A Comparison of Two Alternative Monetary Approaches to Exchange Rate Determination over the Long-Run

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ABSTRACT

The aim of this paper is to compare the conventional monetary model of the exchange rate with an alternative model, which incorporates a stock price measure and is based on Friedman's money demand function. These models are then compared using data from the UK, Canada and the USA, applying the Autoregressive Distributed Lag (ARDL) Bounds testing approach and the Phillips-Hansen approaches to cointegration. Although the results from the conventional monetary model are poor, the version which includes stock prices produces evidence of a long-run relationship, which has more appropriate long-run coefficients than the conventional model.

Key words: *Exchange Rate, Stock Price, ARDL, Cointegration*
JEL Classifications: F30, E44

1. INTRODUCTION

The aim of this paper is to investigate the monetary model of exchange rate determination over the long-run. We assess two versions of this model, the conventional model and a version that incorporates an equity effect (Morley, 2007), based on Friedman's (1988) money demand specification. The primary reason for the inclusion of equities into the model is to reflect the increased capital mobility between international stock markets, following the removal of capital controls in the late 1970s and early 1980s.

Over recent years there have been a number of occasions when movements in national stock markets have corresponded with changes in the respective exchange rates. This was particularly evident during the East Asian financial crisis, where a collapse in the countries exchange rates were preceded by falls in the respective stock markets (Granger et al., 2000). Increasingly foreign exchange movements are determined by international investors buying and selling equities on international capital markets, rather than the more traditional explanation based on consumer demand for foreign goods. This phenomenon has been facilitated by the increasing flows of capital between international financial markets[1] following the deregulation of financial markets during the 1970s and 1980s.

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[1] Since the lifting of capital controls in the 1970s, the increase in the flows of capital between stock markets has been dramatic, for instance the US Treasury indicates that UK agents bought $1962 million dollars of US stocks in 1977, by 2005 this had increased to $ 1100 billion of US stocks. Similarly the purchase of UK stocks by US agents increased from $650 million in 1977 to $876 billion in 2005. Similar increases occurred between Canada and the USA. In addition, Hau and Rey (2005) report that the proportion of gross cross-border transactions in equities and bonds rose from 4% of GDP in 1975 to 245% by 2000 for the USA.

Recent evidence suggests that the monetary model in its basic form may not be relevant across all countries. Rapach and Wohar (2002) suggest that the conventional model investigated over a long time period appears to hold for some countries but not others. Two of the currencies which fail to provide evidence of a long-run relationship are Canada and the UK, we suggest this may be due to a mis-specification of the model and the exclusion of the equity effect, to reflect the substantial capital flows between these countries stock markets.

A number of studies have indicated that the UK economy may not be particularly well explained by the standard economic models, which ignore differences in the nature of the UK asset markets and market traders relative to other prominent economies. For instance, French and Poterba (1991) seek to explain the greater level of investment in foreign equities by the UK in terms of behavioural finance, in particular the way in which the investors form expectations about return and risk. These differences would need to be incorporated into any asset market model of exchange rate determination by explicitly including equities into the model.

In addition to contrasting the results for the conventional monetary model with that of the equity based version, we also compare the long-run relationship using different cointegration[2] techniques. Although other studies such as Pesaran and Shin (1999) compare the effects of different cointegration techniques, this has not been done using the monetary model of the exchange rate before. Firstly, we use the Autoregressive Distributed Lag (ARDL) bounds testing approach, developed by Pesaran et al. (2001), which as noted allows us to test for a long-run relationship in a mix of $I(0)$ and $I(1)$ variables. We then compare these results with an alternative approach to modelling the long-run using cointegration; the Phillips-Hansen fully modified OLS estimators. The specific use of these two techniques is because of their direct comparability as noted by Pesaran and Shin (1999). Finally, we note any differences using these two techniques compared to the standard Johansen Maximum Likelihood (ML) procedure, which is also used as it has proven very popular in the literature over the last 15 years.

Recent results using a panel approach have produced largely positive results in terms of a long-run cointegrating relationship and the correct signs on the monetary model parameters. These studies include Groen (2000) and Mark and Sul (2001), although as Rapach and Wohar (2002) suggest, in the light of the results from their tests on individual countries, it might be interesting to test various sub-panels, to find out if the result of a cointegrating relationship with the monetary model holds across all the countries tested. However Groen (2002) has developed an alternative panel approach to cointegration, which allows for a substantial degree of cross-country heterogeneity and finds this improves the results. In this paper we suggest a potential source, in terms of differences in the equity markets for some of the observed cross-country heterogeneity. Other recent studies on individual countries produce contrasting results, which often depend on the techniques used and the assumptions underlying those techniques. For instance Cushman (2000) finds little evidence of a long-run cointegrating relationship for the Canadian dollar, although Francis et al. (2001) using the same exchange rate, finds a more positive result.

