ESTIMATING AN AGGREGATE IMPORT DEMAND FUNCTION FOR GHANA

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ABSTRACT

Imports are very crucial for the survival of a small open economy such as Ghana. In this paper, we estimate an import demand function for Ghana for the period 1970 to 2002, as well as consider the time series properties of the data. The time series behaviour of the data indicates a long term relationship between real exchange rates, GDP, and merchandise import. Our empirical estimates suggest that real income (GDP) is the main factor influencing imports in Ghana. The results also indicate that economic growth (real GDP) and depreciation in the local currency could stimulate increased demand for merchandise imports. Further analysis revealed that shocks to imports, real GDP and real exchange rate are important in explaining various innovations in the error variance of each of these variables at different time horizons and at different magnitudes. Particularly, the evidence shows that at short time periods about 65%, 95% and 80% of shocks to real exchange rates, merchandise imports and GDP respectively, are attributed to own shocks.

Keywords: *Ghana, import demand, variance decomposition, real GDP, relative prices.*

INTRODUCTION

Since the early 1990's, the Republic of Ghana has sought extensive reforms to reverse previous inward-looking policies (e.g. import-substitution industrialisation), and trade liberalization has been an integral part to them.

Imports are of extreme importance to a resource-constraint developing economy such as Ghana for development. Fuel and energy, mainly oil, accounted for 16 percent of 1990 imports; capital goods, 43 percent; intermediate goods, 28 percent; and consumer goods, 10 percent, according to the World Bank (World Bank, 2004). Between 1960 and 2002 manufactured imports have constituted about 65.28% of merchandise imports (World Bank, 2004). For the past decade, oil imports have constituted an average of about 21 per cent of total merchandise imports (Bank of Ghana, 2008).

Trade is essential to Ghana's economic development. Merchandise imports as a share of GDP have expanded substantially, from 29% in 1993 to 39%, in 1998. A significant portion – around 55 per cent – of Ghana's GDP was spent on import payments in 2002. Trade is relatively concentrated, both in commodities

and markets. Primary products, overwhelmingly gold and cocoa, account for most exports. Non-traditional exports, including, processed food, timber, and aluminium products, account for 20% of exports, up from 3% in 1986. However, export diversification has slowed. Most manufactured products, along with machinery and other inputs, are imported. Ghana is a net importer of services, especially of "freight and merchandise insurance".

Ghana's main trading partner remains the European Union (EU), accounting for almost half of total exports - partly due to trade preferences — and imports. Within the EU, Italy has overtaken the United Kingdom and Germany as the main export markets. Italy, the United Kingdom, and France are the main European sources of imports. Ghana's regional trade with members of the Economic Community of Western African States (ECOWAS) accounted for 17% of exports in 1999, up from 13% in 1994. The share of African imports also rose, from 23% in 1994 to 27% in 1999.

With the recent stabilisation of the macro economy, increasing national incomes, stable foreign exchange rates, reducing import tariffs and, reducing import prices may have contributed to the increasing trends in imports into the country. Anyemedu (1995) has argued that policies to liberalise trade in the Ghanaian economy have increased the aggregate import demand. The degree, however, to which imports may promote economic development in Ghana, will depend on changes in key composition of import demand as well as the capacity that the economy has developed to substitute domestic production for imported goods.

Oteng-Abayie and Frimpong (2008) estimated an Aggregate Import Demand Function of Ghana using disaggregated expenditure components. Our focus however is different as we look at aggregate expenditure and other macroeconomic factors. Given the vital role played by imports in foreign trade and economic development, there is clearly a need to provide more evidence on Ghana that would help guide policymakers to predict the response of imports to shocks under foreign exchange liberalisation. The paper will also determine whether there exist a long run relationship between Ghana's aggregate import and its major components for the period 1970 to 2002.

There is a vast body of empirical literature on the determinants of aggregate imports. Quite a few studies in sub Saharan African countries suggest that real GDP, real effective exchange rate, and relative prices are the major determinants of aggregate import demand.

