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MONETARY POLICY AFTER THE GLOBAL CRISIS

How Important Are Economic (Divisia) Monetary Aggregates for Economic Policy?

(in honour of William A. Barnett)

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Title of the paper

Money demand, divisia aggregate and share price volatility in the UK

Authors

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MONEY DEMAND, DIVISIA AGGREGATE AND SHARE PRICE VOLATILITY IN THE UK

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Keywords

Monetary aggregates, Divisia, Share prices, Volatility, Monetary Policy

JEL: E41, E44, E52

MONEY DEMAND, DIVISIA AGGREGATE AND SHARE PRICE VOLATILITY IN THE UK

1.0 Introduction

This paper investigates two closely linked research questions which have been brought to the fore by the recent financial crisis and increased stock market volatility. Both investigations rely on a money demand framework, which for a long time has been attracting a diminished interest. Not surprisingly perhaps, as money demand functions, the relationship between monetary aggregates and their traditional determinants such as output and interest rates, have exhibited a significant amount of instability in the last four decades while stability is an important pre-requisite for a more prominent role of money in policymaking. One should however note that the instability that is generally mentioned in the literature is with reference to official Simple Sum aggregates. These are constructed by simply adding up assets that have varying degrees of liquidity. The issue with this approach is that not all assets contribute equally to economic activity. Notes and coins are primarily held for transactions, in contrast to saving deposits, and thus will have a closer relationship with economic activity which is one of the main targets of monetary policy.

Around the time instability in money demand functions started emerging, Barnett (1978, 1980) suggested an alternative to Simple Sum aggregates – Divisia aggregates. These weight asset components according to the degree of liquidity services they provide; thus notes and coins get the highest weights while savings deposits get a smaller weight. From this perspective, the Divisia aggregate is more representative of economic activity. In spite of diminished interest in money demand functions, a small number of researchers have continued investigating the merits of Divisia aggregates (see for example, Serlettis and Gogas, 2014). They have recently attracted more attention following the recent financial crisis which exposed the weaknesses of current policy models; these do not give a prominent role to money (see for example, Castelnuovo, 2012). In countries such as the US and the UK, the policy rate has been stuck at the zero lower bound (ZLB) for close to a decade, and although interest rates have a prominent role in current policy models, they have not been able to influence economic activity and have not been informative about the stance of policy. Being faced with the ZLB, countries such as US and UK have adopted quantitative easing measures, in simpler terms, they have injected money directly into the economy with the aim of boosting economic activity. From that perspective, at least, monetary aggregates, and in particular Divisia, are more useful at influencing economic activity than interest rates and a better indicator of the policy stance. This statement is supported by the findings of some recent studies. For the Euro area, Darvas (2015) shows that Divisia aggregates perform in a theory-consistent manner but not Simple Sum aggregates. Keating *et al.*, (2014) find that Divisia aggregates perform remarkably well post financial crisis period for the US. One of the aims of this paper is therefore to investigate whether or not similar supportive evidence can be found for the UK.

In recent decades, volatility in share prices has increased following events such as the dot com bubble, the financial crisis and the European sovereign debt crisis. Within this context, the other main contribution of this paper is to investigate the extent to which share price volatility influences the demand for money and affects its stability. Friedman (1988) laid the foundation for such an investigation; he postulated that share prices can have both a wealth and substitution effect on the demand for money. The wealth effect refers to a positive relationship between the demand for money and share prices, indicating that as share prices increase the demand for money also increases. Friedman (1988, pp. 222) provides the following explanations for the positive wealth:

"(1) A rise in stock prices means an increase in nominal wealth …. (2) A rise in stock prices reflects an increase in the expected return from risky assets relative to safe assets. Such a change in relative valuation need not be accompanied by a lower degree of risk aversion or a greater risk preference. The resulting increase in risk could be offset by increasing the weight of relatively safe assets in an aggregate portfolio, for example, by reducing the weight of long-term bonds and increasing the weight of short-term fixed-income securities plus money. (3) A rise in stock prices may be taken to imply a rise in the dollar volume of financial transactions, increasing the quantity of money demanded to facilitate transactions."

The substitution effect, on the other hand, refers to an inverse relationship between the demand for money and share prices, indicating that as share prices increase the demand for monetary assets falls. This can be because equities become more attractive as a component of a portfolio of assets. Thus, investors may switch from low interest yielding monetary assets to equity holdings. The net effect of stock prices on demand for real money balances may be positive or negative, depending on which of the two is more dominant.

Choudhry (1996) finds that share prices have a positive wealth effect on the demand for money in the US. In the case of Canada, he finds evidence of both wealth and substitution effects; an outcome which appears dependent of the level of monetary aggregation.