[2] An advantage of the ARDL bounds testing approach is that the critical values produced by Pesaran et al. (2001) allow for the inclusion of a mix of $I(0)$ and $I(1)$ variables in the cointegrating relationship. Although the Johansen ML approach can also be used with a mixture of $I(0)$ and $I(1)$ variables, Rahbek and Mosconi (1999) suggest that including $I(0)$ series in a VECM can produce nuisance parameters in the asymptotic distribution of the trace for the cointegration rank. See Wickens (1996) for further concerns over the Johansen ML procedure.

In addition to studies of the exchange rate using monetary based models, there have also been a variety of studies examining the relationship between stock prices and exchange rates over recent years, some of which have concentrated on a direct relationship between stock prices and exchange rates, whilst others have analysed the relationship within the context of a specific model. One of the first attempts to model and test the relationship between exchange rates and stock prices was Solnik (1987), where he suggested that stock prices reflect expectations about future economic activity and therefore affect exchange rates. He found that the nature of the relationship varied across countries as well as depending on whether capital controls existed. More recent contributions include Ehrmann et al. (2005) and Hau and Rey (2006), who have developed a model relating stock prices to exchange rates in an "uncovered equity parity" based model[3].

Studies using the Granger causality test have also been used extensively to test the direction of causality between these variables. Bahmani-Oskooee and Sohrabian (1992) show that there is bi-causality whilst other tests suggest that causality is predominantly from stock prices to the exchange rate (Granger et al., 2000), possibly due to the higher number of market participants[4]. A further category of research explores the relationship between stock prices and exchange rates in the context of a conventional exchange rate model. Smith (1992) develops a model based on the portfolio balance approach. In common with other studies, both approaches show that stock prices have a significant effect on the exchange rate. A final related area of research, which finds similar significant relationships, emphasises international equity flows and their effects on the respective capital markets. These studies comprise mainly empirical studies such as Bekaert and Harvey (2000), Richards (2005) and more theoretical studies, such as Griffin et al. (2004), although this study assumes foreign and domestic investors are divided by information asymmetry rather than the exchange rate. Richards (2005) using high frequency data shows that in emerging markets foreign investors have a significant effect on domestic equity markets, whilst Bekaert and Harvey (2000) concentrate on the effects of liberalisation of markets on equity flows into emerging markets, finding that liberalisation decreases the cost of capital.

The remainder of the paper is as follows. Section 2 outlines the theoretical case for including equities in the monetary model and discusses the econometric methodology used in the paper. Section 3 describes the data set and presents the time series results. Section 4 contains the conclusions and considers some implications for the integration of capital markets.

[3] In the conventional monetary model, it is assumed that expectations are either formed exogenously or determined by the other explanatory variables in the model, as discussed by Copeland (2005). Alternatively, we could have incorporated uncovered interest parity (UIP) into the model with rational expectations, in which case the monetary model would have omitted the interest rate differential in the long-run, given that the expected change in the exchange rate equals zero.

[4] An alternative interpretation to the causal relationship suggested by one of the referees stems from the East Asia crisis. If foreign investors suspect an impending collapse, they will move out of the stock market, causing the exchange rate collapse – as they move out of the currency, the exchange rate might collapse, which would then cause the stock market to collapse. It would be very difficult to disentangle causal chains here because of the hidden variable "expectations", and its unknown determinants. Note that one must separate domestic and foreign investors in the stock market, according to this theory.

2. THE MODEL AND METHODOLOGY

In the conventional monetary model the exchange rate adjusts to balance the international demand and supply of monetary assets. The demand for money is usually considered to be a function of the level of interest rates and income. However, there is an increasingly good case for including equity prices as separate determinants of the demand for money. In particular Friedman (1988) using a largely empirical approach and Boyle (1990) with a more theoretical approach, find significant evidence of stock prices affecting money demand. Caruso (2006), Hsing (2007), Dow and Ellendorf (1998) and Cassola and Morana (2004) provide empirical and theoretical evidence supporting the relationship between money demand and the level of the stock market using a variety of techniques including cointegration, Vector Autoregressive (VAR) models and impulse response functions. Cassola and Morana (2004) also find stock prices have an important role in the transmission mechanism, with particular reference to the European Union. Overall the results strongly support the inclusion of stock prices in the money demand function, regardless of disagreements over the approach used.

