and Wallace (1992), Mizen and Pentecost (1994), Milner et al. (1996), and Ratti and Jeong (1996) to cite just a few; and second, on the evaluation of the impact of the particular ratchet variable, π_{MAX}; as in Piterman (1988), Melnick (1990), Kamin and Ericsson (1993), and Mongardini and Mueller (1999).

The relative magnitudes of short- and long-run shocks play an important role in the costs of currency substitution. Short-run expectations of devaluation generate portfolio shifts from the devaluing domestic currency into the appreciating foreign currency. This renders the money demand equation an unstable apparatus for monetary policy and impairs monetary autonomy. If the majority of shocks are long-lasting, currency substitution may turn to dollarization or, in Europe, euroization. Dollarization is regarded as a situation in which a foreign currency is used in all its three functions along with the domestic currency (i.e., as a unit of account, a store of value, and a means of payment); see Calvo (1996). This definition owes itself to the use of the dollar in some Latin American countries to fulfil all the domestic roles of money. Consequently, in Europe a natural counterpart to dollarization would be euroization. Euroization is perhaps better characterised as a phenomenon with permanent rather than short-run impacts only. A permanent and high degree of currency substitution is particularly harmful for seigniorage and public finance.

We identify the permanent and transitory shocks on foreign currency balances in the UK economy using Blanchard-Quah (1989) decomposition. We assume that

there are two types of aggregate shocks which have an impact on foreign currency balances and on the opportunity cost of holding money. One of these shocks, which we call the speculative shock (a temporary shock), affects both the opportunity cost variable and foreign currency balances. The other, which we call the ratchet effect (a permanent shock) may have a permanent effect on foreign currency balances.

The remainder of this study is structured as follows. Section 2 discusses the demand for foreign currency balances. Section 3 presents the Blanchard-Quah decomposition, Section 4 gives the results, and Section 5 concludes.

2. Permanent and Transitory Components of Currency Substitution

Currency substitution studies have mainly focused on the short-run impacts of currency substitution; for a survey on currency substitution see Giovannini and Turtelboom (1995) and Mizen and Pentecost (1996). Traditionally, estimations of the impacts of short-run speculation have utilized the money service approach of Miles (1978), which follows Chetty's (1969) model on the liquidity services provided by money; see for instance Miles and Steward (1980) and Rojas-Suarez (1992). The approach has been dynamized into the intertemporal context by İmrohoroğlu (1994) and Buffman and Leiderman (1993, 1994). However, the money service approach exaggerates short-term speculation as it includes money balances in the agent's utility function and entirely omits the transaction demand for the foreign currency in question. This has been criticized, for example by Bordo-Choudri (1982) and Marquez (1987), who, however, exempt from criticism the approach where income is included.

Portfolio balance models, like that of Branson and Henderson (1985), have also to some extent overcome this criticism even though they have mainly focused on examining short-run speculation. Portfolio balance models include income as an empirical counterpart of wealth, which also potentially captures the long-run dynamics of currency substitution. The empirical application of portfolio balance models, in general, leads to the estimation of a standard Goldfeld-type money demand equation augmented with currency substitution and capital flows; see Cuddington (1983), Fasano-Filho (1986), McNown and Wallace (1992), Mizen and Pentecost (1994), and Chowdhry (1995) to cite just a few.

If there were no speculation on changes in the exchange rate, foreign currency balances would only be demanded for transaction purposes in international trade. Ratti and Jeong (1994), deVries (1988), and Milner et al. (1996) all include a foreign trade variable to capture the impact of transaction demand on foreign currency balances. In addition, transaction costs can generate long-run persistence; see Bana and Handa (1990). These costs may be related to the ratchet effect on currency substitution. Accordingly, an increase in the opportunity cost of holding domestic money generates a permanent increase in the size of foreign currency balances. A decrease in the opportunity cost, in turn, will not decrease foreign currency balances by the same amount. The latter is explained by the costs from switching from the use of the local currency for transactions to the use of a foreign currency; see Guidotti

and Rodriquez (1992) and Sturzenegger (1992). Another explanation is offered by the hysteresis stemming from the greater use of foreign currency balances; see Uribe (1997). In sum, there is evidence for the existence of both permanent and short-run components in the dynamics of currency substitution.