Bissoondeeal et al., (2010) present evidence of both wealth and substitution effects for the UK household sector money demand function. The outcome appears to be dependent on the type of aggregation method used in constructing the monetary aggregates. Boone and van den Noord (2008) find that share prices are negatively linked to the demand for money for the Euro area.

There are however, only a couple of papers investigating the impact of share price volatility on the demand for money - Carpenter and Lange (2002) for the US and Carstensen (2006) for the Euro area. The data in both studies end well before the onset of the financial crisis; moreover, none of the papers consider the Divisia aggregate. This paper therefore offers a novel contribution to the literature by including the Divisia aggregate in investigating the impact of share price volatility on the demand for money. The aforementioned studies find that increased volatility pushes investors to seek refuge into safer monetary assets. However, it is conceivable that some investors, motivated by the high risk-high return relationship, are risk-seeking. The net effect on the demand for money will therefore depend on the more dominant attitude towards risk.

2.0 Econometric Model and Data

2.1 Econometric Model

The following model is a standard money demand function augmented with share prices and a measure of their volatility.

(1) $$(m/p)_t = \alpha_0 + \alpha_1 y_t + \alpha_2 I_t + \alpha_3 sp_t + \alpha_4 vol_t + \varepsilon_t$$

m_t is nominal money supply, p_t is the overall price level, y_t is real income, I_t represents interest rates, sp_t is a measure of share prices, vol_t is a measure of share price volatility and ε_t is the residual term. Apart from I_t, all variables are in logarithm form.

The literature suggests that α_1 should be positive, as money demand should increase when income increases, and it should also be close to 1 (see, for example, Sriram (2001). It also predicts that α_2 should be negative as I_t represents the opportunity cost of holding money. The discussion presented in Section 1 suggests that a definitive sign for α_3 has not been established; it could be either positive or negative depending on whether the wealth effect or the substitution effect dominates. If most investors are risk-averse then we would expect α_4 to be positive, however if they turn out to be risk-seeking then α_4 will be negative.

We search for a long-run relationship of the form represented by Equation 1, using a cointegrated vector autoregressive (VAR) model framework based on Johansen's (1988) maximum likelihood method. Let z_t denote a $p \times 1$ set of variables, which are not integrated of an order higher than one, then the cointegrated VAR may be represented in vector error correction form as:

$$\Delta z_t = \sum_{i=1}^{m-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-1} + deterministic\ components + \vartheta_t \quad (2)$$

where Γ_is and Π are coefficient matrices and ϑ_t is a vector of Gaussian error terms. Let $r = rank(\Pi)$, then if $0 < r < p$,the matrix Π can be partitioned into $p \times r$ matrices α and β such that $\Pi = \alpha\beta'$ and $\beta' z_t$ is I(0) (Johansen and Juselius, 1990). r is the number of cointegrating relationships and each column of β is the cointegrating vector. The trace test is quite commonly used to establish the number of cointegration relationships; however, some studies show that the trace test suffers from lack of power in small samples (see, for example, Jacobson *et al*., (1998). Therefore, in this paper we use the Bartlett small size correction of the trace test (Johansen, 2002). Equation (2) is also employed for estimating short-run money demand equations.

2.2 Data

We use UK quarterly data for the aggregate economy for the period 1977Q1 to 2012Q4. The starting point is constrained by the availability of the Divisia aggregate. The broadest level (M4) of the two monetary aggregates are obtained from the Bank of England's website[1]. Gross domestic product (GDP) is used as a measure of income, consumer price index (CPI) as the measure for overall price level, Treasury bill rate (TBR) as the relevant interest rate, and FTSE all share price index (FTSE) as the measure for stock market activity. GDP, CPI, TBR and FTSE are obtained from Datastream. The monetary aggregates, GDP, CPI, and FTSE are all in seasonally adjusted form. The monetary aggregates, GDP and FTSE are converted to real terms using CPI. We use the squared return of the logarithm of FTSE as a

[1] http://www.bankofengland.co.uk/boeapps/iadb/index.asp?first=yes&SectionRequired=A&HideNums=-1&ExtraInfo=false&Travel=NIxSTx

proxy for the stock market volatility (e.g., West and Cho, 1995). The two measures of money, GDP, TBR and FTSE are represented graphically in Figure 1.

[Please insert Figure 1 here]

3.0 Results and Discussions

As we mentioned earlier that volatility in share prices has increased since 2000, in addition to conducting the analysis for the whole sample, we also partition the dataset in 2000 and conduct separate analyses for both sub-samples to gauge the relative importance of volatility in each segment. Moreover, we will estimate a traditional money demand specification (Model 1) and sequentially augment it with share prices (Model 2) and volatility (Model 3).

