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Focus on Ghana-UK-Germany Trade Linkage Model

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GHANA INTEGRATED TO THE WORLD ECONOMY:

FOCUS ON GHANA-UK-GERMANY TRADE LINKAGE MODEL

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Contents

1.0 **Introduction**

The Ghanaian economy is relatively small, open and trade dependent, particular, on the European Union (EU). The EU's economic growth directly affects Ghana's gross domestic product without it being similarly affected to any extent by what happens in Ghana (Sarpong (1997b)).

This study presents a trade-linked macroeconometric model of Ghana, UK and Germany to examine, particularly, the international transmission mechanism of macroeconomic disturbance effects in the trade relation on Ghana's economy. To examine the influence on Ghana of her domestic policies on trade with these economies, we have proposed and estimated a small but 'representative' country model of UK and Germany (and for USA and Japan's bilateral trade links) which are crucial in making specific assumptions of the world economy on Ghana's economic growth prospects. We do not, however, consider tariff and non-tariff barriers to trade in the developed markets as well as supply characteristics in the advanced economies. The estimated equations are in the Keynesian fashion and draw on the work of Kinoshita (1989) and Sarpong (1997a). Data over 1970-1991 are used in the equation estimation. The early data cutoff is largely due to data lags in Ghana's bilateral trade flows.

Trade linked macroeconometric models are constructed with the central objective of providing an analysis and a description of international dependencies and to enhancing the workings of the different economies and their interactions on a global scale. For example, the models of Project Link which provide for a comprehensive coverage of the global economy have expanded considerably from the late 1960s to more than 250 participants and 80 country models linking trade flows, prices, capital flows, interest rates, exchange rates, migration, technology transfers and global commodity markets. More specifically, country trade linked models are provided to study the effect 'lock-in' policies would have on a country's economic growth and development. 'Lock-in' policies connote the 'harmonization and possible co-ordination of economic policies and domestic (trade) laws and institutions' (Rodrik, 1995) of reforming LDCs to credible world institutions such as NAFTA, EU which enhances trade integration to the world and intensification of free trade in goods and services.

The study is set within the 'lock-in' context and the main question to be addressed is: how does external economic perturbations in the EU, US and

Japan influence Ghana's policy goals of GDP growth, (bilateral) export growth, the nominal current account balance and inflation; and, which domestic policy (fiscal) instruments are most influential in "enhancing" these goals in the liberalized world economy. The policy conclusions of the study deals exclusively with the Ghanaian side of the relationship since the linked countries overall importance to each other is significantly more relevant for Ghana. The objective is achieved by systematic perturbation of the model's exogenous variables to highlight some fiscal policy instruments of Ghana that enhances her trade integration to the rest of the world. The model is equipped to study macroeconomic policy options confronting the Ghanaian economy, especially fiscal stimulus measures and policies designed to increase exports. These include aligning real exchange rates that promote domestic production to export and is also competitive with rival countries in world markets.

In what follows, in section 2, we show how Ghana relates to the EU and other trading partners in trade terms. In section 3, we describe the basic structure of the model to be used in simulating the workings of the Ghanaian economy in an integrated world economy. This is a sector by sector overview of each model block with a brief description of the underlying theoretical underpinnings. It also provides a description of the trade linkages that connect economic activity and prices in the economies of Ghana, UK and Germany and to the US and Japan. Appendix A and B report the estimated equations and the list of variables and the sources of data.

For policy application purposes, the estimated model requires a series of validation tests to ascertain how good it is and its suitability for policy simulations. In section 4, we compare some of our model estimated trade parameter elasticities to previous studies. In section 5, we report the simulation results used to validate our model. These include a series of tests on the model: a description of the model's response to a battery of exogenous shocks and of key model multiplier properties for country specific effects. Next, in section 6, we provide the policy simulation results of the fully integrated model's response to similar shocks and trace the country specific and cross-county effects. In addition, exchange rate movements between the US Dollar and the German Mark on one hand (to represent the introduction of the EURO) and the US Dollar against the German Mark and UK Sterling Pound on the other, are simulated to trace their effect on the Ghanaian economy and subsequent domestic policy remedies. The summary and conclusion is provided in section 7.

2.0 **Importance to Ghana of global trade linkage to the EU**

There is a consensus that trade plays a decisive role in accelerating economic growth, although the issues involved in enhancing these growth effects can be numerous and complex[1] especially for developing countries. The Ghanaian economy has adopted an outer-oriented trade policy, a policy favorable to long-term economic growth. This contrasts to an import substitution policy pursued until early 1980s. Krueger (1995, p. 36) is more assertive on the relative merits of the two orientations: 'import substitution has not been a viable development strategy: reliance on an outer-oriented trade policy and integration with the international economy is'.[2] An outer-oriented developing country's growth prospects are enhanced if there are commitments to liberalization of the trade and payments regime, dismantling of the restrictive import regime, relying more on the private sector to encourage economic growth and the harmonization of trade and industrial policymaking machinery with that of world institutions.

2.1 **Pattern of Ghana's trade direction**

Table 1 shows Ghana's trade direction between 1970-1995 in terms of export and import shares. These shares are defined, in current values, as:

Export share i , j = Exports from Country i to j / Total Exports of Country i
Import share j , i = Import of Country j from i /Total Imports of Country j

From Table 1, Ghana's export are concentrated mostly in the EU member countries. Her export shares with the EU averages 45 per cent over 1970-1995. The EU, USA and Japan market account for about 65 per cent of her export trade. In 1990 these markets accounted for 80 per cent of her export. Ghana's trade relation with the Soviet bloc peaked in the mid 1980's and her exports to ECOWAS (Economic Community of West African States) is low, giving the homogeneity in their export composition.

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1 See Rodrik, Dani's comments to Krueger (1995).
2 Krueger, Anne O. (1995), *Trade Policies and Developing Nations*, Integrating National Economies, The Brookings Institution, Washington, D.C.

Table 1: **Pattern of Ghana's trade flow**

Export share to major partners (%)

From \ To		UK	Germany	EEC	USA	Japan	USSR/ E.EUR	ECOWAS[2]	ROW[3]
	71	23.81	10.23	50.03	22.21	8.10	2.68	1.23	15.8
	75	14.51	8.25	38.15	12.75	7.15	16.25	1.98	23.7
	80	17.57	10.78	40.10	15.49	9.00	24.33	0.64	10.4
Ghana[1]	85	20.30	6.06	37.85	8.19	9.69	6.44	4.31	33.5
	90	13.43	31.08*	62.00	12.88	5.93	4.93	2.54	12.7
	94	12.10	13.73	47.34	11.72	3.57	0.69	16.30	20.5

(*) The share for this period seems large but it is not a mis-type.

Import share to major partners (%)

To \ From		UK	Germany	EEC	USA	Japan	ECOWAS[2]
	71	24.82	12.48	49.44	15.00	9.25	3.63
	75	15.03	11.38	38.07	16.14	6.50	8.65
	80	21.42	12.15	45.77	13.20	2.91	12.77
Ghana[1]	85	29.80	13.57	54.93	6.85	7.15	29.93
	90	19.70	8.24	43.56	9.42	4.77	22.37
	94	15.53	5.50	41.49	6.61	6.66	19.63

Footnotes: Data source: Direction of Trade Statistic Yearbooks of the IMF

1. Export/Import value for 1990 and 1994 are total to world. The rest are IFS totals.
2. ECOWAS: Economic Community of West African States. Data excludes Ghana.
3 ROW = Rest of the World

Similarly, the EU market accounts for a large share in Ghana's imports. Ghana's imports from ECOWAS, however, has been increasing over the decades.[3] The continued accessibility of the EU, US and Japanese markets to the exports of Ghana augur well for her trade expansion and hence the need to strengthen her trade policy environment.

