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Modelling the Demand for Money in Sub-Saharan Africa (SSA)

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Abstract

In this paper, we extend the work of Hamori (2008) to include three main innovations: (i) we consider an open economy version of money demand which is more representative for small open economies like those in SSA; (ii) we consider both the homogenous and heterogeneous panel cointegration methods to estimate the money demand function in SSA; and (iii) we consider specific analyses for the prominent sub-regions in SSA namely, East Africa, South Africa, Central Africa and West Africa in order to further validate the choice of heterogeneous panel cointegration for modelling money demand in SSA. We find a cointegrating relationship among money demand, income, price level, exchange rate and interest rate in SSA and thus, the consideration of an open economy version is fundamental when modelling money demand in SSA. The specific regressions for the sub-regional units in SSA indicate the existence of heterogeneity in regression estimates. Thus, the consideration of heterogeneous panel cointegration method is valid and ignoring this heterogeneity feature when modelling money demand for SSA countries may yield biased and inconsistent results.

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1.0 Introduction

Essentially, the empirical analyses of money demand functions have been well documented in the literature. A number of these studies have focused on country specific analyses (see for example, Baba et al.,1992 for USA; Drake and Chrystal, 1994 for UK; Fielding, 1994 covering individually four African countries namely Cameroon, Ivory Coast, Kenya and Nigeria; Bahmani-Oskooee and Shabsigh, 1996 for Japan; Haug and Lucas, 1996 for Canada; Lutkepohl and Wolters, 1998 for Germany; Deng and Liu, 1999 for China; Nell, 1999 for South Africa; Choi and Oxley, 2004 for New Zealand; Akinlo, 2005 for Nigeria; Bahmani-Oskooee and Economidou, 2005 for Greece; and James, 2005 for Indonesia). Some studies have as well captured a cross-section of countries. For example, Artis et al. (1993) and Dreger et al. (2006) deal with EU; Arrau et al. (1995) and Kumar (2011) focus on selected Developing countries; and Bahmani-Oskooee and Rehman (2005) and Kumar and Rao (2012) cover selected Asian countries.

Unlike EU and Asia, the issue of modelling regional money demand is very recent in Sub-Saharan Africa (SSA). To the best of our knowledge, Hamori (2008) appears to be the only notable work in this regard. The latter considers only the long-run relationship using a non-stationary approach. He finds evidence of a cointegrating relationship of the money demand function in SSA. In the present study however, we add three main innovations to improve the work of Hamori (2008). First, we consider an open economy version of money demand which is more representative for small open economies like those in SSA. Second, we consider both the homogenous and heterogeneous panel cointegration methods to estimate the money demand function in SSA. The latter method is included to capture any probable significant difference in the estimates of the money demand function across the SSA countries. In fact, Horváth et al. (2011) in the modelling of money demand for Central Europe, show that the estimates of money demand differ even for very similar countries and propose that heterogeneous panel cointegration methods be used. Third, in the former method, we consider specific analyses for the prominent sub-regions in SSA namely, East Africa, South Africa, Central Africa and West Africa in order to further validate the choice of heterogeneous panel cointegration for modelling money demand in SSA.

We find a cointegrating relationship among money demand, income, price level, exchange rate and interest rate and therefore the consideration of an open economy version is fundamental when modelling money demand in SSA. This finding is consistent with the work of Dreger et al (2006) which concludes that a well-behaved long-run money demand relationship in the Member States of the European Union (EU) can be identified only if the exchange rate as part of the opportunity cost is included. In addition, the specific regressions for the sub-regional units in SSA indicate the existence of heterogeneity that has to be dealt with in the analysis of the money demand function. Thus, the consideration of heterogeneous panel cointegration method is valid and ignoring this heterogeneous feature when modelling money demand for SSA countries may yield biased and inconsistent results (see also Baltagi, 2008 and Horváth et al., 2011).

The next section deals with the methodology employed in this paper. While analyses of results are presented in section three, section four concludes the paper.