3.1 Unit root tests

In the first instance, all the variables are subjected to the augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller, 1979) to identify their orders of integration. We conduct the test for the whole sample as well as for the two partitioned samples defined earlier. As a robustness check, we conduct the ADF test with 1, 2 and 4 lags. The results for the whole sample, presented in Panel A of Table 1, suggest that, vol_t is an I(0) variable at the conventional 5 per cent significance level. The ADF test with 4 lags suggests that the Simple Sum aggregate has an order of integration higher than one; but testing with lags of 1 and 2 suggests the variable is I(1). The remaining variables also appear to be I(1).

The results presented in Panel B of Table 1, for the period 1977Q1 to 1999Q4, largely correspond to those in Panel A; one difference is that the ADF test with 4 lags suggests income has an order of integration higher than one. However, the ADF test with lags 1 and 2 suggest that income is (1). The results presented in Panel C of Table 1, for the period 2000Q1 to 2012Q4, are somewhat different from those in Panels A and B. There is some indication that vol_t is not an I(0) variable and apart from the interest rate variable, all other variables show some evidence of non-stationary behaviour in their first difference form. One possible explanation for such findings in Panel C may be linked to the size of the sample. Standard unit root tests such as the ADF test tend to have low power against the alternative of the null of a unit root in small samples (see for example, Chaudhuri and Wu, 2003). With this in mind and the fact that the results in Panels A and B largely suggest vol_t is an I(0) variable and other variables are I(1) variables, we proceed with the assumption that these variables are valid candidates for cointegration analysis.

[Please insert Table 1 here]

3.2 Cointegration results

Cointegration test results for the whole sample and the two segments are presented in Panels A, B and C of Table 2. The deterministic component allowed is an unrestricted constant in the cointegration relationship, consistent with studies such as Bissoondeeal *et al*., (2014). Our procedure for selecting the lag length is as follows: for the two segments, we start with a lag length of 2, whereas for the whole sample, we start with 3. We then augment the lag length it if the residuals of the model are autocorrelated; these are checked using the Lagrange multiplier (LM) tests also reported in Table 2.

Out of the 9 Simple Sum models being considered, the Bartlett corrected test suggests cointegration relationships in 5 cases at the conventional 5% level. For other cases, we find evidence of cointegration at the 10% level.

Out of the 9 Divisia models, 5 of them show evidence of cointegration at the 5% level and one at the 10% level. The remaining 3 present evidence of cointegration outside the 10%, however, one is just outside the 10% level; therefore we will consider the latter for further analysis[2] .

[Please insert Table 2 here]

The cointegration relationships for the different models are presented in Table 3. Cointegration relationships not consistent with economic theory are presented with a grey background. Looking at results for the entire sample, in Panel A, and for the Simple Sum aggregate, the magnitude of the income variable is fairly distant from theoretical predictions for the baseline model (Model 1) and its counterpart which is augmented with share prices (Model 2). The cointegration tests did not suggest any relationships for the corresponding Divisia models. However, for the specification including the share price volatility (Model 3), for both Simple Sum and Divisia aggregates, the coefficients of the income and opportunity cost variables are consistent with theoretical predictions. Share price volatility has a positive impact on the demand for money in both cases and thus indicating risk aversion behaviour.

[2] There are two models showing evidence of more than one cointegration relationship at the 5% level. Following studies such as Binner *et al*., (2005), we will focus on the first cointegration relationship.

However, share prices have opposing effects on the two monetary aggregates; with the Simple Sum model we find a wealth effect, whereas we find a substitution effect with the Divisia model. Bissoondeeal *et al*., (2010) made a similar finding for the household sector; the results here, for the entire economy, reinforce those results. To make sense of the results it is worth re-emphasising the difference between the two types of monetary aggregates is that the Divisia measure weights the component assets according to their level of liquidity in contrast to Simple Sum. Therefore, given the fact that Divisia aggregates give smaller weights to less liquid assets, their behaviour is essentially more representative of highly liquid assets. In that sense, the substitution effect observed with the Divisia model could be attributed to shifts between highly liquid assets and equities. As the yield on highly liquid assets tend be relatively low or even zero, a significant difference in yield between such assets and equities could motivate investors to re-adjust their portfolio in favour of the latter. Moreover, the cost of switching away from such highly liquid assets tends to be very low. The wealth effect captured by the Simple Sum aggregate could then be reflecting the behaviour of less liquid assets which, although have the same weight as their highly liquid counterparts, are present in a higher ratio. Such a switch could be motivated by, for example, investors wanting to maintain their level of risk preference as mentioned in the Section 1. Moreover, switching to less liquid assets is still associated with an element of return as they are more investment orientated assets.