Mwega (1993) used annual data for the period 1964-91, and finds non-significant or marginally significant short-run relative price (-0.156) and real income (0.888) aggregate import demand elasticities for Kenya. On the other hand, aggregate imports are significantly responsive to previous imports (0.181), to lagged foreign exchange reserves (0.16) and to foreign exchange receipts (0.129). The error correction model (ECM) coefficient (-1.02) is found significant, validating the ECM specification and suggesting that errors are fully corrected within the year. Mwega (1993) therefore concludes that for Kenya, the estimation results suggest that policies which directly increase export earnings and access to external capital inflows are likely to have a larger impact on import volumes than policies concentrating primarily on aggregate demand and exchange rate management.

Egwaikhide (1999) used annual data from 1953 -89 and reports the following short-run aggregate import demand elasticities for Nigeria: (a) previous imports are found non-significant; (b) lagged foreign exchange earnings (0.308), relative prices (-0.895) and real income (0.587) are found to strongly influence total imports in Nigeria; and (c) a significant ECM coefficient (-0.411) validates the ECM specification and suggests that errors are not fully corrected within the year. Egwaikhide (1999) therefore concludes that for the case of Nigeria, foreign exchange earnings, relative prices, and real income play important roles in influencing import behaviour. However, the effects of foreign exchange availability are found particularly

remarkable. It is thus suggested that to increase total imports, it would be essential to implement a set of macroeconomic and sector-specific policies that considerably relax the binding constraint on foreign exchange availability. Also, the near unity of the price elasticity of import demand suggests high sensitivity of demand for imports. Therefore, assuming neutrality of other economic policies, he suggests that devaluation can reduce the demand for aggregate imports.

ECONOMETRIC MODEL AND DATA

The econometric model used to estimate aggregate import demand for imports into Ghana is dictated by the typical formulation postulated by economic theory. Adapting the theoretical framework proposed by Senhadji (1998) cited in Agbola and Damoense (2005), we assume that Ghana's merchandised import decision is made up of economic agents who decide how much domestically produced goods (d_t) and imported goods (m_t) to consume. Here, the domestically produced merchandise serves as a numéraire. The intertemporal decision problem of economic agents can be expressed as:

$$Max_{\{d_t, m_t\}_{t=n}^{\infty}} = E_0[\sum_{t=0}^{\infty}(1+\varphi)^{-1}u(d_t, m_t)] \quad (1)$$

Subject to the constraints:

$$b_{t+1} = (1+i_t)b_t + (e_t - d_t) - p_t m_t \quad (2)$$

$$e_t = (1-\rho)\bar{e} + \rho e_{t-1} + \omega_t \quad \omega_t \sim (0, \sigma^2) \quad (3)$$

$$\lim_{T\to\infty} \frac{b_{T+1}}{\prod_{t=0}^{T}(1+i)^{-1}} = 0 \quad (4)$$

where φ is the consumer's subjective discount rate, i is the world's interest rate, b_{t+1} is the next period stock of imported merchandise if positive, and the next period's deficit if negative, e_t is the stochastic endowment. The error term is assumed to follow an autoregressive AR (1) process with unconditional mean ε and an unconditional variance $\sigma^2/(1-\rho^2)$ and where σ^2 is the variance of the independent and identically distributed (*iid*) innovation ω_t; and ρ determines the degree of persistence of the endowment shock; and p_t is the relative prices of imported merchandise (Senhadji, 1998).

From above, the expression in equation (2) represents the domestic trade equation; equation (3) represents the stochastic process driving domestic merchandise production; and equation (4) denotes the transversality condition that rules out Ponzi games (Senhadji, 1998). Now, the first order conditions of the intertemporal decision problem are:

$$u_t^d = \lambda_t \quad (5)$$

$$u_t^m = \lambda_t p_t \quad (6)$$

$$\lambda_t = (1+\varphi)^{-1}(1+i)E_t\lambda_{t+1} \quad (7)$$

where λ_t is the Lagrange multiplier on the domestic trade equation.