The dependence of the Ghanaian economy, particularly on trade, on EU also suggests business fluctuations, amplified by growth cycles, in the EU could impact on business fluctuations in the Ghanaian economy. In Figure 1 we present a graphical display of the growth cycle estimated between Ghana and the EEC over 1970-1989 using quarterly GDP growth rates.

[3] Ghana is dependent on oil imports from Nigeria which accounts for a large share in her import trade.

Figure 1: **Growth Cycle of EEC-Ghana :1970-1989**

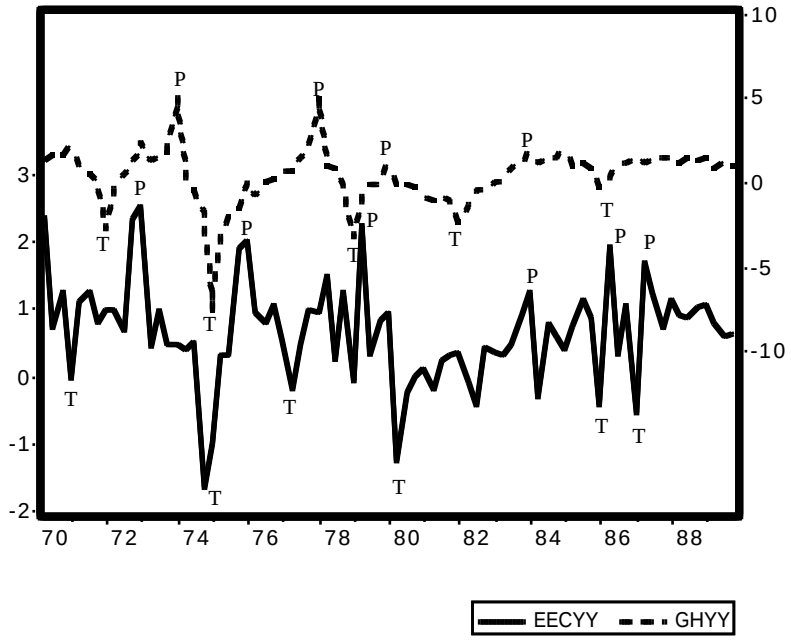

Figure 1 discerns two distinct expansion-contraction cycles for Ghana (1972-1978; 1978-1984) and for the EEC (1971-1976; 1976-1984) over the period 1970-1990. The perceived peak and trough points in the cycle are summarized in Table 2.

Table 2: **Economic expansion: points of peaks and troughs in EEC - Ghana quarterly GDP 1972-1984**

									Average (1972-1984)	
Area	T	P	T	P	T	P	T	P	T-P	P-T
									[quarters]	
EEC	71/1	73/1	74/4	76/1	77/2	79/3	80/2	84/1	9.0	6.0
Ghana	72/1	74/1	75/1	78/1	79/1	80/1	82/1	84/1	8.0	5.0

Footnotes: **P** perceived peak points in the cycle
T perceived trough points in the cycle

Figure 1 and Table 2 indicate over the two decades Ghana's business cycle, measured by movements in real GDP growth, seems to follow business fluctuations in the EEC. There appears to be a two to four-quarter lead in

business fluctuation in the EEC relative to the Ghanaian economy over the period.[4] From 1984, Ghana's economic liberalization and de-regulations seem to sustain her economic expansion.

We also compute a measure of the intensity of various trade partner imports from Ghana using the intensity of trade index (ITI) of Kojima (1964) and Drysdale (1969) following from Brown (1949) study. ITI is defined for country i's (Ghana) exports to country j (trading partners) as the share of i's exports going to j, (X_{ij}/X_i), relative to the share of j's imports (M_j) in world imports net of i's import $(M_W - M_i)$, that is:

$$ITI_{ij} = \frac{X_{ij}}{X_i} / \frac{M_j}{M_w - M_i}$$

The index permits a comparison in the trend in trading partner's imports from Ghana to her total exports relative to trading partners import performance in world imports.

Table 3**. Intensity of trade index (ITI) of Ghana to EU, Germany, UK, USA and Japan**

Year	EU	GERMANY	UK	USA	JAPAN
1971	1.290	1.002	3.301	1.547	1.381
1975	1.026	0.894	2.175	0.895	1.004
1980	1.160	1.208	3.200	1.271	1.343
1985	1.075	0.721	3.512	0.427	1.400
1990	1.394	3.122	2.097	0.867	0.724
1995	1.312	1.273	2.743	0.735	0.587

An ITI index greater than unity imply a bilateral value of Ghana's export to trading partner that is higher than might be expected given the trading partners importance in world imports as a whole. In general, Table 3 show

[4] For full details see Sarpong, Daniel Bruce 'EEC and the Ghanaian Economy: a business fluctuation linear dependence test', Discussion Papers in Statistics and Quantitative Economics, Universität der Bundeswehr Hamburg, Nr. 74, March 1997.

Ghana's trade has been relatively more intense with the EU countries than the USA and Japan over the recent decade. The possible explanations of the 'intense' trade could be characterized to include their geographical proximity, cultural and historical ties and the structure of trade barriers and preferences.

However, current global economic trends indicate that a failure to implement trade enhancing policies could shift drastically the benefits to such a relationship. In this perspective, the importance to Ghana of her global linkage to the EU are defined in the following terms. In general, African economies are worried about the stringent fiscal criteria as a round-up to the single monetary union. Fears are that big cuts in expenditures may result in fewer financial flows to these economies. Also, developments in the Central and Eastern European countries pre-occupies the EU to devoting more resources to assist in their development and could affect EU's assistance to African economies. There is also the added fact that there is more flexibility for a developed economy to disengage from an LDC not pursuing trade liberalization, as a result of the end of the cold-war, and shifting trade relations between developed and developing countries to trade liberalization and getting prices right (Oppenheimer and Bödecker, 1992). Lome IV is expected to expire in the year 2000. What happens after this date to the ACP countries will be dictated more by trade developments since EU will be preoccupied with stringent fiscal/monetary adjustments to the EURO introduction and thereafter. Ghana is also dependent on the outside world in terms of export and import, and particularly on EU (UK, Germany, Netherlands, etc), USA and Japan and must be concerned about trade liberalization. The major attraction to linkaging is the 'lock-in' effect. EU is a huge market with common trade policies and is traditionally open to African economies. So an integration of domestic trade policies to EU would be seen as: (a) harmonizing domestic (trade) laws and institutions to a credible world institutions which could 'lock-in' her reforming policies and renders them irreversible; (b) would enhance the private sectors expectations of the policy regime as well as an enhancement of the respect for private enterprise, property, enforcement of contracts, and the rule of law and enhance investment, especially foreign direct investment.

3.0 **Structure of model**

The model we construct is a "representative" multi-country model of Ghana, UK and Germany and consists of four blocks: the demand and output, wage and price, income distribution and trade linkage. Each country's model is "representative" for simplicity but an attempt is made to simulate the realities of the economies included in the link model as close as possible. The UK and Germany models are assumed - a very strong assumption - to share similar general theoretical specifications and categorizations of final demand components, balance of payments and other components but there are some differences due to differing policy instruments elicited to influence outcomes in the respective economies as shown in the estimated country model equations.

3.1 **Demand and output block**[5]

3.1.1 ***Consumption***

Final consumption is divided into two main categories for each country: private and government. Government consumption is exogenous for all the countries. The model do not disaggregate private consumption. In general terms, the private consumption function is specified as:

$$C_t = f\left(YD, \left(\frac{PC - PC_{t-1}}{PC_{t-1}} \cdot 100\right), C_{t-1}\right)$$

Consumption depends positively on real disposable income and negatively on the growth in consumer price. In the models of UK and Germany we estimate a per-capita private consumption function.