Let us now assume that the dynamics for the relative currency balances (i.e., currency substitution), fcd/m, consist of two components: a permanent component (i.e., the ratchet effect, z) and a transitory component (i.e., speculation, p):

$$\left(fcd/m\right)_t = f_1\left(p_t, z_t\right) + e_{t1}. \tag{1}$$

The ratchet effect (z) has a long memory comprising all the permanent effects of changes in the opportunity cost of holding domestic money, transaction demand, and transaction costs. The permanent component need not be a random walk. The speculative component, (p), has a short-run impact only. Thus, the dynamics of currency substitution comprises two components: one permanent and the other transitory.

Examination of the importance of these disturbances will test several hypotheses related to currency substitution. First, the speculative role of currency substitution gets explored as we examine the importance of temporary shocks on foreign currency balances. Second, the permanent component will reveal the long-run nature of currency substitution. The ratchet effect on currency balances is thus explored in a new fashion. Third, the relative importance of these shocks will identify the type of costs incurred in currency substitution: a large and permanent component will have consequences both for the autonomy of monetary policy and seigniorage revenue. A relatively large temporary component, in turn, gives us reason to expect that problems related to currency substitution will mainly be due to the short-run reallocation of currency balances which induces instability in the money demand equation and could impair monetary autonomy. We now examine the importance of these factors.

We make the simplifying assumption that there are two kinds of disturbances that affect the opportunity costs of holding domestic money (m) and foreign currency balances (fcd). We posit the interest rate differential ($idif$) as a measure for the opportunity cost of holding domestic money with respect to a foreign currency balance. (To gauge the robustness of the results, we also applied tests using UK inflation as the opportunity cost variable; however, the results remained largely unchanged.) The interest rate differential measures expectations of exchange rate change; see equation (2). Hence it captures the potential yield from holding foreign currency balances and the expected losses from domestic currency holdings due to changes in the exchange rate:

$$E_t(e_t - e_{t+1}) = i_t^h - i_t^f, \tag{2}$$

$$idif = i_t^h - i_t^f = f_2(p_t, z_t) + e_{t2}. \tag{3}$$

The interest rate differential in equation (3) is also subject to two types of disturbances, permanent (*z*) and transitory (*p*), with restrictions stemming from the Blanchard-Quah (1989) decomposition. The decomposition stipulates that the first disturbance has no long-run effect either on the opportunity cost of holding domestic money ($idif = (i^h - i^f)$) or on relative currency balances, i.e., currency substitution (fcd/m). The second disturbance has no long-run effect on *idif* but may have a long-run effect on fcd/m . The disturbances are uncorrelated for all leads and lags. It is also required that the vector of *idif* and fcd/m , denoted *X*, follows a stationary process and has a Wold decomposition.

The model can be presented as a moving average representation of a vector of variables *X* and an equal number of shocks:

$$X_t = \sum_{i=0}^{\infty} L^i A_i \varepsilon_t \,, \tag{4}$$

where matrix A_i represents the impulse response of shocks to the elements of X_t. In (5), the subscripts (*fcd/m*)*t* and (*idif*)*t* refer to the independent ratchet effect and speculative shocks and a_{11i} represents the element a_{11} in matrix A_i :

$$\begin{bmatrix} fcd/m \\ idif \end{bmatrix} = \sum_{i=0}^{\infty} L^j \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \varepsilon_{(fcd/m)t} \\ \varepsilon_{(idif)t} \end{bmatrix}. \tag{5}$$

The identification of the Blanchard-Quah decomposition requires that the temporary shock has no long-run effect on the relative currency balances. In the long run, if the relative currency balances are to be unaffected by the speculative shock, it follows that the cumulative effect of the temporary shock on the *cur/m* sequence must be zero. The model then implies restriction (6). The model is estimated by VAR techniques: each element of the vector X_t is regressed on the lagged values of all the estimates of *X*:

$$\sum_{i=0}^{\infty} a_{11i} = 0 \,, \tag{6}$$

$$\begin{aligned} X_t &= B_1 X_{t-1} + B_2 X_{t-2} + \ldots B_n X_{t-n} + e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots, \end{aligned} \tag{7}$$

where *B* represents the estimated coefficients and e_t denotes the comprised residuals from the VAR. The residuals are transformed into ratchet and speculative shocks. We assume that the underlying temporary and speculative shocks are linear combinations of the residuals from each of the two equations in the VAR. Thus,

$$e_t = C\varepsilon_t \,. \tag{8}$$

In the two-by-two case considered, four restrictions are required to define the elements in matrix *C*. Two of these are due to normalization, which defines the

variances of the speculative and ratchet shocks as unity. The third comes from the assumption that ratchet and speculative shocks are orthogonal. This implies that speculative shocks cannot have a contemporaneous effect on the aggregate ratchet effect or vice versa. The fourth restriction, which allows matrix *C* to be uniquely defined, guarantees that the speculative shocks have only contemporaneous effects on foreign currency balances. This implies equation (6) and, in terms of VAR:

$$\sum_{i=0}^{\infty}\begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix}\begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}=\begin{bmatrix} 0 & . \\ . & . \end{bmatrix}. \tag{9}$$

These restrictions allow matrix *C* to be uniquely defined and the speculative and ratchet shocks to be identified.