[Please insert Table 3 here]

We conduct the CUSUM of squares test on the short-run specification of the two long-run money demand equations discussed above to test their stability. Results presented in Figure 2 show that the Divisia model is remarkably stable around the financial crisis episode, in sharp contrast to its Simple Sum counterpart. The Divisia model displays some instability around 1990; this is quite close to UK's experience with the exchange rate mechanism, which was associated with a different policy, and also the 1987 stock market crash.

[Please insert Figure 2 here]

Results for the first segment, in Panel B of Table 3, suggest that none of the Simple Sum cointegration relationships seem close to theoretical predictions; income has the wrong sign and its magnitude is fairly large. For Divisia, only Model 1 has the correct sign and magnitude for the income variable. The opportunity cost has the wrong sign but this is not unusual in the literature. Therefore, it appears from these results that instability in money demand functions in that period has less to do with developments in the stock market but rather due to significant financial innovation occurring around that time. Given that the Simple Sum aggregate weights component assets equally, this implies that the different components are considered perfect substitutes. As Drake and Mills (2001, pp. 218) discuss this assumption is particularly inappropriate during periods of substantial financial innovation which involve changing interest yields on component assets. Since Divisia weights the component assets based on their level of liquidity, which essentially is measured via opportunity costs relating to 'own' interest rate differentials from a benchmark rate, it therefore has the ability to endogenise financial innovation involving changing interest yields. As can be seen from the Figure 1, interest rates were quite high and variable in the 1977Q1 to 1999Q4 period and some of the interest rate movements may well be due to financial innovation. Therefore, in contrast to Simple Sum aggregates, Divisia aggregates are better suited to cope with such occurrences.

For the second segment, the results, in Panel C of Table 3, for both Simple Sum and Divisia aggregates and for all models, are largely consistent with theory and appear qualitatively similar. One explanation for not finding major differences between the two aggregates could be linked to the subdued behaviour of interest rates which appear lower and less volatile in contrast to the earlier period. Nevertheless, stability tests based on short-run money demand specifications, in Figure 3, show that Divisia models are more stable than Simple Sum ones. Share prices and their volatility both have a positive effect on the demand for money. Thus, in contrast to the first segment, share price volatility has a more significant role in the second segment. This conforms to our earlier statement that volatility has increased post 2000. Similarly, share prices have a more significant role in the second segment which perhaps is not surprising as the level of engagement with the stock market is relatively higher as compared to the previous period. As Guiso et al., (2003) explain, increased stock market participation could be due to falling transaction costs, including components such as trading costs, management fees and information costs.

[Please insert Figure 3 here]

4.0 Conclusions

We evaluate the performance of a Divisia aggregate against its official Simple Sum counterpart in a money demand framework. We also investigate the extent to which the stability of our money demand specifications has been affected by share prices and their volatility which has increased in the recent decade.

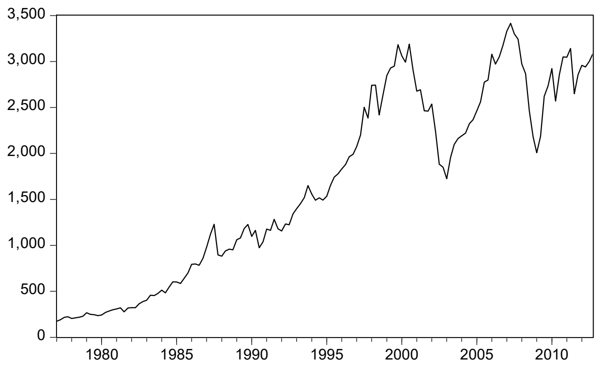
We find that the Divisia aggregate shows more stability with policy targets, such as output, than its Simple Sum counterpart, particularly during the financial crisis and beyond, a period when current policy models, in which money has no role, have exhibited instability. These results corroborates the recent results from the US (Keating et al., 2014) and Euro area (Darvas, 2015). The results imply that the Divisia monetary aggregate is more informative about future developments in output and is also more informative of the policy stance during the current quantitative easing episode when the policy rate has been stuck close to the zero lower bound. We also find that the influence of the share prices and their volatility on monetary aggregates have increased, particularly in recent decades. Whereas, the majority of previous studies have focussed on establishing whether a wealth effect or a substitution effect exists, our analysis uncovers that the substitution effect is more closely linked to highly liquid assets and the wealth effect to more savings-orientated assets. We are able to reach this conclusion by comparing the behaviour of the Divisia aggregate relative to its Simple Sum counterpart; an exercise rarely conducted when seeking to establish the wealth or substitution effect.