2.0 Methodology

2.1 The Model

The demand for money is conventionally assumed to be influenced by the level of income and interest rates and these factors are usually explained in terms of the transactions, the precautionary, and the speculative motives of money demand. While the level of income is the main factor influencing the first two mentioned motives of money demand, the rate of interest which represents the opportunity cost of holding money is assumed a major driving factor for the third motive. Further, for developing countries (as in Sub-Saharan Africa) where the financial markets are either absent or partly developed, studies have revealed that another opportunity cost of holding money is the cost of physical capital or inflation rate. We also include exchange rate to capture small open economies like the countries in SSA (see Horváth et al., 2011). In functional form, the demand for money is usually expressed as:

$$\left(\frac{M}{P}\right)_t = f\left(\left(\frac{Y}{P}\right)_t, R_t,\ EXR_t\right) \tag{1}$$

where M is the narrow money, P is the price index, Y is the nominal GDP as a measure of income, R is the nominal interest rate and EXR denotes nominal effective exchange rate. By further simplifications and taking the natural logarithm of the resulting equation would give the demand for money equation expressed in panel data framework as:

$$ln(M_{it}) = \alpha + \beta_1 ln(Y_{it}) + \beta_2 ln(P_{it}) + \beta_3 ln\ (R_{it}) + \beta_4 ln(EXR_{it}) + \varepsilon_{it}; \tag{2}$$

$$\beta_1, \beta_2, > 0;\ \ \beta_3, \beta_4 < 0$$

Typically, the demand for money is positively determined by the price level and income and negatively related to its opportunity cost, the interest rate and exchange rate. Equation (2) represents the static (long-run) demand for money function. However, the dynamic adjustments are captured using the ECM derived from equation (2) and is expressed as:

$$\Delta ln(M_{it}) = \mu + \sum_{\tau=1}^{m} \gamma_\tau \Delta ln(M_{it-\tau}) + \sum_{i=0}^{p} \varphi_i \Delta ln(Y_{it-i}) + \sum_{j=0}^{q} \delta_j \Delta ln\big(P_{it-j}\big) + \sum_{r=0}^{k} \vartheta_r \Delta ln(R_{it-r}) + \sum_{\lambda=0}^{h} \phi_\lambda \Delta ln(EXR_{it-\lambda}) - \alpha ECF_{it-1} + v_{it};\ \ v_{it} \sim N(\,0, \sigma_v^2) \tag{3}$$

where ECF represents the error correction factor and is usually used to measure the speed of adjustment of the money demand function to its steady state when there is disequilibrium. The Hendry type General-to Specific (GETS) approach is used to obtain the parsimonious model. The ECF is obtained as:

$$ECF_{it} = ln(M_{it}) - (\alpha + \beta_1 ln(Y_{it}) + \beta_2 ln(P_{it}) + \beta_3\ ln(R_{it}) + \beta_4\ ln(EXR_{it})) \tag{4}$$

Thus, in this paper, we estimate both equations (2) and (3) to obtain estimates for the long run and short run dynamics of money demand function in SSA respectively. Note that in the homogenous case, the underlying assumption is that $\beta_i = \beta$ while in the heterogenous case, $\beta_i \neq \beta$. By implication, the homogenous panels constrain the regression coefficient vector to be equal across panels whereas the heterogeneous panels fit parameters as averages of the N individual group regressions. Here, β_i is the regression parameter for each cross-sectional unit and β represents the pooled regression parameter.

2.2 Estimation Procedure

The analyses in this paper are carried out in three phases. First, we conduct Panel unit roots using the prominent tests namely Levin, Lin and Chu Test, Im, Pesaran and Shin Test, ADF Fisher Chi Square Test and PP Fisher Chi Square Test. Second, we perform Panel cointegration tests using the theoretically validated tests namely Residual-Based DF and ADF Tests (Kao Tests) and Johansen Fisher Panel Cointegration Test.[1] Third, we estimate the cointegrating equations from equation (2) using the fully modified OLS (for the homogeneous case) and mean-group estimator (for the heterogeneous case) to obtain both the long-run and short run elasticities. To facilitate the estimation of the heterogeneous panel cointegration, we apply the *xtpmg* command in STATA which aids in the estimation of large-N and large-T panel-data models, where non-stationarity may be a concern.

2.3 Data

We use annual data for the period 1980 to 2010 (an extension of the period used by Hamori, 2008) for 24 Sub-Saharan African countries. As earlier mentioned, these countries are further divided into sub-regions for region-specific analyses. A list of the countries used is presented in the appendix (see table 1). Data utilized for estimation are obtained from the World Development Indicators (WDI) Database.

3.0 Results and Policy Implications

3.1 Panel Unit Root Test

Tables 2 and 3 (in the appendix) present the results of the unit root tests conducted for all the variables both at their level and first difference respectively. The tests are conducted for all the selected SSA countries (pooled) and the sub-regions (namely West Africa, East Africa, Central Africa and Southern Africa). Descriptive statistics like the line plot reveal that the variables used have individual effects and individual linear trends. Hence, the unit root tests carried out take cognizance of these characteristics of the data used. The results show that all the variables (both exogenous and endogenous) are stationary at their first difference with individual effects and individual linear trend. Having established the order of integration of the variables, we further conduct the panel cointegration test.