Following Clarida (1994) as espoused by Senhadji (1998), we assume that the instantaneous utility function u is addilog, such that we have:

$$u(d_t, m_t) = A_t d_t^{1-\alpha}(1-\alpha)^{-1} + B_t m_t^{1-\beta}(1-\beta)^{-1}$$

$$\text{for } \alpha>0, \beta>0 \quad (8)$$

$$A_t = e^{a_0+\varepsilon_{A,t}} \quad (9)$$

$$B_t = e^{b_0+\varepsilon_{B,t}} \quad (10)$$

where A_t and B_t are exponentially stationary random shocks to preferences, and $\varepsilon_{A,t}$ and $\varepsilon_{B,t}$ are stationary shocks and α and β are curvature parameters.

Substituting equation (8) into equations (5) and (6) and simplifying yields the following,

$$d_t = \lambda_t^{-1/\alpha} A_t^{1/\alpha} \quad (11)$$

and

$$m_t = \lambda_t^{-1/\beta} B_t^{1/\beta} p_t^{-1/\beta} \quad (12)$$

Now, substituting equations (11) and (12) into equation (2), and taking logs, and simplifying we have

$$\tilde{m}_t = c - \frac{1}{\beta}\tilde{p}_t + \frac{\alpha}{\beta}\tilde{d}_t + \varepsilon_t \qquad (13)$$

Where $\tilde{m}_t$ is the log of import quantity, $\tilde{p}_t$ is the log of relative prices and $\tilde{d}_t$ is the log of GDP and the other variables are as defined above.

As pointed by Hooper and Marquez (1995), much of the work in this area since Goldstein and Khan (1985) have focused on the relationship between exchange rates and trade prices, i.e. exchange rate pass-through, rather than price and income elasticities themselves. Following Tambi (1998) for Cameroon and Annie (2000) for Fiji, we also incorporate real effective exchange rate (RER) in our import demand model as a policy variable. Movements in the RER affect resource allocation by changing the country's competitiveness in international trade. A declining RER effectively increases Ghana's competitiveness and supports her exports but is also reflected in higher import costs.

The import demand function in equation (13) is similar to the standard import demand equation specified in the econometric literature (see Amano and Wirjanto, 1996; Sinha, 1997; Dutta and Ahmed, 2001). Based on the extensive literature on the elasticity approach (see also Apostolakis, 1991, for a survey), the import demand function in equation (13) can be expressed in the form:

$$\text{In } IMP_{it} = a_O + a_1 \text{ In } GDP_{it} + a_2 \text{ In } RPI_{it}\varepsilon_t \qquad (14)$$

where lnIMP_{jt} refers to the real value of import quantity (in Cedis) in period *t*, lnGDP_t denotes real per capita GDP for Ghana in period *t*, and RP_{jt} denotes relative prices of imports, defined as the ratio of import price index to domestic consumer price index in period *t* and represents the price of domestic substitutes, RER_t denotes real effective exchange rate, and where i = 1, 2, 3 for total imports respectively, *ln* is the natural log, and ε_t is a conventionally assumed disturbance term which satisfies all the stochastic assumptions of ordinary least squares. The use of relative price index eliminates multicollinearity that could potentially exist between import price and domestic price of a product. The model specified in equation (14) is estimated using ordinary least squares (OLS).

We use annual times series data for merchandise imports values, real GDP and real exchange rate from the World Bank's *World Development Indicators* (2004). Data on the consumer price index (domestic prices) and export price index data are taken from the IMF's International *Financial Statistics* (2004).

RESULTS AND DISCUSSION

Descriptive Statistics

The summary statistics of the logarithmic transformation of the series are given in Table 1.

Table 1: Descriptive Statistics

Statistic	GDP	IMP	RER	RPI
Mean	22.34824	21.44297	5.276596	22.73388
Std Dev	0.261919	0.409446	0.959811	0.937537
Skewness	0.679864	-0.04092	1.256651	0.427260
Kurtosis	2.087514	2.360402	3.204405	3.821050
Jarque-Bera	3.687053	0.571705	6.093536	1.930949
p-values	*(0.15825)*	*(0.751375)*	*(0.047512)*	*(0.38080)*

Real GDP has the highest mean value, while real exchange rates record the lowest mean value. Over the sample period, the relative prices of imports and the real exchange rate have shown much volatility than real GDP and merchandise import volumes. It is clear from the summary statistics that none of the variables in our model follows a normal distribution. Imports are negatively skewed while exchange rates, GDP and relative import prices are all positively skewed. The p-values from the Jarque-Bera statistic indicate that we can accept the null hypothesis of normal distribution at the 1% significance level for all the variables.