3.1.2 ***Gross investment***

Gross investment, not disaggregated into components, is specified as:

$$I = f(GDP, \Delta GDP, R, KST, I_{t-1})$$

Gross investment is assumed to be influenced positively by real gross national product and negatively to the aggregate capital stock in line with the stock adjustment principle. The income variable assume the multiplier and/or the accelerator form. The third variable, R, is a cost of capital term and is included if significant. It is composed of nominal interest rate less an

5 For actual notations and estimated equations see Appendix A.

inflation rate. If the real interest rate rises, general investment falls. In the Ghanaian model, aggregate import is a significant variable in aggregate capital formation. Changes in stock balances aggregate supply and demand and is included as a determinant in gross capital formation (Ghana) or is specified as an adjustment of the existing capital stock (UK and Germany).

3.1.3 ***Import and export***

Exports are disaggregated into bilateral trade and treated under the separate section of trade linkage below. Each country's import, however, is determined by domestic demand and relative price. The relative price is export prices from other countries adjusted by exchange rate (in the Ghanaian model also adjusted for by import tax rate) relative to domestic prices. For the UK and Germany models, however, imports are divided into goods and services. Determination of import of goods or services have the general form:

$$M_t = f\left(GNP, \frac{PM}{PP}, M_{t-1}\right)$$

Real imports are higher if domestic demand (GNP) is strong, if exporter prices (PM) are lower or if overall domestic price (PP) are higher.

3.1.4 ***Output supply***

Supply side responses are incorporated only into the Ghanaian model. Output growth is a major determinant of exports in the Ghanaian economy. Ghana is a small open economy where her commodity export prices are determined by world prices[6]. This implies that the demand curve for Ghanaian commodity export is infinitely elastic and therefore the volume of commodity exported is supply determined. The supply of exports are guided by the ability of the domestic traded sector to attract resources from the non-traded sector. Domestic producers move resources into the production of exports when there is an increase in the domestic price of traded goods relative to non-traded goods.

Domestic output is determined within the Ghanaian model with simultaneous feedbacks between the supply and demand components in the demand-output sector. GDP is built up from the production side of agriculture, industry and services. Gross national expenditure (GNE) is calculated as the sum of the demand components of consumption, investment, government expenditure and net trade. The two components

6 An exception is cocoa export, where Ghana does influence international prices to some extent.

(GDP and GNE) are then reconciled by taking a change in stock variable. The linkage from the demand side to the production sectors of agriculture, industry and services comes about as a result of the demand categories appearing as arguments in the supply-response functions of the production sectors (Klein and Behrman (1970); Marzouk (1975); Chowdhury (1986); Sarpong (1997a)). Feedback from supply to the demand sector is reflected in the use of real output (agriculture, industry and services) as an activity variable in the final demand components.

3.2 **Wage and price**

The key price indicator in the UK and Germany models are the unit labour cost index and producer price index. In the Ghanaian model, it is the aggregate output deflator. The unit labour cost index is explained by private consumption price index and growth in output. The producer price index is explained by labour cost, growth in output and import price. The aggregate output deflator in the Ghanaian model is influenced by supply output, import price and money. The other price indexes are functions of these key price indicators. Certain exogenous variables (dummy for economic liberalization in Ghana, for example) are also included. Following are the formulation for the key price indicators:

$$ULC = f\left(PC, \left(\frac{GNP - GNP_{t-1}}{GNP_{t-1}} \cdot 100\right)\right) \qquad \text{Unit Labour Cost Index}$$

$$PP = f\left(ULC, \left(\frac{GNP - GNP_{t-1}}{GNP_{t-1}} \cdot 100\right), PM\right) \qquad \text{Producer Price Index}$$

$$PGDP = f\left(GDP, PM, MS_{t-1}\right) \qquad \text{Aggregate Price Deflator}$$

All the explanatory variables, except the output variable (productivity considerations), are positively associated with the unit labour cost. The output growth variable is positively associated with the producer price index (excess demand considerations). Trade prices are discussed in the trade linkage below.

3.3 **Income distribution**

This block is determined largely by identities following national accounting procedures in the aggregate. Basically:

Aggregate output (GDP) ≡ Output of supply sectors (Ghana only)

Expenditure (GNE = GDP (UK, Germany) ≡ consumption + investment + changes in stock + government consumption + exports less imports

National income ≡ aggregate output (GDP) less capital allowance

National disposable income ≡ national income less taxes

Changes in stock ≡ GDP - GNE (Ghana)

In the model of UK and Germany, national income (NI) is a function of GDP

$$NI = f(GDP)$$

Nominal aggregate tax revenues are exogenized in the linked model.

3.4 **Trade linkage**

The economies in the model are linked through trade flows and prices. Economic activity (GDP) determines each economy's demand for imports and in turn influence exports from other countries. Relative export price, an export competitive variable, influence trade flows. Ghana is not an export competitor to the economies of UK or Germany. However, the Ghanaian economy competes with other developing countries in the markets of the advanced economies for similar commodity exports. The advanced economies compete with each other.

An economy's import price is determined by a weighted average of export prices of her major trading partners. On the other hand, export prices are determined by several factors. For Ghana, on one hand, she influences the price of her major agricultural export commodity, cocoa. On the other, she is a price-taker for her non-cocoa exports. Hence two variables, a weighted average of unit value of import price of her major trading partners and determinants of her unit value export of cocoa determines her overall export price. This export price, adjusted for domestic exchange rate, competes with the export price of other non-oil developing countries in the markets of the advanced economies.

The advanced economies export prices are set by two factors: domestic cost push factors (domestic inflation) and a competitive price variable facing domestic exporters. Inada and Wescott (1994) indicate the latter variable conditions domestic exporters to international price competition in world markets. As domestic inflation rise, domestic export price increase and

hence domestic export become less competitive in world markets. However, as competitors' price go down relative to domestic export price, there will be some tendency for domestic exporters to lower prices somewhat, at the expense of profits, to stay competitive and so the overall loss of competitiveness will be partially offset.[7] We discuss below the export and trade price determination in the model.

3.4.1 ***Export***

Nominal total export in domestic currency in the national accounting identities for each country is disaggregated into goods (merchandise) and services:

$$XGS_i = XG_i + XS_i$$

Export of goods are then reconciled with bilateral trade flows of the respective country's direction of trade. The nominal bilateral flows are deflated by the aggregate domestic export price deflator. Specifically, in real terms,

$$XG_i = \sum_{j=1}^{n} XG_{ij}$$

$i \neq j$ = Ghana, UK, Germany,USA, Japan, restof the world

These exports are then determined principally by merchandise imports of the corresponding bilateral trading country and relative competitive export price:

$$XG_{ij} = f(MG_j, \frac{PX_i}{PX_j})$$

Export of services, XS_i, is not treated similar to export of goods since there is a dearth in data on bilateral trade in services. Aggregate export of services is assumed to follow the level of aggregate export of goods in the economy.

For the Ghana model, export is not differentiated into goods and services. However, following the bilateral trade flow approach utilized here, export of services accumulates in the ‘export to the rest of world’. Also supply output influence export activity of the economy. This is factored into Ghana's bilateral export activity equations by including the supply GDP as a

7 Inada, Yosihisa and Robert F. Wescott (1994), 'The ICSEAD Japan-U.S.-ROW Model' in, *Econometric Models of Asian-Pacific Countries*, S. Ichimura and Y. Matsumoto (eds.), Springer-Verlag, Tokyo, pp. 5-26.

trend variable. Each country's export to 'rest of world' is mostly a trend variable.

3.4.2 ***Trade prices***

Two principal reinforcing trade 'prices' influence Ghana exports: one, maintaining an export competitive edge over other non-oil developing countries in the markets of the advanced economies (world markets) and, two, maintaining a real exchange rate to enhancing export and import.