On the theoretical side, Friedman (1988) suggests four possible channels through which stock prices might directly affect money demand. Firstly, as stock market fluctuations tend to outweigh fluctuations in income, stock market movements are generally associated with changes in the wealth to income ratio and hence the money to income ratios. Secondly, a rise in stock prices reflects an increase in the expected return from risky assets relative to safe assets. The implied increase in portfolio risk can be offset by an adjustment away from other risky assets such as long term bonds toward safer assets including money. Thirdly, a rise in stock prices reflects an increased level of financial transactions and thus an increase in the demand for money. Friedman assumes that all channels affect the domestic money demand.

The above three ‘wealth’ or ‘income effects’ all suggest a positive relationship between the level of the stock market and money demand. However with the fourth effect, as the real stock prices increase, equities become more attractive to investors causing a ‘substitution effect’ from money to equities. The relationship between equity prices[5], the demand for money and exchange rate is therefore an empirical question. To capture these effects we incorporate a stock market index into the standard money demand function (assuming the income effect dominates, as shown to be the case in Friedman, 1988).

Based on the inclusion of stock prices in the money demand function the following model is estimated, in the conventional bilateral format (assuming the US represents foreign variables):

$$e_t = \lambda_0 + \lambda_1(m-m^*)_t + \lambda_2(y-y^*)_t + \lambda_3(s-s^*)_t + \lambda_4(i-i^*)_t + u_t \qquad (2.1)$$

Where e_t is the exchange rate, m_t is the money supply, y_t is real income, s_t is the real stock price and i_t is the nominal interest rate. A * indicates a foreign variable and $\lambda_1, > 0, \lambda_2 < 0, \lambda_3 \gtrless 0, \lambda_4 = 0$

According to Friedman (1988) the stock price index could be either positively or negatively signed in the money demand function and therefore the monetary model. An alternative interpretation of this relationship in the long-run is provided by Bahmani-Oskooee and Sohrabian (1992), who suggest an explanation for why the relationship between stock prices and the exchange rate could be negative. A rise in domestic equities facilitates an increase in

[5] As noted, we assume that causality runs from stock prices to the exchange rate, for a justification of this assumption and a discussion on the causality between these variables see Bahmani-Oskooee and Sohrabian (1992).

domestic wealth, which produces an increase in the demand for money and thus interest rates. Higher interest rates will attract foreign capital, which will produce an appreciation of the domestic currency. (Although beyond the scope of this study, a fuller analysis would incorporate some form of expectations). As noted in the introduction the literature has generally found a significant relationship between the exchange rate and stock prices.

The ARDL approach to cointegration (see Pesaran et al., 2001) involves estimating the conditional error correction version of the ARDL model for the exchange rate and difference between the domestic and foreign money supply, real output, real stock prices and interest rates:

$$\begin{aligned}\Delta e_t = \lambda_0 + \sum_{i=1}^{p}\lambda_1 \Delta e_{t-i} + \sum_{i=0}^{p}\lambda_2 \Delta dm_{t-i} + \sum_{i=0}^{p}\lambda_3 \Delta dy_{t-i} + \sum_{i=0}^{p}\lambda_4 \Delta ds_{t-i} \\ + \sum_{i=0}^{p}\lambda_5 \Delta di_{t-i} + \delta_1 e_{t-1} + \delta_2 dm_{t-1} + \delta_3 dy_{t-1} + \delta_4 ds_{t-1} + \delta_5 di_{t-1} + u_t\end{aligned} \quad (2.2)$$

Where *dm*, *dy*, *ds* and *di* are the differences between the domestic and foreign money supply, real income, real stock prices and interest rates respectively. We then ‘bounds test’ for the presence of a long-run relationship between exchange rates, stock prices, income, interest rates and the money supply using two separate statistics. The first involves an *F*-test on the joint null hypothesis that the coefficients on the level variables are jointly equal to zero (see Pesaran and Shin, 1999 and Pesaran et al., 2001). The second is a *t*-test on the lagged level dependent variable. The statistics have a non-standard distribution and depend on whether the variables are individually $I(0)$ or $I(1)$.