[1] See Baltagi (2008) for a comprehensive theoretical exposition on Panel unit root tests and Panel Cointegration tests.

3.2 Panel Cointegration Test

Having established that all our variables are integrated of the same order, we adopt both a residual-based panel cointegration test (that is the Kao test) and the Johansen-type panel cointegration test to examine if there exists a long run relationship among the variables used. As presented in Table 4 (in the appendix), the null hypothesis of no cointegrating relationship among the variables in equation (2) can be rejected and we accept that there is at least one cointegrating vector for the selected SSA countries and the sub-regions at 5 percent level of statistical significance. Thus, our evidence appears to validate the findings of Hamori (2008) that a stable money demand function exists in SSA. The next contention however relates to the magnitude of elasticity coefficients for this demand function. The next sub-sections deal with the long-run and short run elasticities of the money demand function for SSA.

3.3 Long Run Elasticity Coefficients

Given that our cointegration tests establishing cointegrating relationships, we apply both the homogenous and heterogeneous panel estimation methods to obtain the long run elasticity coefficients. The results obtained in the former case are presented in Table 5. For the full sample, it is apparent that the results meet apriori expectations (except for the price level which is negative). The long run income elasticity coefficient is positive of about 0.9 while the elasticity coefficient of interest rate is negative of about 0.98. This result is in line with Hamori (2008) and Kumar and Rao (2012) who also find an income elasticity coefficient of about 0.9 in studies carried out for selected SSA and Asian countries respectively. The results for the different regions in SSA however differ. These variations may be underscored by the fact that the interest rate, inflation and degree of dollarization differ greatly across these sub-regions (see also Luca and Petrova, 2008, and Rosenberg and Tirpak, 2009; Horváth et al., 2011). While all the regressors are statistically significant in the case of Central Africa and East Africa, only price is not significant in the money demand function for South Africa and exchange rate and interest rate are not statistically significant for West Africa. These significant variations in the money demand functions across the sub-regions in SSA indicate some level of heterogeneity that has to be dealt with in the empirical analyses of money demand function for SSA. This is one of the contributions of this paper.

Table 6 shows the results of the heterogeneous panel estimation for the selected SSA countries. All the long run elasticity coefficients are correctly signed and statistically significant and thus, money demand function for SSA is sensitive to changes in income, price, interest rate and exchange rate. We find that the demand for narrow money is positively related to both income and price and negatively to both interest rate and exchange rate. In addition, we find that the income elasticity coefficient of 0.72 is slightly lower than that obtained under the homogenous panel. This indicates that by accounting for the heterogeneity feature in the demand function, it seems that the quantity theory of money, supporting a long-run income elasticity of unity, does not apply in the context of SSA. This may suggest that the supply of money should grow more sluggishly than output to achieve the goal of price stability (see Ball, 2001).

The negative relationship between money demand, interest rate and exchange rate depict that individuals diversify their portfolios in the economy either by acquiring other financial and/or real assets such as stocks, bonds and real estate property or by substituting other currencies such US Dollar and UK Pounds Sterling for domestic currency in their financial portfolio (see also

Valadkhani and Alauddin, 2003). The relationship between money demand and exchange rate in SSA is also consistent with the work of Bahmani-Oskooee (1996) which argued that if a depreciation of domestic currency results in an increase in expectations of further depreciation, the public may decide to hold more foreign currency and less domestic money. Overall, the findings suggest that the demand for money in SSA is a necessity. In the long run, the demand for money in SSA is driven by the level of income, exchange rate and rates of interest and inflation.

3.4 Short Run Elasticity Coefficients

Another contribution of this paper is the estimation of short run elasticity coefficients for money demand function in SSA. Our cointegration analyses establish the long run relationship and estimates. However, a more insightful result can be obtained from the dynamic adjustment model as specified in equation (3). This estimation provides the short run elasticity coefficients on one hand and on the other hand, it gives the speed of adjustment of the money demand function to its long run or steady state level in the event of transitory shocks or distortions. Table 7 (in the appendix) reveals the estimates of the error correction model for the selected SSA countries using the heterogeneous panel estimation. The results of the parsimonious model reveal that the coefficient of the error correction term is significant and negative. This lends further support to our earlier result that the estimated variables are cointegrated. However, only the level of income and the error correction mechanism are statistically significant. Thus, in the short run, the demand for money responds more actively to increase in income than other variables. The short run income elasticity coefficient of money demand is about 0.56. This implies that, ceteris paribus, a 1 percent increase in income will result into about 0.56 percent increase in money demand in Sub-Saharan Africa in the short run. Although, this figure is lower than that of the long run, they both ascertain the necessary nature of money demand in SSA.