Import price is a weighted average of unit export price of a country's trading partners. The weights, w_i, chosen for a fixed base year (1985) is measured as import of country i from country j to total import of country i:[8]

$$PFI_i = \sum w_{ij} \cdot UVE_j$$

Domestic import price deflators are then functions of this trade weighted foreign import price variable, bridged by the appropriate domestic exchange rate, and for Ghana, by including import tariff rate and such exogenous variables as petroleum price:

$$PM_i = f(PFI_i \cdot EXR_i, P_{oil})$$

For export price of Ghana, a trade-weighted export price variable is constructed:

$$PFE_i = \sum w_{ij} \cdot UVM_j$$

where the weights are measured as exports of country i to country j to total exports of country i and UVM (dollar basis) is the unit value imports of trading partners. Export price in the Ghanaian model is then determined as:

$$PX = f (PFE \cdot EXR, UVECOC)$$

This formulation postulates that Ghanaian export price is determined by both domestic factors (factors determining export price of Ghanaian cocoa) and international market prices.

The export prices of UK and Germany are determined by domestic cost factors (factors determining unit value of exports) and competitor price; competitor price here defined as:

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[8] These weights are calculated in the Sarpong (1997c).

$$PCM_i = \sum_{j=1}^{n} w_{ij} \cdot UVE_j$$

$i \neq j$ =UK, Germany, USA, Japan

The weights, fixed for 1985 base year, are measured as export of country i to country j to total exports of country i in dollar basis. The export price (in dollar basis) are determined for UK or Germany as:

$$PX\$ = f(UVE\$, PCM)$$

A bridge equation, incorporating the domestic exchange rate, links the dollar base to the domestic export price.

4.0 **Equation estimated parameter elasticities**

Tables 4, 5 and 6 summarize the estimated short and long-run marginal propensities to consume in Ghana, UK and Germany (Table 4) for the private consumption functions; the estimated propensities to import for the import functions (Table 5) and the estimated bilateral export trade elasticities of the bilateral export trade equations (Table 6).

Table 4 **Consumption Function:**

$$\mathbf{C = a + b \cdot Y + c \cdot (g(PCP)) + d \cdot C_{t-1}}$$

Country	b	c	d	R^2	DW	MPC.l= $\frac{b}{1-d}$
Ghana	0.509	-1.74	0.441	0.945	1.99	0.91
Germany[1]	0.180	-0.76	0.813	0.995	1.74	0.96
	(0.166)					(0.85)
UK[1]	0.125	-0.14	0.845	0.991	1.87	0.81
	(0.11)					(0.65)

Notes:
(1) Per-capita consumption.
(MPC.l) long-run marginal propensity to consume. (Figures in brackets are elasticities)
(g(*)) Percentage growth in the variable represented by the asterisk.

Table 5 **Import Function:**

$$\log(M) = a + b\cdot\log(GDP) + c\cdot\log\left(\frac{PM}{PGDP}\right) + d\cdot\log(M_{t-1})$$

Country		b	c	d	R^2	DW	LDE	LPE
Ghana		1.844	-0.1990	-	0.85	1.91	2.844*	-
Germany	good**	1.927	-0.0266	-	0.97	1.43	-	-
	service	0.798	-0.5627	0.565	0.95	1.78	1.84	-1.294
UK	good	1.505	-0.1354	0.196	0.99	1.78	1.87	-0.168
	service	1.317	-0.3950	-	0.91	2.20	-	-

Notes:
(*) Sum of two year parameter estimate on GDP
(**) Log estimate of the equation used in simulation.
(LDE) long-run demand elasticity of imports (b/(1-d))
(LPE) long-run demand price elasticity of imports (c/(1-d))

In Table 4, the estimated parameter elasticities of the consumption functions for Germany and UK are comparable to the estimated elasticities in the QUEST model[9]. The QUEST model elasticities are 0.39 and 0.11 for Germany and UK respectively for the short run, and in the long run, unity.

In Table 5, demand or income activity elasticity for import in the long-run are larger than unity for UK and Germany. The long-run demand elasticity estimates are comparable to QUEST estimates of 1.20 and 1.23 for Germany and UK respectively for good imports. The price elasticity for good imports are also comparable to the estimates in the QUEST model for Germany and UK. In Ghana the long-run income variable has an elasticity estimate of 2.84. A one-percent growth in income (GDP) tends to cause a more than 2 percent change in imports of goods and services in Ghana. Ghanaian imports are price in-elastic.

The estimates in Table 6 show an income variable for Ghanaian exports that in the short run are highly elastic. It appears Ghana's exports rise faster in the UK market in the short run among her enumerated trading partners. Nonetheless, a one percent growth in the market of an importing

9 See Andries Brandsma, "The Quest Model of the European Community", in, S. Ichimura and Y. Matsumoto (eds.), Econometric Models of Asian-Pacific Countries, Springer-Verlag Tokyo (1994), pp. 145-167. See also (1) Quest - A macroeconometric model for the countries of the European Community as part of the world economy, European Economy, No. 47, March 1991, pp. 163-237 (1990 version), (2) Italianer, Alexander, Estimation of international trade linkages in the QUEST model, European Economy, No.31, March 1987, pp 61-130.

country will tend to cause a more than a one percent change increase in demand of exports from Ghana. It also suggests that through direct and indirect channels, macroeconomic disturbances in UK, Germany, USA and Japan may lead to an amplified disturbance in Ghana's macro-variables.

Table 6 **Estimated Trade Elasticities in the Bilateral Trade Equations**

$$\log(E_{ij}) = a_{ij} + b_{ij}\log(M_j) + c_{ij}\cdot\log((PE_i/EX_i)/(PM_j/EX_j)) + d_{ij}\log(E_{ij,t-1})$$

Exporter	Importer	Demand Elasticity		Price Elasticity		TREND
		S	L	S	L	
Ghana[1]	Germany	2.712	-	-1.079	-	-0.161
	UK	3.899	-	-0.373	-	-0.217
	USA	2.824	-	-0.03*	-	-0.170
	Japan	3.495	5.432	-0.202	-0.314	-0.320
	Row	-	-	-	-	-0.078
Germany[2]	Ghana	1.003	-	-0.638	-	-0.098
	UK	-	1.30	-0.482	-2.960	-
	USA	1.315	2.33	-0.395	-0.703	-0.046
	Japan	-	1.68	-0.254	(-8.33)	-
	ROW	-	-	-	-	0.037
UK[2]	Ghana	0.802	-	-0.385	-	-0.043
	Germany	0.592	1.936	-0.289	-0.946	-
	USA	0.662	-	-0.365	-	0.015
	Japan	1.429	1.851	(-0.835)	(-1.082)	-
	ROW	-	-	-	-	0.027

Notes: (1) Price is with respect to other non-oil exporting developing countries.
(2) Income variable is import of goods. For Ghana it is import of goods and services.
(S) short run elasticity (L) long run elasticity
(*) Not statistically significant
The inclusion or exclusion of $E_{ij,t-1}$ and Trend depended on the overall fit of the estimated equation.

The estimated bilateral trade price elasticities are in-elastic for the short run. The largest short-run price elasticity is estimated for Ghanaian exports to the German market. A one percent decrease (increase) in export price of Ghana relative to rival exporters (non-oil exporting developing countries) to the German market could encourage (discourage) exports of around 1.0

percent from Ghana. The estimated bilateral trade price elasticities among Germany, UK, US and Japan are comparable to the estimated long-run price elasticities in the QUEST model. For example, the long-run UK export to Germany price elasticity of -0.946 compares to the QUEST range of 0.5-1.0 for trade of UK with the EC countries. The estimated long run bilateral price elasticity of Germany exports to UK of -2.96, however, diverges from QUEST long-term range of 0.5-1.0 of Germany trade with the EC countries.