Instead of the conventional critical values, this test involves two asymptotic critical value bounds, depending on whether the variables are $I(0)$ or $I(1)$ or a mixture of both. If the test statistic exceeds their respective upper critical values, then there is evidence of a long-run relationship, if below we cannot reject the null hypothesis of no cointegration and if it lies between the bounds, inference is inconclusive. If the test statistic exceeds its upper bound, then we can reject the null of no cointegration regardless of the order of integration of the variables.

The conditional long-run model can then be produced from the reduced form solution of (2.2), when the first-differenced variables jointly equal zero. The long-run coefficients and error correction model are estimated by the ARDL approach to cointegration, where the conditional ECM is estimated using OLS and then the Schwarz-Bayesian criteria is used to select the optimal lag structure for the ARDL specification of the short-run dynamics.

The long-run estimates produced by the ARDL bounds testing approach are compared to those generated by two other techniques. The first is the Phillips-Hansen fully-modified OLS procedure, using a semi-parametric estimation procedure with Bartlett lags as proposed by Phillips and Hansen (1990). This technique is used as a direct comparison to the ARDL approach, following the original research on the ARDL technique by Pesaran and Shin (1999) who suggest the two approaches can be directly comparable (see Pesaran and Shin, 1999). The final set of long-run estimates which are noted, are produced by the standard Johansen Maximum Likelihood procedure (Johansen and Juselius, 1990). Although the three techniques involve different assumptions regarding how the long-run coefficients are generated, the results should provide evidence on whether any failure of the model is due to the methodology employed.

3. EMPIRICAL RESULTS

We initially estimate the conventional monetary model for the UK pound against the US dollar and UK pound against the Canadian dollar. The estimation is over the period 1984 quarter 1 (the previous 4 quarters used to create the lagged variables) to 2004 quarter 2. Quarterly data[6] extracted from *International Financial Statistics* and the country's national accounts[7] has been used. GDP is used for the income variable and the money supply is represented by M1 for the US and Canada, and M2 for the UK (as a result of changes in the early 1980s M2 in the UK now corresponds with M1 in the USA). The stock market is represented by the main market index and the treasury bill rate is used for the interest rates.

The start of the sample period was chosen because in the early 1980s the UK changed the definition of its monetary aggregates and in addition all three countries lifted their capital controls during the late 1970s and early 1980s, allowing capital to flow more freely between their stock markets. The UK currency is tested against the US dollar due to the size and international importance of its stock market and similarly with the Canadian stock market, although it is not of a comparable size to the US market. Therefore the relationship between the exchange rate and stock prices would not be expected to be as significant with the Canadian dollar.

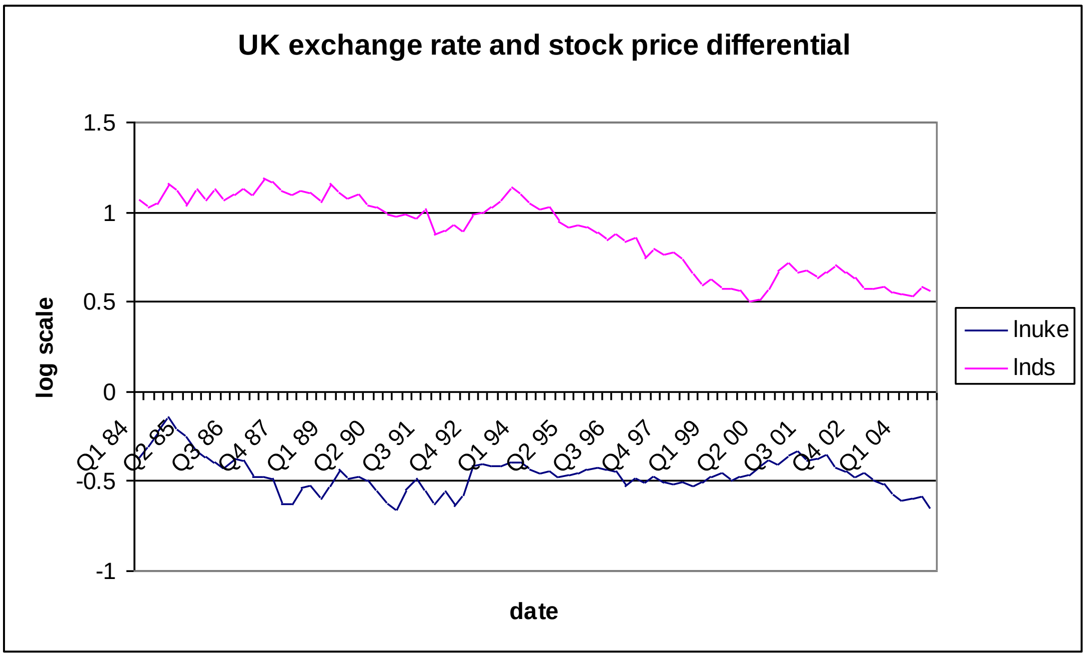
	ADF Test	
Variables	Test for $I(1)$	Test for $I(2)$
uke	2.296	-8.268
dusm	-0.091	-5.290
dusy	-3.404	
duss	-0.386	-10.428
dusi	-1.955	-8.269
uce	-2.410	-7.897
ducm	-1.155	-7.874
ducy	-2.176	-3.697
ducs	-2.939	