Share price volatility has a positive impact on the demand for money. An important policy implication of this finding is that during periods of heightened uncertainty, increases in the monetary holdings will not necessarily result in inflationary pressures as the increase is due to a refuge-seeking behaviour rather than a transaction-motivated one.

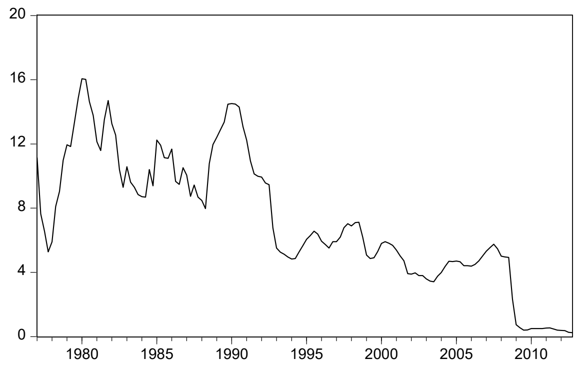
FIGURES

Figure 1: Graphical representation of series

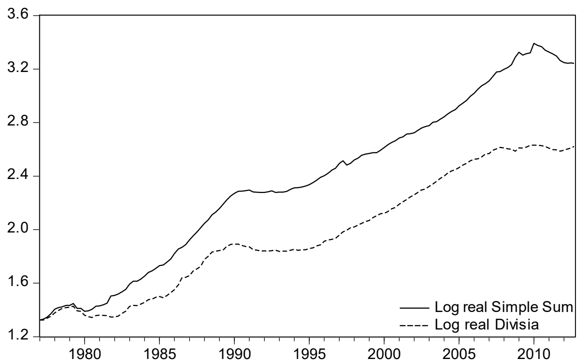
FTSE All Share price index



Treasury bill rate



Simple sum and Divisia monetary aggregates



Logarithm of real GDP

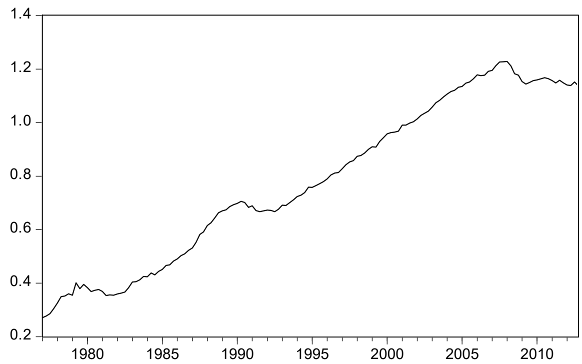
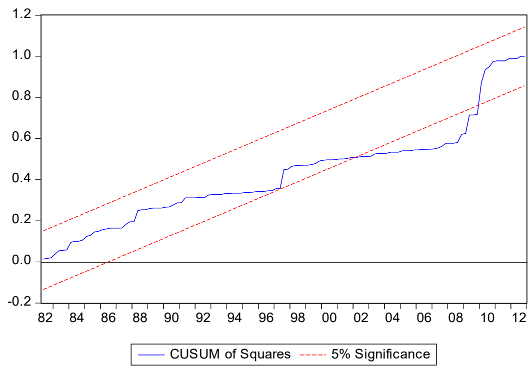


Figure 2: Stability test for whole sample) (Black and White figure would be sufficient)

Simple Sum Model 3



Divisia Model 3

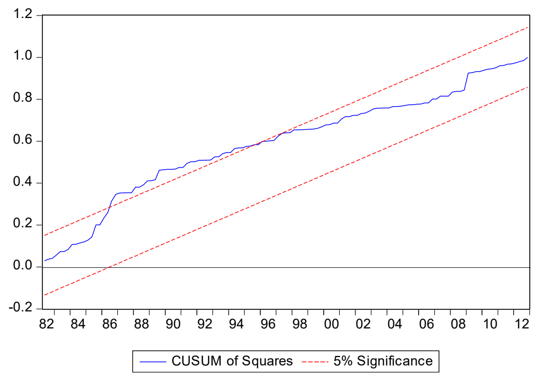
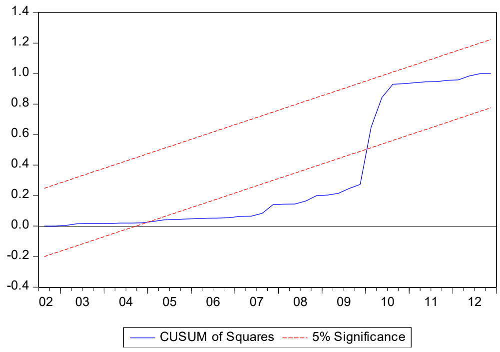
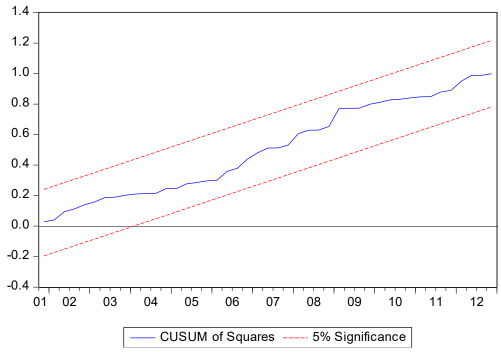