The coefficient of the error correction term of about -0.15 implies that about 15 percent of the adjustment towards the equilibrium takes place in the first year. Therefore, it will take approximately 6.5 years for the money demand function to adjust fully to transitory shock. This is close to the result obtained for the speed of adjustment of the money demand function of selected Asian countries by Kumar and Rao (2012) involving Fixed Effects Error Correction Model (FE-ECM). Overall, the speed of adjustment of money demand in SSA is quite slow in responding to transitory shock.

4.0 Conclusion

This paper empirically models the demand for money in 24 selected SSA countries and the regions therein using both homogeneous and heterogeneous panel estimation methods. It finds the existence of a cointegrating relationship among money demand, income, price level, interest rate and exchange rate. More specifically, the consideration of an open economy version of money demand function for small open economies in Africa is desirable as it provides more insightful information in the modelling framework. For example, we have been able to establish that in the event of exchange rate depreciation, the public may decide to hold more foreign currency and less domestic money. We also find that the income elasticity of money demand in SSA is less than 1 which indicates money demand rises less than 1-to-1 with a rise in income. In the same vein, an increase in the interest rate or return on nonmonetary assets decreases the demand for money and thus, individuals appear to diversify their portfolios in the economy.

Further, the dynamic error correction analysis carried out reveals that, in the event of any distortion to the money demand, only about 15 percent of such shock is restored within a period of one year while it takes approximately 6.5 years for long run equilibrium to be restored.

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Appendix: Tables

Table 1 : SSA countries used in the analysis

West Africa	Central Africa	Southern Africa	East Africa
Burkina Faso	Cameroon	Botswana	Kenya
Cote d'Ivoire	Central African Republic	Lesotho	Seychelles
Gambia	Chad	Malawi	Uganda
Ghana	Congo DR	Mauritius	
Mali	Gabon	South Africa	
Mauritania		Swaziland	
Niger		Zambia	
Nigeria			
Senegal			
Togo			

Table 2: Panel Unit Root Test Result (At level)

Countries		At level			
		LLC	*IPS*	*ADF*	*PP*
All Selected SSA Countries	*LOG(M1)*	1.39 *(0.92)*	9.63 *(1.00)*	24.88 *(1.00)*	31.34 *(1.00)*
	LOG(NGDP)	-4.98 *(0.00)*	4.46 *(1.00)*	47.77 *(0.98)*	65.46 *(0.63)*
	LOG(P)	-5.53 *(0.00)*	1.12 *(0.87)*	75.63 *(0.24)*	162.39 *(0.00)*
	LOG(R)	-0.01 *(0.49)*	-0.45 *(0.33)*	82.67 *(0.14)*	100.66 *(0.00)*
West Africa	*LOG(M1)*	-0.96 *(0.17)*	4.67 *(1.00)*	15.61 *(0.95)*	15.40 *(0.95)*
	LOG(NGDP)	-2.16 *(0.02)*	3.12 *(0.99)*	13.97 *(0.97)*	13.98 *(0.97)*
	LOG(P)	-4.50 *(0.00)*	-0.90 *(0.19)*	39.22 *(0.03)*	57.55 *(0.00)*
	LOG(R)	-2.06 *(0.00)*	-0.66 *(0.25)*	24.58 *(0.54)*	39.50 *(0.04)*
Central Africa	*LOG(M1)*	3.30 *(0.99)*	5.16 *(1.00)*	0.68 *(1.00)*	0.91 *(1.00)*
	LOG(NGDP)	-0.42 *(0.34)*	2.33 *(0.99)*	3.41 *(0.99)*	5.52 *(0.94)*
	LOG(P)	-1.72 *(0.04)*	0.64 *(0.74)*	8.30 *(0.76)*	9.64 *(0.64)*
	LOG(R)	3.68 *(0.99)*	4.17 *(1.00)*	1.26 *(0.99)*	1.12 *(1.00)*
Southern Africa	*LOG(M1)*	-0.07 *(0.47)*	3.41 *(0.99)*	2.66 *(0.99)*	4.99 *(0.99)*