Table 3.1 The Augmented Dickey-Fuller (ADF) test for a unit root.
Notes: *uke* is the exchange rate, *dusm*, *dusy*, *duss* and *dusi* are the differential between UK and US Money supply, real income, real stock prices and interest rates respectively; *uce*, *ducm*, *ducy*, *ducs*, *duci* are the UK/Canadian exchange rate and differential between UK and Canadian M1, real income, real stock prices and interest rates respectively. For each variable the first column of statistics tests the null hypothesis that the series is $I(1)$ against the alternative that it is $I(0)$. The second column tests the null that the series is $I(2)$ against the alternative that it is $I(1)$. The critical values for both these tests at the 5% levels of significance is -2.89.

[6] In other studies monthly data has been used, however, this required the use of industrial production as a proxy for income, which in general is not as good as GDP, for which only quarterly data was available. Other measures of stock prices have also been linked with money demand (Friedman, 1956), however when incorporated into the model they did not perform as well as the main market indexes.
[7] The UK and the USA were used as both countries have financial systems based around financial markets, rather than the banking sector as in Germany or France. Stock market indexes are as follows: US; Standard and poor Composite index; UK; FTSE All Share Index, Canada: Toronto composite index. The following data was taken from the IFS: GDP- line 99b, treasury bill rate – line 60c and prices – line 64, money supply data was taken from the national accounts.

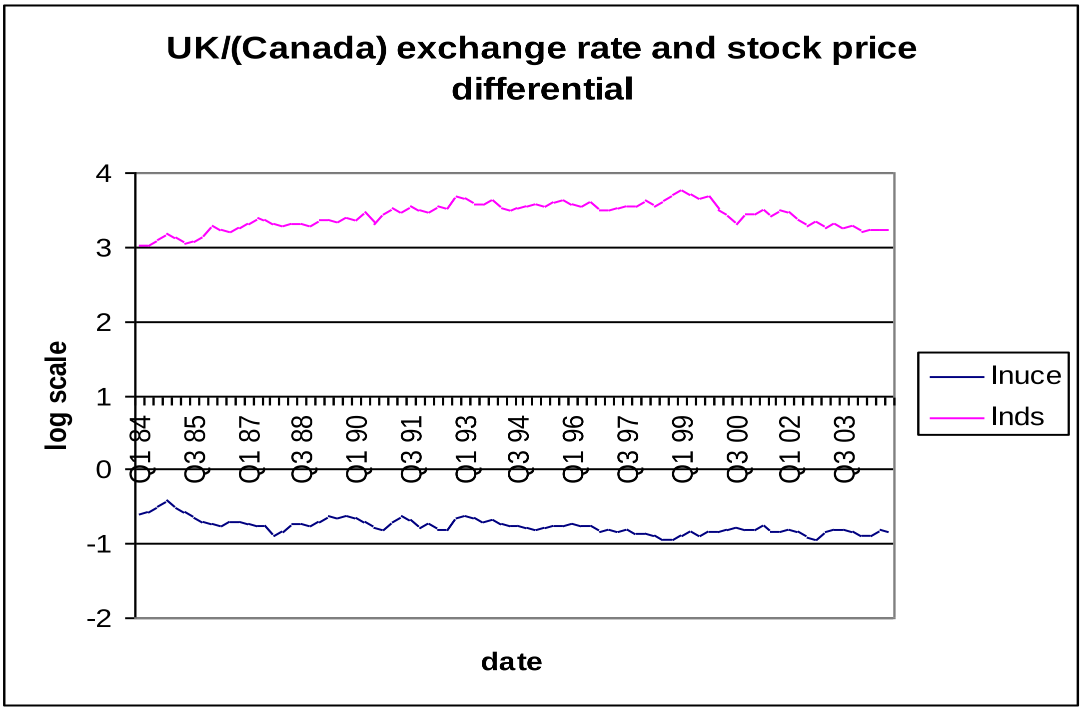
All the variables were first tested for stationarity using the Augmented Dickey-Fuller (ADF). The results in Table 3.1, Figures 3.1 and 3.2 with respect to the exchange rate and stock prices show that the majority of variables are *I*(1), although the UK/US output differential is *I*(0) and the UK/Canada interest rate and stock price differential are borderline *I*(0), as is suggested in Figure 3.2. The ambiguities in the order of integration of the variables lend support to the use of the ARDL bounds approach rather than one of the alternative cointegration tests.