Figure 3: Stability test for the second segment (2000Q1 to 2012Q4) (Black and White figure would be sufficient)

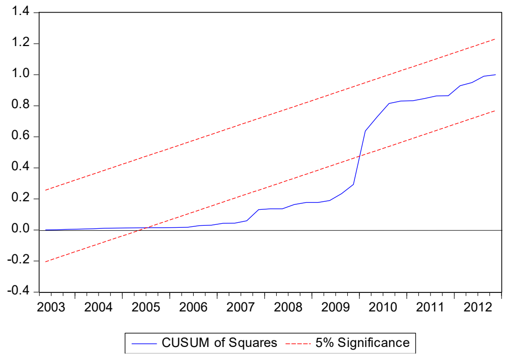
Simple Sum Model 1



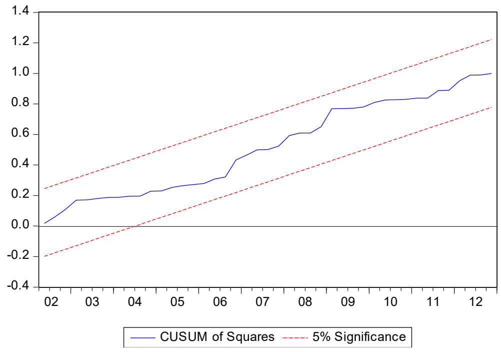
Divisia Model 1



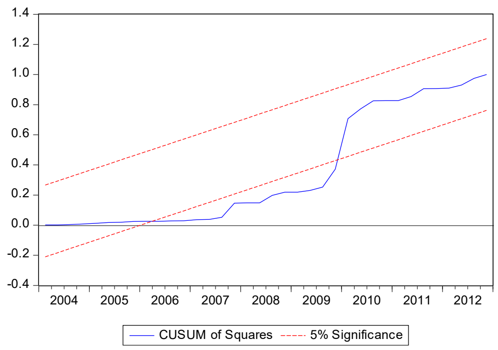
Simple Sum Model 2



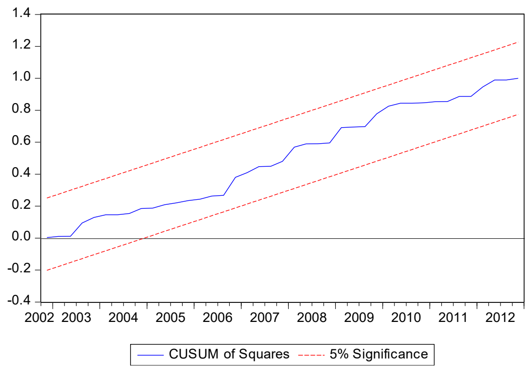
Divisia Model 2



Simple Sum Model 3



Divisia Model 3



TABLES

Table 1: Unit root tests

Panel A: 1977Q1 to 2012Q4

		1 Lag	2 Lags	4 Lags
Simple sum $(m/p)_t$				
	Level	-1.091	-1.603	-2.625
		(0.93)	(0.79)	(0.27)
	First difference	-5.225	-4.522	-2.202
		(0.00)	(0.00)	(0.21)
Divisia $(m/p)_t$				
	Level	-1.751	-2.472	-2.886
		(0.72)	(0.34)	(0.17)
	First difference	-4.41	-3.769	-3.719
		(0.00)	(0.00)	(0.00)
y_t				
	Level	0.194	-0.907	-1.832
		(0.99)	(0.95)	(0.68)
	First difference	-5.122	-4.008	-3.639
		(0.00)	(0.00)	(0.01)
I_t				
	Level	-1.255	-1.338	-1.072
		(0.65)	(0.61)	(0.72)
	First difference	-7.091	-6.38	-5.49
		(0.00)	(0.00)	(0.00)
sp_t				
	Level	-1.774	-1.671	-1.327
		(0.71)	(0.76)	(0.88)
	First difference	-8.394	-6.716	-5.155
		(0.00)	(0.00)	(0.00)
vol_t				
	Level	-7.792	-6.369	-4.494
		(0.00)	(0.00)	(0.00)