	LOG(NGDP)	-5.18 *(0.00)*	-0.85 *(0.20)*	19.04 *(0.16)*	32.67 *(0.00)*
	LOG(P)	-4.15 *(0.00)*	-0.82 *(0.21)*	19.60 *(0.14)*	77.46 *(0.00)*
	LOG(R)	-2.83 *(0.00)*	-3.63 *(0.00)*	41.65 *(0.00)*	23.32 *(0.05)*
	LOG(M1)	4.50 *(1.00)*	7.22 *(1.00)*	0.05 *(1.00)*	0.02 *(0.00)*
	LOG(NGDP)	1.70 *(0.96)*	5.56 *(1.00)*	0.67 *(1.00)*	0.63 *(1.00)*
	LOG(P)	0.56 *(0.71)*	4.06 *(1.00)*	0.82 *(0.99)*	0.60 *(1.00)*
East Africa	*LOG(R)*	0.51 *(0.70)*	-0.19 *(0.44)*	8.45 *(0.58)*	28.90 *(0.00)*

Source: Authors' Computation.
Note: LCC, IPS, ADF and PP represent Levin, Lin and Chu Test; Im, Pesaran and Shin Test; ADF Fisher Chi Square Test and PP Fisher Chi Square Tests respectively. P values are in italics and brackets

Table 3: Panel Unit Root Test Result (At first difference)

Countries		**At First Difference**				**Order of Integration**
		LLC	*IPS*	*ADF*	*PP*	
	LOG(M1)	-11.23 *(0.00)*	-12.81 *(0.00)*	304.58 *(0.00)*	588.47 *(0.00)*	I (1)
	LOG(NGDP)	-8.22 *(0.00)*	-9.74 *(0.00)*	233.49 *(0.00)*	408.90 *(0.00)*	I (1)
	LOG(P)	-10.25 *(0.00)*	-10.21 *(0.00)*	261.24 *(0.00)*	298.24 *(0.00)*	I (1)
All Selected SSA Countries	*LOG(R)*	-12.97 *(0.00)*	-14.49 *(0.00)*	352.72 *(0.00)*	590.88 *(0.00)*	I (1)
	LOG(M1)	-7.68 *(0.00)*	-8.14 *(0.00)*	118.68 *(0.00)*	232.00 *(0.00)*	I (1)
	LOG(NGDP)	-5.46 *(0.00)*	-6.37 *(0.00)*	90.70 *(0.00)*	143.21 *(0.00)*	I (1)
	LOG(P)	-8.65 *(0.00)*	-6.59 *(0.00)*	93.58 *(0.00)*	106.36 *(0.00)*	I (1)
West Africa	*LOG(R)*	-8.11 *(0.00)*	-8.88 *(0.00)*	127.60 *(0.00)*	247.85 *(0.00)*	I (1)
	LOG(M1)	-5.95 *(0.00)*	-5.50 *(0.00)*	53.08 *(0.00)*	89.15 *(0.00)*	I (1)
	LOG(NGDP)	-3.4 *(0.00)*	-4.90 *(0.00)*	49.91 *(0.00)*	82.03 *(0.00)*	I (1)
	LOG(P)	-5.58 *(0.00)*	-5.98 *(0.00)*	59.14 *(0.00)*	66.07 *(0.00)*	I (1)
Central Africa	*LOG(R)*	-5.51 *(0.00)*	-5.54 *(0.00)*	52.66 *(0.00)*	110.81 *(0.00)*	I (1)

Southern Africa	*LOG(M1)*	-6.95 *(0.00)*	-7.28 *(0.00)*	76.82 *(0.00)*	149.35 *(0.00)*	I (1)
	LOG(NGDP)	-4.34 *(0.00)*	-3.28 *(0.00)*	35.99 *(0.00)*	76.56 *(0.00)*	I (1)
	LOG(P)	-5.24 *(0.00)*	-4.96 *(0.00)*	53.30 *(0.00)*	65.06 *(0.00)*	I (1)
	LOG(R)	-11.55 *(0.00)*	-10.12 *(0.00)*	110.48 *(0.00)*	105.76 *(0.00)*	I (0)
East Africa	*LOG(M1)*	-2.43 *(0.00)*	-3.36 *(0.00)*	29.69 *(0.00)*	74.86 *(0.00)*	I (1)
	LOG(NGDP)	-3.37 *(0.00)*	-3.49 *(0.00)*	31.44 *(0.00)*	56.80 *(0.00)*	I (1)
	LOG(P)	-5.29 *(0.00)*	-5.03 *(0.00)*	44.54 *(0.00)*	42.66 *(0.00)*	I (1)
	LOG(R)	2.96 *(0.99)*	-2.76 *(0.00)*	29.26 *(0.00)*	70.89 *(0.00)*	I (1)