Table 2. Unit Root Test Results

	H_0: unit roots I (1). H_1: trend stationary I (0)			
	ADF		PP	
Variable	**Level**	**1st Difference**	**Level**	**1st Difference**
GDP	1.016442	-4.17566	- 1.239918	-4.608281
IMP	-1.156572	-4.608281	-1.123941	-4.608281
RER	-1.040727	-3.85550	-3.216849	-6.368480
RPI	-3.213401	-3.833264	-1.130620	-3.833264

***Note**: The MacKinnon critical values for ADF tests are -3.4382 (1%) and -2.8642 (5%). The MacKinnon critical values for PP tests are -3.4335 (1%) and -2.8628 (5%).*

Unit Root Test

Having examined the behaviour of the variables, this section proceeds to examine the time series properties. We employ the Augmented Dickey-Fuller (ADF) test and the Philips-Perron (PP) test. The essence of these tests is primarily aimed at determining the roots that characterise our data.

The results of the unit root are summarised in Table 2. The ADF test statistic for GDP at the level is 1.016442 with corresponding critical values of 1% and 5% as -3.4382 and -2.8642 respectively. We observe that the test statistic is greater than the critical value i.e. it is less negative. It is therefore not possible to reject the null hypothesis of unit root. However the first differences of the logs give us stationary series. From Table 2, the ADF test statistic is now more negative than the critical values at 1% and 5%, and hence, the null hypothesis of a unit root is convincingly rejected. This applies to imports, real effective exchange rates and relative import prices; the levels are I(1) while the first difference of the logs I(0), suggesting there exist a long run relationship among merchandise imports, real exchange rates, GDP and import prices. The Philips-Peron test gives similar results and interpretation except that it incorporates an automatic correction to the Dickey-Fuller procedure to allow for autocorrelated residuals. This evidence of long run relationship among the variables rules out spurious correlations for a well specified model. Given these time series properties of the data, the natural extension would have been to estimate a short run error correction model. However, in this paper, we estimate only long run elasticities and consider the response to shocks and the impact on the various variables for macroeconomic policy making in Ghana. The rational for this exercise is borne out of an obvious limitation in the data.

Variance Decomposition

Figure 1 and Table 4 (see appendix) present variance decomposition results for each variable in our model at the forecast horizon of one through 10 years. The decomposition enables us to understand the proportion of the fluctuation in a series explained by its own shocks versus shocks from other variables. In general we expect a variable to explain almost all its forecast error variance at short time horizons and smaller proportions at longer time horizons. We employ Monte Carlo simulation on the data with 100 repetitions. The first output is the duration of the simulation period, which in this case ranges from year one to year ten. The standard error of the forecast of the variable follows next. The remaining columns provide the decomposition of the individual variables. By construction the percentage of the error variance attributable to own shocks in the first step is 100%.

The contribution of GDP to its own shock from the Table 4A (see appendix) is 100% in the first year. This implies that at relatively short periods of time, shocks to real GDP is explained by

Table 3: Estimates of Aggregate Import Demand Function

	Dependent variable is lnIMP_t	
	Ordinary Least Squares	**Cochrane-Orcutt estimates**
Regressor	Coefficient	Coefficient
Constant	-6.7107 *(-8.2708)*	-3.42015 *(-2.0052)*
ln$RGDP_t$	2.9376 *(8.2022)***	1.43597 *(1.9218)**
lnRPI_t	0.17193 *(2.6494)***	-0.1154 *(-0.8161)*
lnRER_t	0.10761 *(1.8961)**	0.0833017 *(1.1992)*
Diagnostics		
Adj. R^2	0.92237	0.94926
SER	0.13318	0.1103
F-stat.	88.1294 ***	38.0037***
DW	1.103	1.638
SBC	9.6604	-26.6173
AIC	11.9314	-30.9814
χ^2_{Norm}	0.43403 [0.805]	0.30068 [0.860]

(***), (**) and (*) are 1%, 5% and 10% significant levels. t-values are in *(..)*. p-values are in [..].