Panel B: 1977Q1 to 1999Q4

		1 Lag	2 Lags	4 Lags
Simple sum $(m/p)_t$				
	Level	-1.131	-1.435	-2.118
		(0.92)	(0.84)	(0.53)
	First difference	-4.175	-3.354	-2.237
		(0.00)	(0.02)	(0.20)
Divisia $(m/p)_t$				
	Level	-1.597	-2.13	-2.437
		(0.79)	(0.52)	(0.63)
	First difference	-3.616	-3.142	-2.988
		(0.00)	(0.03)	(0.04)
y_t				
	Level	-1.131	-1.97	-3.19
		(0.88)	(0.61)	(0.09)
	First difference	-4.41	-3.315	-2.696
		(0.00)	(0.02)	(0.08)
I_t				
	Level	-1.942	-2.125	-1.826
		(0.32)	(0.24)	(0.37)
	First difference	-5.651	-5.132	-4.295
		(0.00)	(0.00)	(0.00)
sp_t				
	Level	-2.546	-2.378	-1.744
		(0.31)	(0.39)	(0.72)
	First difference	-7.876	-6.004	-4.851
		(0.00)	(0.00)	(0.00)
vol_t				
	Level	-6.01	-5.107	-4.076
		(0.00)	(0.00)	(0.00)

Panel C: 2000Q1 to 2012Q4

		1 Lag	2 Lags	4 Lags
Simple sum $(m/p)_t$				
	Level	0.573	0.097	-1.017
		(1.00)	(1.00)	(0.93)
	First difference	-3.092	-2.868	-0.764
		(0.03)	(0.06)	(0.82)
Divisia $(m/p)_t$				
	Level	-0.273	-0.92	-0.277
		(0.99)	(0.95)	(0.99)
	First difference	-2.325	-1.831	-2.101
		(0.17)	(0.36)	(0.25)
y_t				
	Level	-0.45	-0.576	-0.487
		(0.98)	(0.98)	(0.98)
	First difference	-3.023	-2.371	-2.493
		(0.04)	(0.15)	(0.12)
I_t				
	Level	-1.255	-0.967	-1.086
		(0.64)	(0.76)	(0.71)
	First difference	-4.313	-2.998	-3.126
		(0.00)	(0.04)	(0.03)
sp_t				
	Level	-2.468	-2.776	-2.314
		(0.34)	(0.21)	(0.42)
	First difference	-4.136	-3.884	-2.902
		(0.00)	(0.00)	(0.06)
vol_t				
	Level	-5.159	-3.348	-2.491
		(0.00)	(0.02)	(0.12)

Notes:

1. The numbers in brackets are p-values.

2. The tests for $(m/p)_t$, $y_t$and sp_t in levels conducted with a constant and a trend. The tests for these variables and I_t, in first differences are conducted with constant. The test for $I_t$and vol_t in levels are conducted with a constant.

Table 2: Cointegration tests

Panel A: 1977Q1 to 2012Q4

Simple sum						
	Baseline model		Baseline + sp_t		Baseline $+sp_t+vol_t$	
r	Trace	P-value	Trace	P-value	Trace	P-value
0	27.533	0.09	46.283	0.07	90.919	0.00
1	8.023	0.47	18.887	0.51	45.471	0.08
2	0.461	0.50	6.272	0.67	19.989	0.44
3	-	-	0.94	0.33	6.145	0.68
4	-	-	-	-	0.705	0.40
VAR lag length,k	3		3		3	
LM(1)	0.381		0.429		0.686	
LM(k)	0.205		0.506		0.307	

Divisia						
	Baseline model		Baseline + sp_t		Baseline $+sp_t+vol_t$	
r	Trace	P-value	Trace	P-value	Trace	P-value
0	25.414	0.15	34.947	0.46	78.165	0.01
1	6.515	0.64	14.803	0.80	35.494	0.43
2	1.685	0.19	4.897	0.82	15.545	0.75
3	-	-	1.507	0.22	4.879	0.82
4	-	-	-	-	1.295	0.26
VAR lag length,k	3		3		3	
LM(1)	0.164		0.604		0.917	
LM(k)	0.611		0.677		0.565	

Panel B: 1977Q1 to 1999Q4

Simple sum						
	Baseline model		Baseline + sp_t		Baseline + sp_t+ vol_t	
r	Trace	P-value	Trace	P-value	Trace	P-value
0	29.026	0.06	55.789	0.01	104.776	0.00
1	3.675	0.92	14.129	0.83	56.035	0.01
2	0.202	0.65	3.318	0.94	14.821	0.79
3	-	-	0.046	0.83	3.785	0.91
4	-	-	-	-	0.018	0.89
VAR lag length,k	2		2		2	
LM(1)	0.398		0.707		0.925	
LM(k)	0.796		0.984		0.958	