On Ghana's export promotion variables, Equation 43-47, price competitiveness of Ghana, defined here as the ratio of Ghana's export price to the export price of non-oil exporting developing countries in the foreign markets, is significant (although with low elasticities) in Ghana's trade with Germany, UK and Japan. A real alignment of the domestic exchange rate could promote Ghana's export competitiveness relative to rival countries in the markets of Germany, UK and Japan. Secondly, Ghana's aggregate output has a significant impact on the volume of exports to her bilateral trading partners. The supply components of aggregate output, Equations 8-10, are determined by components of gross domestic expenditure, implicitly considering the input-output type of production process for the sample period of 1970-1991. The real exchange rate for exports is significant in the supply response equations of agriculture and industry.

5.0 **Model validation**

The model is validated separately for the stand-alone countries and later for the fully linked trade model. In the country models, bilateral partner variables are exogenous. In the fully trade linked model, most partner variables become endogenous.

In a simulation context, historical forecasts should match the behaviour of actual data as close as possible. The historical forecast is also called baseline forecast. The historical forecast is validated by a quantitative measure: the mean absolute percentage error (MAPE).[10] In addition, model 'shocks' are undertaken to check on the performance and stability of the model. The latter is the multiplier/policy shock analysis. In section 5.1 we report the simulated country model multiplier and elasticity properties and in section 6.0 the fully integrated model properties.

10 The MAPE statistic provides an unit free measure to compare alternative models and equations. The statistic is given by: $MAPE = (1/T) \sum |(Y^S - Y^A)/Y^A|$ where Y^S is the simulated value of the endogenous variable, Y^A is the actual value of the endogenous variable and T is the number of observations. Multiply by 100 to convert to percentages.

5.1 **Country model simulated properties**

(A) ***Historical forecast simulations***

The equations are simulated over the period 1980-1991 using the dynamic Gauss-Seidel method. The period extends into Ghana's economic adjustment and liberalization phase, hence provides an indicator for the assessment of economic 'shocks' on the economy in an integrated world economy. It is also a period where conventional fiscal and exchange rate policies have been employed, in the world economy, as important instruments to fostering world trade stability.

Table 7: **MAPE: SELECTED COUNTRY SPECIFIC AND LINKED MODEL VARIABLES**

variable	GHANA(1)	GHANA(2)	UK(1)	UK(2)	GERMANY(1)	GERMANY(2)
GDP	0.035	0.037	0.014	0.013	0.009	0.010
YAGH	0.015	0.016	--	--	--	--
YIGH	0.084	0.085	--	--	--	--
YSGH	0.043	0.045	--	--	--	--
MT	0.257	0.261	0.042	0.042	0.033	0.030
XT	0.131	0.134	0.020	0.020	0.021	0.023
CABN	4.030	3.933	1.667	1.644	0.983	0.989
CP	0.053	0.055	0.014	0.014	0.011	0.011
GCF	0.149	0.155	0.053	0.051	0.021	0.021
PGDP	0.108	0.108	0.031	0.031	0.007	0.007
X_{GH-GE*}	0.522	0.640	--	--	0.116	0.260
X_{GH-UK*}	0.159	0.248	0.079	0.168	--	--
X_{GH-US}	0.544	0.558	--	--	--	--
X_{GH-JP}	0.188	0.192	--	--	--	--
X_{GE-UK*}	--	--	0.050	0.068	0.025	0.054
X_{GE-US}	--	--	--	--	0.058	0.058
X_{GE-JP}	--	--	--	--	0.106	0.106
X_{UK-US}	--	--	0.070	0.070	--	--
X_{UK-JP}	--	--	0.113	0.113	--	--

(*) Bilateral exports (read forward and reverse) (1), (2) MAPE for unlinked and linked country model simulation respectively

The simulated values of the major endogenous variables trace the actual data well (plots not reported). Turning points in the actual data are traced by the simulated data except for Ghana's bilateral export trade. The MAPE for the stand-alone and linked country model is reported in Table 7. The errors are below 10 percent for the major endogenous variables for the county specific and linked models. In general MAPE for the linked variables of bilateral export increase for the joint model simulation. MAPE for Ghana's export trade are large due to fluctuations in the data for most of the sample period. Errors related to the current account balance are also large. In historical data, they take both positive and negative values hence most quantitative measures of model simulations do not represent goodness of simulation performance.

(B) ***Multiplier properties***

Three simulation tests, two fiscal and one exchange rate policy, are performed with the country specific models: (1) increase in government expenditures, (2) taxation experiment, and (3) exchange rate alignment.

(1) ***Increase in government expenditures***

Government aggregate consumption expenditures are permanently increased by an amount equal to one percent (1%) of the historical real GDP. The shock is compared to the baseline simulations. In the simulation we assume monetary accommodation (interest rates are exogenous in the model) whereby the monetary authorities would be assumed to take corrective actions to offset the tendency of interest rates bidding up with the higher level of economic activity by accumulating reserves. The source of financing increased government expenditure is crucial in analyzing the effects of this shock on the economy. In the Ghanaian situation, we assume increased expenditures results from grants from abroad. In the UK and Germany, they result from bond financing.

In Tables 8A and 8B, we report the simulation conducted for the permanent shock increase in real government expenditures. For each shock we report a partial derivative, PD, and is the conventional multiplier of the endogenous variables and elasticity (EL) approximation for selected endogenous variables. The PD and EL are measured as:

$$(PD\_Y_i)_t = \frac{\hat{Y}^p_{it} - \hat{Y}_{it}}{\hat{X}^p_j - \hat{X}_j}$$

$$(EL\_Y_i)_t = \frac{\hat{Y}^p_{it} - \hat{Y}_{it}}{\hat{X}^p_j - \hat{X}_j} \cdot \frac{\hat{X}_j}{\hat{Y}_{it}}$$

where $\hat{X}_j$ is the baseline value for an exogenous variable and $\hat{X}^p_j$ is the perturbed value for $\hat{X}_j$. Similarly, $\hat{Y}_{it}$ and $\hat{Y}^p_{it}$ are baseline and perturbed endogenous values for Y_i.

The effect of the shock in Ghana, Table 8A, is an increase in aggregate supply GDP and expenditure GDE. The impact multipliers are 0.61 and 1.31 respectively. The average dynamic multipliers are 1.18 and 1.93 respectively. Import increases as it depends on GDP in excess of exports resulting in an increase in the nominal current account deficit. Increased supply GDP dampens inflationary tendencies. Bilateral exports are stimulated, via increased output. When we compare elasticities, the impact elasticities are stronger on aggregate expenditure, agriculture, import, GDP deflator and supply GDP. In general, the dynamic elasticities with respect to the shock is larger on bilateral export trade of Ghana to US, Germany, Japan and UK. This suggests increased government expenditures that influence aggregate supply GDP could increase aggregate exports.

In Table 8B, the sustained increase in aggregate public expenditure provides an impetus for the demand for goods and services in Germany and UK. The increased demand for goods causes the impact (Keynesian) multiplier in Germany (1.08) and UK (1.62) to be greater than 1 percent of GDP. GDP multipliers decline rapidly for Germany but slowly for UK. Consumption goes up by less than 1 percent in both countries. Part of the increased domestic demand is directed towards foreign goods (import) which rises by less than 1 percent. Real exports virtually do not react to changes for this stimulus in the first and subsequent years for Germany and UK. The nominal current account balance therefore deteriorate for this simulation for both countries. In the long run, prices will react to the change in demand conditions. Price adjustment feeds through and leads to an eventual return of the economy to baseline. These are reflected in the declining dynamic multipliers and elasticities.