In effect, the Blanchard-Quah (1989) decomposition exists if (fcd/m) is not causally prior in (*idif*, (fcd/m)). The existence of the Blanchard-Quah (1989) decomposition can then be tested by applying the test for Granger causality and testing H_0: $c_{12} \neq 0$ and $c_{21} = 0$ in (10):

$$\begin{bmatrix} fcd/m \\ idif \end{bmatrix}=\begin{bmatrix} c_{11}(L) & c_{12}(L) \\ c_{21}(L) & c_{22}(L) \end{bmatrix}\begin{bmatrix} \eta_{(fcd/m)t} \\ \eta_{(idif)t} \end{bmatrix}. \tag{10}$$

If H_0 is true, then the spectral density of the temporary component is zero at frequency zero (i.e., $S_{X0}(w) = 0$ at $w = 0$). This also implies that for fcd/m the sum of MA components is zero. Then *X*(*idif*, (fcd/m)) has a Wold moving average representation which is unique. Accordingly, foreign currency balances should not have an effect on the interest rate differential.

3. Results

The data considered consisted of monthly observations from March 1987 to June 1998. It may be noted that the period after the launch of the euro has been left outside of the analysis. We do not regard this as major problem, since the data from the euro period would have been relatively short anyway.

The interest rate differential *idif* is the difference between the UK and German 3-month interest rates. The time series for interest rates were taken from the *OECD Main Economic Indicators.* Foreign currency deposits *fcd* were private sector holdings of foreign currency deposits in the UK banking system included in the Harmonized Monetary Aggregate MH3. M4 is broad money supply. The Data for *fcd* and M4 were taken from *the Bank of England, Statistical Abstract*. The monetary data was seasonally adjusted. We started the analysis by examining the unit root properties of the data, interest rate differential, *idif*, and the log of relative foreign currency balances $fcd/m4$.

Table 1. Tests for Unit Roots

Series	ADF; l; *t*	AR(1-7)
$fcd/m4$	−1.61; 0; -	$F(7,115) = 0.7818$ [0.9777]
$\Delta(\ fcd/m4\ )$	−12.1; 0; - [***]	$F(7,114) = 0.6918$ [0.6788]
idif	−1.46; 1; -	$F(7,113) = 0.8588$ [0.5414]
$\Delta idif$	−8.11; 0; - [***]	$F(7,114) = 0.8434$ [0.5538]

Notes: ADF refers to Augmented Dickey Fuller test, AR refers to test for residual autocorrelation, $fcd/m4$ is the log of relative currency balances. *t* refers to time trend in the ADF regression, l to the number of lags in the ADF test, [**] to statistical significance at the 0.05 level, and [***] to statistical significance at the 0.001 level. Critical values for the ADF test are from McKinnon (1991): −2.8824 for 0.05 and −3.4785 for 0.01.

Table 1 reports the results of the tests for unit roots. The numbers of lagged differences in the Augmented Dickey-Fuller (ADF) tests were determined along the lines suggested by Campbell and Perron (1991) and Ng and Perron (1995). An upper boundary for the number of lagged differences was initially set to take into account any possible MA components in the time series; see Said and Dickey (1984). The upper boundary for truncation lags is based on Schwert (1989) and equals $12(T/100)^{0.25}$. In our sample $T = 138$, which is approximately 13 lags in the ADF test. We then reduced the number of lags until the last truncation lag turned out to be significant at the 0.05 level. If none of the lags were significant, we ended up with the standard Dickey-Fuller test. Finally, in order to correctly infer the unit roots, tests for residual autocorrelation were made on every occasion. When the residual autocorrelation were found, the number of lags was increased until a non-autocorrelated residual was achieved.