Source: Authors' Computation.
Note: LCC, IPS, ADF and PP imply Levin, Lin and Chu Test; Im, Pesaran and Shin Test; ADF Fisher Chi Square Test and PP Fisher Chi Square Tests respectively. P values are in italics and brackets

Table 4: Panel Cointegration Test Result

Kao Residual Cointegration Test				
	Test Statistics	P value		
All Selected SSA Countries	2.106	0.017		
West Africa	4.650*	0.000		
Central Africa	5.768*	0.000		
Southern Africa	3.531*	0.000		
East Africa	3.013*	0.001		
Johansen Fisher Cointegration Test				
	Trace Test	P value	Maximun Eigenvalue Test	P value
All Selected SSA Countries	161.2	0.000	116.8	0.000
West Africa	37.26	0.010	32.58	0.037
Central Africa	25.46	0.013	18.06	0.114
Southern Africa	34.8	0.001	21.47	0.090
East Africa	31.25	0.000	24.48	0.002

Source: Authors' Computation.
Note: For all the regions, we have at least 1 cointegrating relationship among the variables used.

Table 5: Long-Run Elasticity Coefficients
Method: Homogenous Panel Estimation
Dependent Variable: *LOG(M)*

	Independent Variables			
	LOG(NGDP)	*LOG(P)*	*LOG(EXR)*	*LOG(R)*
All Selected SSA Countries	1.0552***	-0.8342***	-0.0992***	-0.9819***
	(33.654)	*(-33.968)*	*(-2.5339)*	*(-11.710)*
West Africa	0.9953***	0.0431*	-0.0022	-0.0223
	(77.055)	*(1.7081)*	*(-0.1197)*	*(-0.4900)*
Central Africa	0.8451***	-0.6556***	-0.1628***	-0.9408***
	(42.644)	*(-9.5929)*	*(-2.5225)*	*(-12.392)*
Southern Africa	1.0790***	-0.0136	-0.0778***	-0.1545**
	(58.734)	*(-0.5838)*	*(-3.2037)*	*(-2.1396)*
East Africa	1.1829***	0.2277***	-0.3732***	-0.4358***
	(40.141)	*(9.1837)*	*(-8.3202)*	*(-6.9258)*

Source: Authors' Computation.
Note: The t-statistics for the coefficients are in italics and bracket below them. *, **, *** represent 10%, 5% and 1% levels of statistical significance respectively.

Table 6: Long-Run Elasticity Coefficients **Method: Heterogeneous Panel Estimation** **Dependent Variable:** *LOG(M)*		
Variable	Coefficient	T-Stat.
LOG(NGDP)	.722719	9.61***
LOG(P)	.569308	4.85***
LOG(EXR)	-.1631084	-2.06**
LOG(R)	-.5784214	-7.98***
No. of Observations	684	
Breusch-Godfrey LM test for autocorrelation	2.524	
ARCH LM tests	4.043	

Source: Authors' Computation.

Note: *, **, *** represent 10%, 5% and 1% levels of statistical significance respectively. Breusch-Godfrey LM test for autocorrelation tests for higher order serial correlation with the null hypothesis (H_0): no serial correlation. The ARCH (autoregressive conditional heteroskedasticity) LM test is used to test for time varying conditional heteroscedasticity. The ARCH LM test has the null hypothesis (H_0): no ARCH effects.

Table 7: Short Run Elasticity Coefficients **Method: Heterogeneous Panel Estimation** **Dependent Variable:** *LOG(M)*		
Variable	Coefficient	T-Stat.
D(LOG(NGDP))	.5597376	4.59***
D(LOG(P))	.1711767	1.27
D(LOG(EXR))	-.0023214	-0.04
D(LOG(R))	-.0437845	-1.50
EC(-1)	-.1538888	-4.27***
No. of Observations	684	
Log Likelihood	566.5751	
Breusch-Godfrey LM test for autocorrelation	2.524	
ARCH LM tests	4.043	

Source: Authors' Computation.

Note: The *, **, *** represent 10%, 5% and 1% levels of statistical significance respectively.