Table 8A: Multiplier and Elasticity effect of a permanent 1 percent GDP increase shock through government consumption expenditures on domestic variables (Ghana)

YEAR	GDP		YAGH		YIGH		YSGH		GDE		MT		XGHGE		XGHUK		XGHUS		XGHJP		CABN[1]	PGDP	
	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL		PD	EL
1980	0.61	0.07	0.50	0.12	0.02	0.01	0.09	0.03	1.31	0.14	0.14	0.10	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	-0.06	-0.00	-0.12
1981	0.78	0.10	0.54	0.15	0.05	0.03	0.19	0.08	1.59	0.20	0.25	0.23	0.03	0.48	0.01	0.15	0.07	0.50	0.02	0.20	-0.07	-0.01	-0.18
1982	1.08	0.13	0.62	0.16	0.17	0.11	0.29	0.10	1.83	0.22	0.37	0.29	0.03	0.60	0.02	0.18	0.07	0.60	0.02	0.31	-0.18	-0.02	-0.22
1983	1.22	0.15	0.67	0.18	0.20	0.15	0.36	0.11	2.01	0.23	0.45	0.35	0.11	0.81	0.03	0.25	0.08	0.82	0.03	0.44	-0.05	-0.03	-0.26
1984	1.21	0.11	0.59	0.12	0.28	0.15	0.34	0.08	1.97	0.18	0.38	0.28	0.06	0.71	0.04	0.22	0.07	0.72	0.05	0.41	-0.05	-0.04	-0.20
1985	1.18	0.10	0.53	0.11	0.30	0.15	0.35	0.08	1.87	0.17	0.52	0.26	0.07	0.64	0.05	0.19	0.12	0.64	0.06	0.39	-0.04	-0.05	-0.18
1986	1.23	0.11	0.57	0.12	0.29	0.14	0.37	0.08	1.96	0.17	0.51	0.26	0.11	0.62	0.03	0.19	0.12	0.62	0.04	0.39	-0.05	-0.08	-0.18
1987	1.16	0.13	0.58	0.15	0.20	0.12	0.38	0.10	1.91	0.21	0.57	0.31	0.09	0.80	0.06	0.24	0.14	0.81	0.06	0.50	-0.09	-0.10	-0.22
1988	1.29	0.12	0.58	0.13	0.30	0.15	0.41	0.09	2.03	0.18	0.56	0.27	0.09	0.63	0.05	0.19	0.15	0.62	0.05	0.40	-3.02	-0.16	-0.20
1989	1.31	0.12	0.59	0.13	0.28	0.14	0.44	0.10	1.96	0.19	0.76	0.30	0.12	0.74	0.06	0.22	0.17	0.73	0.05	0.45	-0.07	-0.20	-0.21
1990	1.45	0.14	0.62	0.15	0.29	0.15	0.54	0.12	2.34	0.23	0.92	0.33	0.44	0.78	0.09	0.24	0.20	0.77	0.06	0.48	-0.03	-0.27	-0.24
1991	1.64	0.16	0.69	0.17	0.32	0.17	0.64	0.14	2.44	0.24	1.14	0.37	0.58	0.87	0.07	0.26	0.21	0.87	0.07	0.52	-0.04	-0.29	-0.27

Note **(1) Ratio of change between shock variable and baseline variable to baseline variable. Negative sign indicate deterioration.**

PD Multiplier estimate EL Elasticity estimate

Values are corrected to two significant decimal places.

Table 8B: Effect of a permanent 1 percent GDP increase shock through government consumption expenditures on domestic variables (Germany and UK)

YEAR	GDP		CP		MT		XT		PGDP		CABN[1]	GDP		CP		MT		XT		CABN[1]	PGDP	
	GERMANY											UK										
	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL		PD	EL	PD	EL	PD	EL	PD	EL		PD	EL
1980	1.09	0.23	0.24	0.08	0.57	0.39	0.00	0.00	-0.0	-0.0	-0.4	1.62	0.35	0.22	0.08	0.62	0.52	0.00	0.00	-0.459	-0.00	-0.04
1981	1.13	0.23	0.36	0.13	0.62	0.42	0.00	0.00	-0.0	-0.0	-3.8	1.68	0.36	0.45	0.16	0.74	0.61	0.01	0.01	-0.324	-0.01	-0.13
1982	1.18	0.24	0.47	0.16	0.67	0.45	0.00	0.00	-0.0	-0.0	-0.5	1.73	0.38	0.56	0.20	0.78	0.64	0.01	0.01	-0.325	-0.01	-0.12
1983	1.17	0.23	0.55	0.19	0.67	0.43	0.00	0.00	-0.0	-0.0	-0.3	1.71	0.37	0.60	0.21	0.79	0.64	0.01	0.01	-0.373	-0.01	-0.10
1984	1.12	0.22	0.59	0.20	0.65	0.41	0.00	0.00	-0.0	-0.0	-0.3	1.68	0.36	0.64	0.22	0.80	0.63	0.01	0.01	-0.307	-0.01	-0.07
1985	1.05	0.21	0.62	0.21	0.62	0.38	0.00	0.00	0.0	+0.0	-0.2	1.65	0.35	0.66	0.23	0.80	0.61	0.01	0.00	-0.291	-0.01	-0.04
1986	0.96	0.19	0.63	0.22	0.58	0.35	0.00	0.00	+0.0	+0.0	-0.1	1.58	0.32	0.67	0.22	0.82	0.57	0.00	0.00	-0.428	-0.00	-0.03
1987	0.87	0.18	0.62	0.21	0.54	0.32	0.00	0.00	+0.0	+0.0	-0.1	1.53	0.30	0.67	0.20	0.83	0.53	0.00	0.00	-0.288	-0.00	-0.01
1988	0.80	0.16	0.60	0.21	0.51	0.28	0.00	0.00	+0.0	+0.0	-0.1	1.49	0.28	0.67	0.20	0.84	0.51	0.00	0.00	-0.205	-0.00	-0.01
1989	0.74	0.14	0.58	0.19	0.47	0.25	0.00	0.00	+0.0	+0.0	-0.1	1.49	0.28	0.69	0.20	0.85	0.51	0.00	0.00	-0.247	-0.00	-0.00
1990	0.70	0.13	0.56	0.18	0.45	0.22	0.00	0.00	+0.0	+0.0	-0.1	1.48	0.29	0.71	0.21	0.86	0.52	0.00	0.00	-0.443	-0.00	-0.00
1991	0.66	0.12	0.54	0.17	0.43	0.19	0.00	0.00	+0.0	+0.0	-0.0	1.48	0.29	0.75	0.22	0.88	0.53	0.00	0.00	-0.504	-0.00	-0.00

(1) Ratio of difference to baseline values. The negative sign indicate deterioration in the nominal current account balance with this shock.

PD Multiplier estimate. **EL Elasticity estimate.**

Values are corrected to two significant decimal places.

However, aggregate price increases in Germany are relatively non-existent compared to UK. The multiplier properties generated by the model are well comparable to QUEST unlinked simulations for Germany and UK for an increase in public investment by 1 percent of GDP, nominal interest rates fixed. In QUEST, GDP has an impact multiplier of 1.1 (Germany) and 1.0 (UK) and tends to decline. Private consumption has an impact multiplier of 0.3 for both countries with the largest dynamic multiplier of 0.7. Unlike our simulation, real exports decline in QUEST.

(2) ***Tax changes in the economy***

This fiscal policy action assume a one percentage point sustained decrease in the export tax rate (TX) on Ghana; in the historical volume of aggregate nominal tax revenue (Germany) and indirect tax volume (UK) in the separate simulations. TX in the Ghanaian model is a determinant in the real exchange rate. In Tables 9A and 9B we report the simulations on the economies of Ghana, Germany and UK. For Ghana, a decrease in the export tax depreciates the real exchange rate hence stimulates aggregate production and hence export and import. The largest impact elasticities are estimated for GDE, GDP deflator, import and agriculture. On sectoral production, the estimated dynamic elasticities indicate a decrease in TX stimulates production in the industrial sector more than in agriculture and services. Again, in general, the largest dynamic elasticities are estimated for bilateral exports of Ghana to her main partners.