According to the ADF tests, relative foreign currency balances and the interest rate differential were I(1) processes. Subsequently, the analysis was performed for first differences. Another important pre-test concerns the decomposition itself. The Blanchard-Quah decomposition requires that relative currency balances are not causally prior in $X(\Delta fcd/m4\ ,\ \Delta idif)$. Tests for Granger causality with four lags in autoregressive distributed lag suggested the existence of decomposition. The test for $\Delta(\ fcd/m4)$ not causally prior to $\Delta idif$ yielded $F(4,124) = 0.305291$ [0.8740].

The two-variable VAR was estimated including a constant as an exogenous variable and one lag of each of the endogenous variables $\Delta(m4/\ fcd)$ and $\Delta idif$. The lag structure was defined on the basis of the AIC, HQ, and the SIC/BIS information criteria and residual diagnostics. The residuals from the VAR were not strictly Gaussian; see Table 2. No additional dummies were included, however. Given these non-Gaussian residuals, our results should be interpreted with care.

Table 2. Residual Diagnostics *X*((Δ*fcd/M4), Δidif*)

Series	Normality	LB(5)	ARCH(5)
$\Delta(fcd/m4)$	6445.7885	1.2967	0.2352
	[0.0000]	[0.8619]	[0.9987]
$\Delta idif$	19.0373	4.0142	16.6373
	[0.0001]	[0.4041]	[0.0052]

Notes: Normality refers to the Jarque-Bera normality test, LB(5) to the Ljung-Box test for residual autocorrelation for 1-5 lags, and ARCH(5) for the Lagrange multiplier test for residual ARCH for 1-5 lags. Figures in parentheses indicate statistical significance. The Portmanteau test for joint residual autocorrelation has $\chi^2(12)$ 9.7332 [0.6394].

Figure 1. Impacts of the Temporary (DFCDM4) Component in a System *X*(Δ*fcdm4, didif*)

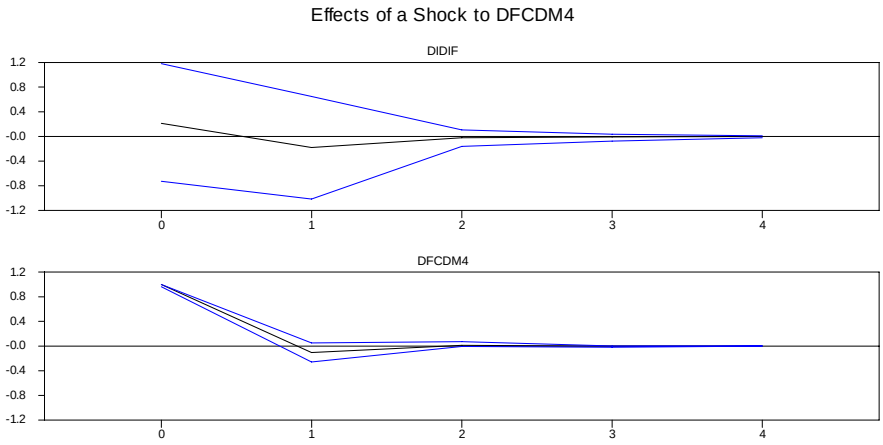


Figure 2. Impacts of the Permanent (DIDIF) Component in a System X(Δ*fcdm4, didif*)

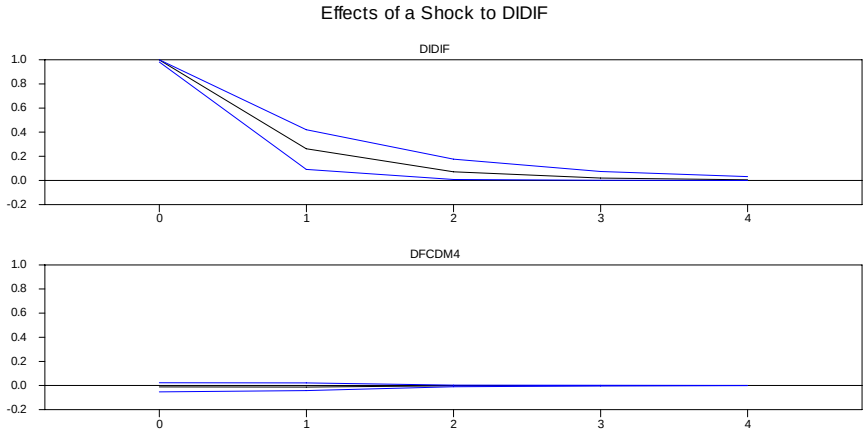


Figure 3. Accumulated Impact of the Temporary (DFCDM4) Component in a System X(Δ*fcdm4, didif*)