Divisia						
	Baseline model		Baseline + sp_t		Baseline + sp_t +vol_t	
r	Trace	P-value	Trace	P-value	Trace	P-value
0	26.856	0.11	55.369	0.01	105.723	0.00
1	4.249	0.88	18.184	0.56	56.507	0.01
2	0.661	0.42	3.667	0.92	19.488	0.47
3	-	-	0.586	0.44	4.158	0.89
4	-	-	-	-	0.874	0.35
VAR lag length,k	3		2		2	
LM(1)	0.280		0.179		0.384	
LM(k)	0.472		0.277		0.736	

Panel C: 2000Q1 to 2012Q4

Simple sum						
	Baseline model		Baseline + sp_t		Baseline $+sp_t+vol_t$	
r	Trace	P-value	Trace	P-value	Trace	P-value
0	36.482	0.08	49.539	0.03	73.082	0.03
1	16.714	0.34	11.378	0.95	35.666	0.42
2	5.986	0.05	8.959	0.38	4.004	1.00
3	-	-	6.294	0.01	8.255	0.45
4	-	-	-	-	6.449	0.01
VAR lag length,k	3		3		3	
LM(1)	0.838		0.817		0.385	
LM(k)	0.349		0.398		0.517	

Divisia						
	Baseline model		Baseline + sp_t		Baseline $+sp_t+vol_t$	
r	Trace	P-value	Trace	P-value	Trace	P-value
0	27.278	0.10	51.512	0.02	78.708	0.01
1	7.795	0.50	19.358	0.48	41.465	0.18
2	1.183	0.28	3.673	0.92	17.783	0.59
3	-	-	0.887	0.34	3.74	0.92
4	-	-	-	-	0.938	0.33
VAR lag length,k	2		2		2	
LM(1)	0.045		0.76		0.454	
LM(k)	0.069		0.503		0.094	

Table 1: Cointegration relationships

Panel A: 1977Q1 to 2012Q4

	Simple Sum		
	Model 1	Model 2	Model 3
y_t	0.001	0.251	1.348
	(0.434)	(0.325)	(0.221)
I_t	-0.155	-0.072	-0.029
	(0.033)	(0.014)	(0.010)
sp_t	-	0.555	0.253
		(0.154)	(0.105)
vol_t	-	-	25.828
			(3.427)
Constant	3.488	1.121	0.648

		Divisia	
	Model 1	Model 2	Model 3
y_t	-	-	1.567
			(0.161)
I_t	-	-	-0.008
			(0.007)
sp_t	-	-	-0.091
			(0.078)
vol_t	-	-	19.918
			(2.527)
Constant			0.936

Panel B: 1977Q1 to 1999Q4

	Simple Sum		
	Model 1	Model 2	Model 3
y_t	-15.883	-7.992	-45.828
	(7.843)	(1.840)	(11.827)
I_t	-2.750	-0.120	0.251
	(0.508)	(0.033)	(0.203)
sp_t	-	3.877	20.465
		(0.761)	(4.909)
vol_t	-	-	-497.241
			(62.607)
Constant	37.268	-2.245	-23.384

		Divisia	
	Model 1	Model 2	Model 3
y_t	1.584	-1022.200	9.785
	(0.087)	(179.970)	(2.401)
I_t	0.032	-9.321	-0.058
	(0.006)	(3.067)	(0.040)
sp_t	-	397.123	-3.635
		(74.405)	(0.995)
vol_t	-	-	99.326
			(12.184)
Constant	0.449	-340.077	5.284

Panel C: 2000Q1 to 2012Q4

	Simple Sum				Divisia	
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
y_t	0.838	2.463	1.838	1.943	1.830	1.856
	(0.562)	(0.358)	(0.487)	(0.146)	(0.039)	(0.048)
I_t	0.004	-0.178	0.092	-0.045	-0.037	-0.035
	(0.029)	(0.021)	(0.030)	(0.006)	(0.002)	(0.003)
sp_t	-	1.009	0.161	-	0.132	0.194
		(0.196)	(0.284)		(0.023)	(0.030)
vol_t	-	-	51.365	-	-	4.560
			(9.796)			(0.716)
Constant	2.072	-2.387	-0.170	0.449	0.121	-0.145

Notes:

(i) Cointegration relationships that do not conform to theory have a grey background.
(ii) Numbers in parentheses are standard errors
(iii) Empty columns indicate that cointegration relationships could not be established with the tests.
(iv) LM statistics are *p*-values

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