Figure 3.1 Plot of UK/US Exchange Rate and UK/US Stock Price Differential



Notes: *lnuke* is the log of the UK/US exchange rate; *lnds* is the log of the UK/US stock price differential.

Figure 3.2 Plot of UK/Canada Exchange Rate and UK/Canada Stock Price Differential



Notes: *lnuce* is the log of the UK/Canada exchange rate; *lnds* is the log of the UK/Canada stock price differential.

In the cointegration tests[8] the Schwarz-Bayesian criteria was used to determine the appropriate lag length, in addition to checking the various diagnostic tests, in particular ensuring there was neither first or higher order serial correlation. As noted by Pesaran et al. (2001), it is particularly important to ensure there is no serial correlation, for the bounds tests to be valid. This process suggested a lag length of 1 would be optimal and produce a serially-uncorrelated error term for both the conventional monetary model and the version including equities.

Exchange Rate	**Equity Monetary Model**		**Monetary Model**	
	F-test	*t*-test	*F*-test	*t*-test
UK/US	4.162*	-4.404*	3.285	-3.478**
UK/Canada	4.588*	-4.138*	4.179**	-3.530**

Table 3.2 Autoregressive Distributed Lag test for cointegration of the Monetary and Monetary model with Equities.
Notes: The critical values for the upper bounds of cointegration tests using the *F*-test are: For the conventional monetary model 4.35 (5%) and 3.77 (10%), for the equity based model are 4.01 (5%) and 3.52 (10%). The *t*-statistic upper bounds critical value are: For the conventional model –3.78 (5%) and –3.46 (10%), for the equity based model they are -3.99 (5%) and -3.66 (10%). A * indicates significance at the 5% level of significance, a ** significance at the 10% level.

The results for the ARDL cointegration tests on all the models are contained in Table 3.2. Both the tests on the conventional monetary model indicate only marginal evidence of a valid long-run relationship between the exchange rate and the explanatory variables, as the test statistics exceed the respective upper critical values only at the 10% level of significance for the *t*-test. For the *F*-test only the Canada/UK test indicates cointegration. In contrast to this marginal result, when equities are added to the model, both the *t*-test and *F*-test indicate a valid long-run relationship at the 5% level of significance for both exchange rates. For this version of the model, we can therefore reject the null of no cointegration, regardless of whether the variables are *I*(1) or *I*(0) or a mix of both. However for the conventional model the presence of cointegration is far less clear cut[9]. These results support those of earlier studies who found evidence of cointegration between exchange rates and stock prices, such as Bahmani-Oskooee and Sohrabian (1992) as well as Granger et al. (2000).

The ARDL models for the conventional monetary model are presented in Table 3.3 and the models including stock prices are presented in Table 3.4. The Schwarz-Bayesian criteria have been used to determine the optimal lag length in these models, starting with a maximum lag length of four. Both models are well specified with reasonable explanatory power, so can be used to generate the long-run coefficients of the two models.

[8] The tests were repeated including a trend in the tests, these results supported the findings of the non-trended tests.
[9] The model was also tested for cointegration using the Johansen ML procedure, however the results were more ambiguous and the results from the maximum eigenvalue and trace statistics were different for both models and both exchange rates, as is commonly the case for tests on the monetary model, as in Tawadros (2001). For a discussion of some of the failings of the Johansen approach see Wickens (1996) and Tawadros (2001), for these reasons the ARDL and Phillips Hansen results are emphasized here. The results indicated that for both countries only when equities were introduced into the model, was there any significant evidence of cointegration, there was only marginal evidence of cointegration for the conventional monetary model. The estimates of the long-run coefficients were also substantially different to those produced by the other two methods, in some cases producing opposite signed variables.