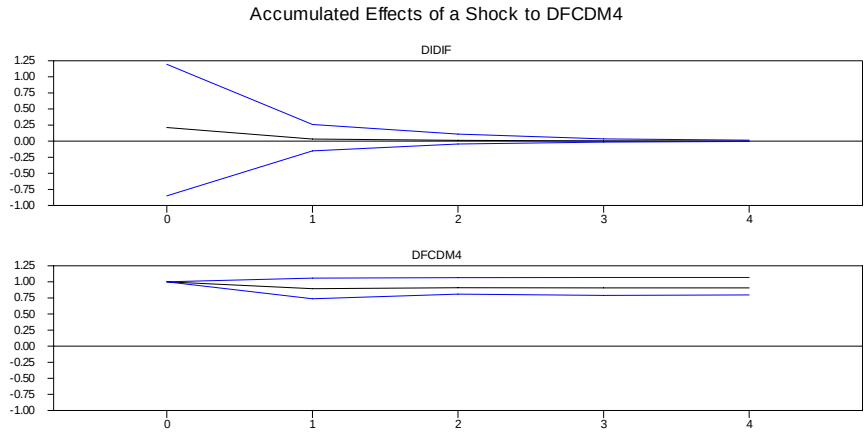
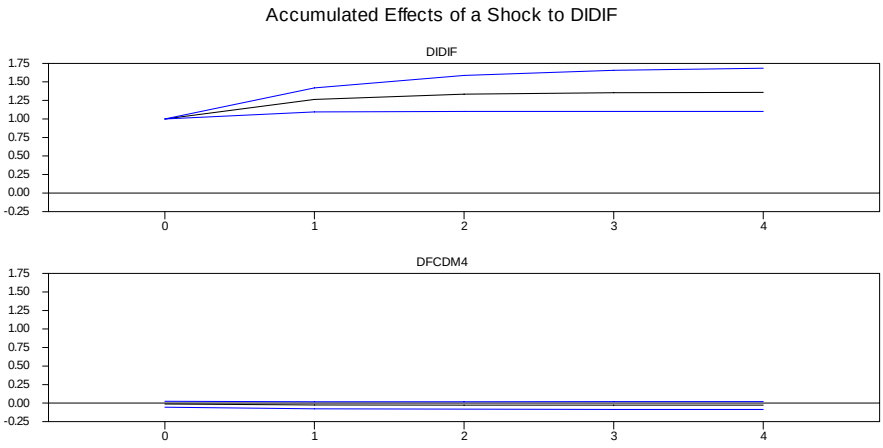


Figure 4. Accumulated Impact of the Permanent (DIDIF) Component in a System X(Δ*fcdm4, didif*)



The dynamic effects of the temporary component (speculation) and permanent component (ratchet effect) are reported in Figures 1 and 2. Figures 3 and 4 display the accumulated impacts of the temporary and permanent components on the interest rate differential and on currency substitution. The figures also present the one-standard deviation bands around the point estimates with 0.95 significance. Standard errors were calculated utilising 5000 bootstraps. Shocks are normalised so that a structural shock equals one. The figures display the effect of a shock in one variable on the other variables. DFCM4 refers to the impact of the temporary component and the DIDIF refers to the impacts of the permanent component.

In principle, the impact of speculation in the UK on foreign currency balances is very short-term. It lasts for only about one month; see Figure 1. The impact of speculation on the interest rate differential is very mild and only lasted about two months. In the beginning, the impact was positive, turning negative after two weeks post of the shock. After two months, post shock the impact was zero.

Figure 3 presents the accumulated impact of speculation. It suggests that speculative shocks had no permanent effect on either currency substitution or the interest rate differential, i.e., realignment expectations. Figure 4 shows the accumulated impact of the permanent component. This suggests that the effects of shocks on the interest rate differential are permanent and that a 1% shock on the interest rate differential would ultimately cause an increase of 1.25 per cent in forward premium between the UK and Germany.

The graphical evidence for the temporary and permanent components is tentative only. More formal statistical evidence can be given for computing the variance decompositions for relative foreign currency deposits ($\Delta fcd/m4$) and the interest rate differential ($\Delta idif$).

The forecast error variance decomposition determines the proportion of the k-month forecast error variance of the variable attributable to the shock. This forecast error is due to unanticipated ratchet and speculative shocks during the last k months. The length of the horizon k, $k = 1, \ldots 10$, gives the percentage of variance of the error in the k-month forecast.