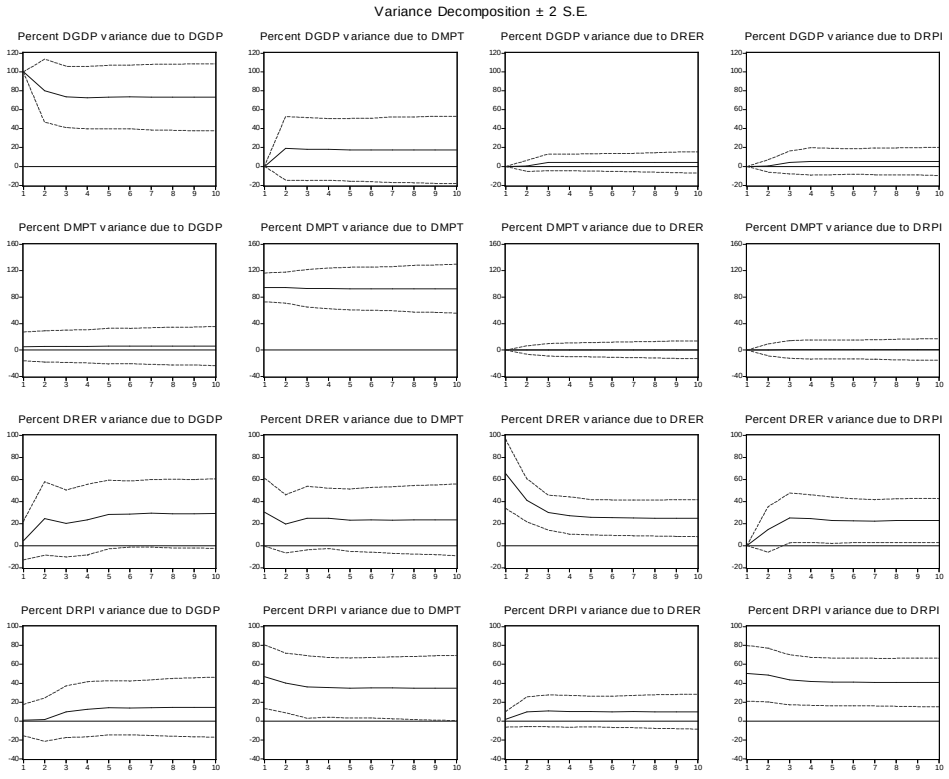

Fig. 1: Variance Decomposition Graphs

the real GDP itself and nothing else. As the time horizon increases from one year, other factors become important in explaining shocks to GDP. For instance in the second step, 80% of the variation in GDP is accounted for by GDP itself whereas real exchange rate fluctuation, merchandise imports, and import prices account approximately for 3.9%, 19% and 3.7% respectively. Over a nine year period, shocks to GDP averaged 73%.

In terms of merchandise imports, close to 95% of the error variance is attributed to imports in the first year. Import prices and exchange rates have little explanatory power at very short time horizons. We reckon this to be typical of the data under consideration. However, as the time horizon increases, import prices and exchange rates become important. By 9 steps ahead (i.e. 9 years in this case), the behaviour of merchandise imports settles to a steady state. Over 93% of the error variance in merchandise imports is attributable to own shocks, while only GDP has much additional explanatory power, about 6%. In Ghana therefore, the most important factor driving the fluctuations in merchandise imports is the shocks (i.e. changes in demand) to the merchandise imports itself.

However the decomposition of the error variance of real exchange rate and import prices give interesting results (Tables 4C and 4D). About 65% of the shocks to real exchange rates is accounted for by own shocks. Clearly the other variables are important in explaining exchange rate shocks. The remaining 35% of shocks to exchange rates is attributed to imports (about 30%), GDP (roughly 5%). This reveals quite clearly that exchange rate fluctuations has much impact on other economic variables within the model, and that real exchange rates, imports and GDP are important in explaining much of the fluctuations in economic activity in Ghana.