	uke		*ukcne*
constant	-2.379 (1.879)**	constant	-1.044 (1.996)**
uke(-1)	0.742 (11.693)*	*ukcne*(-1)	0.772 (12.219)*
Dukm	-0.020 (0.756)	*Dukcnm*	0.115 (2.033)*
Duky	-0.646 (2.028)*	*Dukcny*	-0.458 (1.597)
Duki	-0.009 (2.945)*	*Dukcni*	-0.013 (3.016)*
$\bar{R}^2$	0.769	$\bar{R}^2$	0.782
Durbin's h	1.250	*Durbin's h*	0.998
SC(4)	8.334	*SC*(4)	4.876
Het	3.580	*Het*	2.041
J-B test (2)	2.102	*J-B* test (2)	0.476

Table 3.3 Autoregressive Distributed Lag results for the Monetary Model.
Notes: See Table 3.2. Where *uke* is the UK/US exchange rate, *Dukm* is the differential between the UK and US money demand, *Duky* is the difference between the UK and US output and *Duki* is the difference between the UK and US interest rate. In the second column the variables are the same except they refer to the UK and Canada. $\bar{R}^2$ is the coefficient of determination; *DW* is the Durbin-Watson statistic; *SC*(4) is the 4th order tests for serial correlation. *J-B* is the Jarque-Bera test for normality of the residuals and *het* is the test for heteroskedasticity, *t*-statistics are in parentheses. These test statistics all follow the chi-squared distribution chi-sq(1)=3.842, chi-sq(4) = 9.488.

	uke		*ukcne*
constant	-7.750 (3.783)*	constant	-1.001 (1.656)**
uke(-1)	0.625 (8.940)*	*ukcne*(-1)	0.766 (11.602)*
Dukm	0.275 (2.909)*	*Dukcnm*	0.120 (1.837)**
Duky	-1.535 (3.764)*	*Dukcny*	-0.447 (1.484)
Duks	0.296 (3.228)*	*Dukcns*	0.147 (1.745)**
Duki	-0.012 (4.112)*	*Dukcns*(-1)	-0.159 (2.072)*
		Dukcni	-0.012 (2.850)*
$\bar{R}^2$	0.794	$\bar{R}^2$	0.789
Durbin's h	1.136	*Durbin's h*	0.843
SC(4)	4.597	*SC*(4)	5.934
Het	3.910	*Het*	2.648
J-B test (2)	0.570	*J-B* test (2)	0.134

Table 3.4 Autoregressive Distributed Lag Model for the Monetary Model with Equities.
Notes: See Table 3.3, except that *Duks* is the difference between the UK and US stock price index and *Dukcns* denotes the difference between the UK and Canadian stock price index.

Table 3.5 contains the long-run coefficients for the conventional model using the UK/US exchange rate, where the long-run coefficients have been generated using the ARDL and Phillips-Hansen. The significance tests for the first two sets of results are the standard *t*-test. In both methods, the money demand differential is incorrectly signed and insignificant, with the ARDL and Phillips-Hansen approaches producing very similar coefficients. The output differential is correctly signed and significant in both cases. In addition, the interest rate is negatively signed and significant suggesting uncovered interest parity does not hold between the UK and USA. This could be due to the presence of a risk premium[10]. The results for the UK/Canada test are similar in that with the exception of the interest rate, the ARDL and Phillips-Hansen approaches produce similar results, with the money demand and output variables being correctly signed and significant, although the interest rate is negatively signed and significant again.

	UK/US		**UK/Canada**	
Variable	ARDL	Phillips-Hansen	ARDL	Phillips-Hansen
Dm	-0.076	-0.043	0.505*	0.471*
	(0.761)	(0.758)	(2.384)	(3.727)
Dy	-2.508*	-2.486*	-2.001**	-2.497*
	(2.125)	(3.712)	(1.887)	(4.087)
Di	-0.034*	-0.023*	-0.056*	-0.010
	(2.908)	(3.764)	(2.290)	(0.962)
constant	-9.229**	-9.357*	-4.581*	-5.275*
	(1.962)	(3.494)	(2.497)	(4.959)

Table 3.5 Estimated Long-Run Coefficients for the conventional monetary model UK/US and UK/Canada.
Notes: See Table 3.1 and 3.3. Where *Dm*, *Dy* and *Di* are the difference between the respective money demand, output and interest rates for the UK and USA (columns 2 and 3) and the UK and Canada (columns 4 and 5), *t*-statistics in parentheses. A * indicates significance at the 5% level, **at the 10% level.