Table 3. Variance Decomposition, $X(\Delta(fcd/m4), \Delta idif)$; Responses of Variances Due to Ratchet Effect

Horizon (months)	$\Delta(fcd/m4)$	$\Delta idif$	MSE
0	0.00146	0.99854	0.34908
1	0.00232	0.99768	0.36109
2	0.00233	0.99767	0.36195
3	0.00233	0.99767	0.36201
4	0.00233	0.99767	0.36201

Notes: Horizon refers to k-month forecasts. Figures are the proportions of variance of the k-month forecast error due to the ratchet effect. MSE refers to k-month forecast mean square error of $\Delta idif$.

The variance decompositions suggest that the relative contribution of the permanent component (ratchet effect) on foreign currency balances was only about 0.2% over a three-month horizon; see Table 3. In contrast, the contribution of speculative disturbances for currency substitution was high. Over 99% of the changes were attributed to short-term disturbances, whereas the disturbances attributed to the interest rate differential were mainly long run. The relative contribution of permanent disturbances, over a three-month horizon, was about 99%; see Table 4. This provides evidence of permanent realignment expectations between the UK and Germany. The temporary shocks accounted for less than 1% of the shocks to the interest rate differential. The MSE proposes that the forecast mean square error is much lower for the interest rate than for relative currency balances for all forecasting horizons.

Table 4. Variance Decomposition, $X((\Delta fcd/m4), \pi)$; Response of Variances Due to Speculation

Horizon (months)	Δ(*fcd/m4*)	Δ*idif*	MSE
0	0.99551	0.00449	0.06267
1	0.99094	0.00906	0.06316
2	0.99077	0.00923	0.06317
3	0.99076	0.00924	0.06317
4	0.99076	0.00924	0.06317

Notes: Horizon refers to *k*-months forecast. Numbers are the proportions of variance of the *k*-month forecast error due to the ratchet effect. MSE refers to refers to *k*–month forecast mean square error of Δ(*fcd/m4*).

Overall, our results suggest that in the UK, currency substitution cannot be regarded as a process attributable to a permanent component, such as the ratchet effect. The dynamics of currency substitution is generated almost wholly by short-run speculation. Our findings for the UK were to some extent in contrast with other findings on ratchet effects in currency substitution; see for instance Melnick (1990), Pitterman (1988), and Kamin and Ericsson (1993). This inconsistency might be due to country-specific differences or due to differences in estimation methods.

To conclude, our findings indicate that the permanent component had an unimportant effect on currency substitution in the UK economy. As far the implications for the euro are concerned, this suggests that on average the level of euroization is likely to remain low and is therefore unlikely to constitute a major problem for the UK economy. Foreign currency balances may change due to speculation, but such changes will only be temporary. This does not, however, rule out the possibility that short-run speculation may introduce some instability into the UK money demand equation and impair the autonomy of UK monetary policy.

4. Conclusions

This study decomposed the dynamics of currency substitution in the UK economy into permanent and transitory components. The permanent component was identified as the ratchet effect and the temporary component was attributed to speculation. The Blanchard-Quah (1989) decomposition involved two variables: relative foreign currency balances and the opportunity costs of holding currency, which was measured as the interest rate differential between the UK and Germany.

The ratchet effect appeared to play only a minor role in inducing movements in currency substitution. Short-term speculative shocks were responsible for most of the changes in currency substitution. The permanent component had an effect only on the interest rate differential.

With respect to the harmful impact of currency substitution on monetary autonomy, the following tentative conclusions can be drawn. First, currency substitution, i.e., euroization, as a long-run phenomenon will not present a major problem for the UK economy. Our evidence suggests that since currency

substitution will not be long-lasting, it would not have serious impacts on seigniorage in the UK economy. Second, given that the changes in foreign currency balances were mainly temporary, short-run shifts in money balances and the instability in the money demand equation cannot be ruled out. This potentially implies some difficulties for UK monetary autonomy.

Our analysis, which applied the Blanchard-Quah approach in a novel way, succeeded in revealing some of the unknown dynamics of currency substitution. However, some words of caution are in order. The Blanchard-Quah decomposition would be meaningless if more than two shocks of equal importance were to occur. In addition, we examined the dynamics of currency substitution in pre-EMU data. The launch of the euro notes and coins yet may have a significant impact on currency substitution in the UK. This remains a topic for further research.

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