In Table 9B, a one percent sustained decrease in nominal taxes in Germany and UK has a positive impact multiplier of 0.002 and 0.003 and a dynamic average multiplier of 0.007 and 0.008 on GDP respectively. The dynamic multipliers and elasticity impacts are larger on private consumption but are less than the size of the historical decrease in the nominal tax. The increased demand for goods and services are also directed towards imports. Export do not seem to react to this shock for both countries, hence the nominal current account deteriorates (negligibly for Germany). Price reaction to the decrease in nominal taxes are minimal. Its direction is a decrease in the simulation but turn positive towards the later part of the simulation for Germany.

Table 9A: Ghana: Elasticity impact of a 1 percent decrease in export tax effect in real exchange rate on domestic variables

YEAR	GDP	YAGH	YIGH	YSGH	GDE	MT	XGHGE	XGHUK	XGHUS	XGHJP	CABN	PGDP
	EL	EL	EL	EL	EL	EL	EL	EL	EL	EL	Δ	EL
1980	0.005	0.006	0.002	0.005	0.010	0.007	0.002	0.001	0.000	0.000	0.002	-0.009
1981	0.017	0.005	0.055	0.011	0.013	0.029	0.032	0.010	0.029	0.012	-0.000	-0.030
1982	0.020	0.007	0.046	0.023	0.040	0.046	0.098	0.030	0.102	0.045	0.018	-0.035
1983	0.053	0.028	0.166	0.034	0.043	0.097	0.128	0.040	0.119	0.066	-0.001	-0.094
1984	0.040	0.022	0.116	0.028	0.031	0.111	0.306	0.095	0.321	0.151	-0.002	-0.070
1985	0.036	0.023	0.087	0.026	0.029	0.091	0.237	0.074	0.240	0.152	-0.001	-0.062
1986	0.032	0.017	0.084	0.025	0.028	0.082	0.214	0.067	0.214	0.143	-0.001	-0.056
1987	0.030	0.021	0.066	0.024	0.027	0.076	0.193	0.060	0.191	0.130	-0.002	-0.053
1988	0.026	0.016	0.059	0.022	0.024	0.068	0.184	0.057	0.183	0.123	-0.034	-0.046
1989	0.023	0.014	0.049	0.020	0.019	0.059	0.159	0.050	0.158	0.110	-0.001	-0.040
1990	0.022	0.014	0.043	0.020	0.022	0.054	0.139	0.043	0.136	0.096	-0.000	-0.038
1991	0.021	0.014	0.039	0.020	0.021	0.052	0.133	0.041	0.131	0.089	-0.000	-0.037

Note **Δ Ratio of change between shock variable and baseline variable to baseline variable. Negative sign indicate deterioration.**

PD Multiplier estimate EL Elasticity estimate

Values are corrected to two significant decimal places.

Table 9B: Multiplier and Elasticity of a 1 percent nominal sustained tax decrease on domestic variables (Germany and UK)

YEAR	GDP		CP		MT		XT		PGDP		CABN[1]	GDP		CP		MT		XT		CABN[1]	PGDP	
	GERMANY											UK										
	PD	EL	PD	EL	PD	EL	PD	EL	PD	EL		PD	EL	PD	EL	PD	EL	PD	EL		PD	EL
1980	.002	0.06	.003	0.11	.001	0.10	0.00	0.00	-0.0	-0.0	-0.0	.003	0.03	.002	0.04	.001	0.05	0.00	0.00	-0.010	-0.00	-0.00
1981	.004	0.11	.005	0.21	.002	0.19	0.00	0.00	-0.0	-0.0	-0.3	.005	0.06	.004	0.09	.002	0.10	0.00	0.00	-0.012	-0.00	-0.00
1982	.005	0.15	.007	0.31	.003	0.27	0.00	0.00	-0.0	-0.0	-0.1	.007	0.09	.006	0.13	.003	0.15	0.00	0.00	-0.016	-0.00	-0.00
1983	.007	0.18	.008	0.39	.004	0.33	0.00	0.00	-0.0	-0.0	-0.1	.008	0.11	.007	0.16	.003	0.18	0.00	0.00	-0.023	-0.00	-0.00
1984	.007	0.20	.010	0.45	.004	0.36	0.00	0.00	-0.0	-0.0	-0.1	.008	0.12	.008	0.19	.004	0.21	0.00	0.00	-0.022	-0.00	-0.00
1985	.007	0.22	.010	0.51	.004	0.39	0.00	0.00	+0.0	-0.0	-0.0	.008	0.13	.008	0.21	.004	0.23	0.00	0.00	-0.023	-0.00	-0.00
1986	.007	0.22	.011	0.56	.004	0.39	0.00	0.00	+0.0	0.0	-0.0	.008	0.13	.008	0.21	.004	0.23	0.00	0.00	-0.036	-0.00	-0.00
1987	.007	0.22	.011	0.59	.004	0.39	0.00	0.00	+0.0	0.0	-0.0	.008	0.13	.008	0.22	.004	0.23	0.00	0.00	-0.025	-0.00	-0.00
1988	.007	0.22	.012	0.61	.004	0.38	0.00	0.00	+0.0	0.0	-0.0	.007	0.13	.008	0.22	.004	0.24	0.00	0.00	-0.018	-0.00	-0.00
1989	.007	0.21	.011	0.63	.004	0.37	0.00	0.00	+0.0	0.0	-0.0	.007	0.14	.008	0.24	.004	0.25	0.00	0.00	-0.023	-0.00	-0.00
1990	.006	0.20	.011	0.64	.004	0.34	0.00	0.00	+0.0	0.0	-0.0	.008	0.14	.009	0.25	.004	0.26	0.00	0.00	-0.042	-0.00	-0.00
1991	.005	0.19	.010	0.66	.004	0.32	0.00	0.00	+0.0	0.0	-0.0	.007	0.15	.008	0.25	.004	0.26	0.00	0.00	-0.050	-0.00	-0.00

(1) Ratio of difference to baseline values. The negative sign indicate deterioration in the nominal current account balance with this shock.

PD Multiplier estimate. **EL Elasticity estimate.**

(3) ***Exchange rate alignment experiments***

The countries are assumed to align their respective nominal exchange rates, relative to the US dollar, to improve upon their export competitiveness and to strengthen their balance of payments (BOP) position. An appreciated domestic currency hurts a country' export competitiveness. On the other hand, it cheapens import and helps keep down inflation which helps prevent interest rates hiking too much. A depreciated but stable currency helps keep price of export low to improve export competitiveness. A depreciated and unstable currency undermines global confidence in that countrys' financial market.

The nominal exchange rates of Ghana and Germany in the model are expressed as domestic currency units per US dollar (US$). That of UK is expressed as US$ per unit domestic currency. These rates are exogenous to the model. In these separate simulations, we assume each country devalues her nominal exchange rate by inducing a one-time only (Ghana, 1980) and a permanent 10 percent point devaluation for Germany and UK. Tables 10A and 10B report the separate results of this experiment for Ghana, Germany and UK.

A full implication of exchange rate movements is outlined in the linked model simulations. In Ghana, Table 10A, the one-time exchange rate change is passed through to domestic price of imports, resulting in increases in the GDP deflator (a full pass-through in magnitude) and associated prices. Bilateral exports rise as a result of the depreciation, leading to higher real output and domestic demand. Import falls with devaluation. The nominal current account balance is in deficit in the impact year due partly to the effect of devaluation on import price in excess of export price. The impact elasticity of supply GDP with respect to the exchange rate is 0.005. The largest impact elasticity of 0.75 is estimated for exports to Germany. The effect of the devaluation on the Ghanaian economy lasts several periods and gradually approaches the long run equilibrium path.