	UK/US		**UK/Canada**	
Variable	ARDL	Phillips-Hansen	ARDL	Phillips-Hansen
Dm	0.733*	0.464*	0.513*	0.620*
	(3.286)	(3.561)	(2.278)	(5.561)
Dy	-4.097*	-3.455*	-1.911	-1.891*
	(4.489)	(6.561)	(1.588)	(3.185)
Ds	0.789*	0.492*	-0.049	-0.258*
	(3.752)	(4.020)	(0.181)	(2.061)
Di	-0.032*	-0.024*	-0.051*	-0.018*
	(4.411)	(5.824)	(2.257)	(2.040)
constant	-20.691*	-16.440*	-4.283*	-3.741*
	(4.590)	(6.306)	(1.742)	(3.123)

Table 3.6 Estimated Long-Run Coefficients for the UK/US and Canada/USA Equity Based Model.
Notes: See Table 3.1 and 3.3 except Ds is the difference between the stock price index for UK and USA (columns 2 and 3) and the UK and Canada (columns 4 and 5). A * indicates significance at the 5% level, ** at the 10% level *t*-statistics in parentheses for columns 2 and 3, chi-squared statistics column 4.

The results for the models including equities are in general an improvement for both techniques, especially when using the UK/US exchange rate. The money demand and output

[10] An alternative to the above approach would be to use a Generalised Autoregressive conditionally heteroskedastistic (GARCH) model to specifically model the risk through the conditional volatility, but this is beyond the scope of this study.

differentials are correctly signed and highly significant, the stock price differential is positively signed and significant, which indicates the substitution effect is dominating. The interest rate is again significant and negatively signed. Again the ARDL and Phillips-Hansen approaches produce very similar results. These results again support those of other tests which show evidence of stock prices affecting the exchange rate, such as Smith (1992) and Hau and Rey (2006) among others. Again, the improvement in the results highlights the important historic changes to the foreign exchange markets over recent years, as capital has become internationally more mobile, requiring the use of asset returns other than interest rates in exchange rate models.

The final table has the long-run coefficients for the UK/Canada exchange rate model including equities. Although the results for the money demand differential are significant and correctly signed, both the output and stock price differentials are insignificant when the ARDL approach is used, but significant when using the Phillips-Hansen method. The UK/Canada results for the model including stock prices are not as good as the UK/US results due to the lesser importance of capital flows between the UK and Canada compared with the UK and USA. This reflects the dominant position of the US stock market and its greater popularity with international investors.

4. SUMMARY AND CONCLUSIONS

In this paper we have found only limited evidence to support the conventional monetary approach, although we have found evidence to support an alternative specification, which incorporates an equity effect, particularly for the UK/US exchange rate, this is due to the increasing importance of capital flows between international stock markets. As the literature suggests (Solnik, 1987; Hau and Rey, 2006) stock prices are having an increasingly important effect on exchange rates. In equilibrium, this version of the monetary model produces a stable long-run relationship and when stock prices are included in the model, the money supply and income variables are correctly signed and in general significant, which appears not to be the case with the conventional model. Also the relationship between the exchange rate and stock prices is generally significant and determined by the substitution effect. Overall the results suggest that the ARDL approach and Phillips-Hansen technique produce similar results.

These results support those of other studies that indicate that for the UK and US currencies in particular, over the long run, equities are an important determinant of the exchange rate. These findings not only add to the increasing empirical evidence that in the UK, USA and Canada the foreign exchange markets and stock markets are closely related, but also suggests that especially for the UK and USA, models of the equilibrium exchange rate must be extended to include equity markets in addition to bond markets. As with the portfolio balance model, the exclusion of equities from asset holders portfolios imposes excessively strong restrictions on the monetary model.

The results of the cointegration of the monetary model also implies that purchasing power parity holds in the long-run, as PPP is an important assumption in deriving the monetary model. In addition, future studies could introduce measures of international financial flows into the model as well as the role of alternative investment opportunities. As noted structural issues play an important part in determining the relationship between stock prices and exchange rates, this again could be more explicitly introduced into the study, in particular the role of capital controls, information for foreign investors and the importance of the different types of risk inherent in investing abroad. It would be anticipated that the more risky a currency, the less demand for it so the more likely it is to depreciate, also where capital controls are in place, the less likely there is to be any relationship between equities and exchange rate. Expectations are another factor that could be included in the study, although the form of the expectations would be critical, for instance regressive expectations could introduce an element of overshooting.

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