CONCLUSION

The study examined the key variables that are important in estimating an import demand function for the economy of Ghana. Data from 1970 to 2002, on real exchange rates, value of merchandise imports, real GDP, and relative import prices were used in the analysis. A time series examination of the data shows I(1) behaviour at the levels and I(0) at the first differences, indicating significant long run relationships. OLS and Cochrane Orcutt techniques were utilised for estimating the long run demand for imports function for Ghana. However, given the short duration of the data coupled with the problem of missing values, we consider only variance decomposition of these variables to unit shocks on each other. The results from the estimation of the aggregate import demand model suggest that real income (GDP) is the main factor influencing imports in Ghana. The results also indicate that output growth (real GDP) and depreciation in the local currency could stimulate increased demand for merchandise imports. The results show that shocks to imports, GDP and real exchange rate are important to explaining various innovations in the error variance of each of these variables at different time horizons and at different magnitudes. These findings when matched against Ghana's increasing GDP and depreciating foreign exchange for the past decade of trade liberalisation; it is not surprising that aggregate import demand has also grown over the same period.

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APPENDIX

Table 4A. Variance Decomposition of GDP

Period	S.E	GDP	IMP	RER	RPI
1	0.020036	100.0000	0.000000	0.000000	0.000000
2	0.022372	80.22221	19.00979	0.393950	0.374053
3	0.023666	73.46235	18.17220	4.195906	4.169548
4	0.023828	72.73058	17.93012	4.140598	5.198703
6	0.024255	73.50966	17.31624	4.051930	5.122180
8	0.024340	73.20608	17.46105	4.142684	5.190190
9	0.024353	73.12572	17.47663	4.138248	5.259404
10	0.024356	73.12793	17.47429	4.138931	5.258847

Table 4B: Variance Decomposition of Merchandise Imports

Period	S.E	GDP	*IMP*	RER	RPI
1	0.150859	5.208174	*94.79183*	0.000000	0.000000
2	0.151951	5.476449	*94.44852*	0.000787	0.074249
3	0.152863	5.552051	*93.41047*	0.275770	0.761707
4	0.153004	5.541851	*93.40863*	0.288590	0.760930
6	0.153496	6.020409	*92.82330*	0.382953	0.773341
8	0.153558	6.016684	*92.77960*	0.392423	0.811295
9	0.153561	6.018065	*92.77645*	0.393667	0.811818
10	0.153577	6.033426	*92.75906*	0.394619	0.812894

Table 4C: Variance Decomposition of Real Exchange rates

Period	S.E	GDP	IMP	*RER*	RPI
1	0.136072	4.551655	30.27148	*65.17687*	0.000000
2	0.188924	24.57943	19.67716	*41.09070*	14.65272
3	0.227094	20.05038	24.94420	*29.87336*	25.13206
4	0.242255	23.54110	24.72526	*27.27707*	24.45657
6	0.254581	28.63086	23.47353	*25.34866*	22.54695
8	0.258011	28.94898	23.37572	*24.96064*	22.71466
9	0.258307	28.88996	23.38347	*24.99503*	22.73154
10	0.258919	29.06599	23.31376	*24.88622*	22.73403

Table 4D: Variance Decomposition of Relative Import Prices

Period	S.E	GDP	*IMP*	RER	RPI
1	6.26E+09	0.958498	*46.84834*	1.732817	50.46034
2	7.39E+09	1.408124	*40.28897*	9.693314	48.60959
3	7.90E+09	9.847987	*35.99463*	10.58448	43.57290
4	8.14E+09	12.33723	*35.56377*	10.09502	42.00397
6	8.38E+09	13.80044	*35.22636*	9.672521	41.30068
8	8.47E+09	14.38281	*34.85717*	9.862486	40.89753
9	8.48E+09	14.36249	*34.89231*	9.860451	40.88474
10	8.49E+09	14.54389	*34.81439*	9.836337	40.80538