In Table 10B for Germany and UK, the effect of the 10 percent sustained devaluation is to raise Germany's import price deflator by an average of 4 percent and UK's by 8 percent. Export price deflator of their trading partners and domestic export price deflators in domestic currency terms increases (less than the increase in import price deflators) with nominal devaluation. Import decrease and export increase.

Table 10A: Ghana: Multiplier and Elasticity impact of a 10 percent nominal domestic currency increase in 1975 only on domestic variables

YEAR	GDP		YAGH		YIGH		YSGH		GDE		MT		XGHGE		XGHUK		XGHUS		XGHJP		CABN[1]	PGDP	
	SB	EL	SB	EL	SB	EL	SB	EL	SB	EL	SB	EL	SB	EL	SB	EL	SB	EL	SB	EL		SB	EL
1980	1.001	0.005	1.001	0.008	0.999	-0.01	1.001	0.008	1.005	0.046	0.987	-0.13	1.075	0.745	1.025	0.251	1.002	0.023	1.014	0.135	-0.134	1.012	0.122
1981	1.003	-	1.001	-	1.007	-	1.002	-	1.004	-	1.002	-	0.995	-	0.998	-	1.003	-	1.013	-	-0.050	0.998	-
1982	1.002	-	1.001	-	1.004	-	1.002	-	1.002	-	1.004	-	1.011	-	1.003	-	1.015	-	1.009	-	-0.022	0.998	-
1983	1.001	-	1.001	-	1.003	-	1.002	-	1.002	-	1.004	-	1.009	-	1.003	-	1.010	-	1.007	-	-0.005	0.998	-
1984	1.001	-	1.000	-	1.002	-	1.001	-	1.001	-	1.003	-	1.008	-	1.002	-	1.008	-	1.006	-	-0.004	0.998	-
1985	1.001	-	1.000	-	1.001	-	1.001	-	1.001	-	1.002	-	1.005	-	1.002	-	1.006	-	1.004	-	-0.002	0.999	-
1986	1.000	-	1.000	-	1.001	-	1.001	-	1.001	-	1.001	-	1.004	-	1.001	-	1.004	-	1.003	-	-0.002	0.999	-
1987	1.000	-	1.000	-	1.001	-	1.000	-	1.000	-	1.001	-	1.003	-	1.001	-	1.003	-	1.002	-	-0.003	0.999	-
1988	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	1.001	-	1.002	-	1.001	-	1.002	-	1.002	-	-0.057	1.000	-
1989	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	1.001	-	1.002	-	1.001	-	1.001	-	1.001	-	-0.001	1.000	-
1990	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	1.001	-	1.000	-	1.001	-	1.001	-	-0.000	1.000	-
1991	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	1.001	-	1.000	-	1.001	-	1.001	-	-0.000	1.000	-

Notes **(SB) Ratio of Shock value to Baseline value** (1) **Ratio of change between shock variable and baseline variable to baseline variable. Negative sign indica deterioration.**

(EL) Elasticity estimate.

Table 10B: Multiplier and Elasticity impact of a 10 percent permanent nominal domestic currency increase on domestic variables (Germany and UK)

YEAR	GDP		CP		MT		XT		PGDP		CABN[1]	GDP		CP		MT		XT		CABN[1]	PGDP	
	GERMANY											UK										
	SB	EL	SB	EL	SB	EL	SB	EL	SB	EL		SB	EL	SB	EL	SB	EL	SB	EL		SB	EL
1980	1.00	0.04	1.00	0.01	0.99	-.02	1.01	0.05	1.00	0.02	-0.4	1.00	0.02	0.99	-.01	0.99	-.01	1.00	0.04	-0.259	1.01	0.05
1981	1.01	0.06	1.00	0.02	0.99	-.01	1.01	0.08	1.00	0.04	-2.9	1.00	0.05	0.99	-.01	0.99	-.03	1.01	0.05	-0.108	1.01	0.07
1982	1.01	0.08	1.00	0.04	1.00	0.01	1.01	0.11	1.01	0.06	-0.3	1.01	0.06	1.00	0.00	0.99	-.03	1.01	0.06	-0.132	1.01	0.08
1983	1.01	0.10	1.01	0.06	1.00	0.04	1.01	0.14	1.01	0.06	-0.2	1.01	0.07	1.00	0.01	0.99	-.02	1.01	0.06	-0.193	1.01	0.09
1984	1.01	0.12	1.01	0.09	1.01	0.07	1.02	0.18	1.01	0.06	-0.1	1.01	0.07	1.00	0.02	0.99	-.01	1.01	0.07	-0.168	1.01	0.11
1985	1.01	0.13	1.01	0.11	1.01	0.09	1.02	0.20	1.01	0.06	-0.1	1.01	0.08	1.00	0.03	1.00	0.01	1.01	0.07	-0.186	1.01	0.11
1986	1.01	0.13	1.01	0.13	1.01	0.11	1.02	0.21	1.01	0.06	+0.0	1.01	0.09	1.00	0.04	1.00	0.02	1.01	0.08	-0.575	1.01	0.12
1987	1.01	0.13	1.01	0.14	1.01	0.11	1.02	0.22	1.01	0.05	+0.0	1.01	0.10	1.01	0.05	1.00	0.03	1.01	0.09	-0.434	1.01	0.12
1988	1.01	0.14	1.02	0.15	1.01	0.12	1.02	0.24	1.00	0.04	+0.0	1.01	0.10	1.01	0.06	1.00	0.04	1.01	0.09	-0.356	1.01	0.12
1989	1.01	0.14	1.02	0.16	1.01	0.12	1.03	0.26	1.00	0.04	+0.1	1.01	0.11	1.01	0.07	1.01	0.05	1.01	0.10	-0.421	1.01	0.12
1990	1.01	0.13	1.02	0.16	1.01	0.10	1.02	0.23	1.00	0.04	+0.1	1.01	0.12	1.01	0.08	1.01	0.07	1.01	0.11	-0.741	1.01	0.12
1991	1.01	0.11	1.02	0.16	1.01	0.07	1.02	0.19	1.00	0.04	+0.0	1.01	0.13	1.01	0.09	1.01	0.08	1.01	0.12	-0.919	1.01	0.12

Notes

(SB) Ratio of Shock value to Baseline value

(1) Ratio of difference to baseline values. The negative sign indicate deterioration in the nominal current account balance with this shock.

Due to changes in relative prices, the nominal current account balance deteriorates (Germany - the first 5 years) before improving. Due to gains in price competitiveness, the value of export would increase whilst import decrease.

The real current account balance (not reported) improves over the simulation period for both countries. Devaluation has an upward effect on domestic prices. This is particularly strong on UK that private consumption falls in the first two periods. Brandsma et al.(1994, p.201) make similar observations on UK's private consumption with their simulation of 1 percent government investment increase.

From the stand-alone country model simulation results, we infer that, in elasticity terms, Germany and UK's economy are more responsive to Keynesian policy of changes in government expenditures than in Ghana. In multiplier terms for this simulation, Ghana's economy is more responsive than the others. In general, the economies are more responsive to Keynesian policies of government expenditure changes than the tax and exchange rate changes.

In sum we conclude that the policy simulation shocks on the individual economies produce reasonable qualitative and quantitative response to various types of impulses originating from economic policy measures. Thus the economies modelled here represent a fair structure of the linked economies.

6.0 **Simulating with the fully linked model of Ghana-UK-Germany**

Using the linked 'representative' models of Ghana, UK and Germany, several simulations are conducted. Firstly, own and cross elasticity and multipliers for governments' expenditure and Ghana's tax changes are simulated for 1980-1991. Secondly, the model is simulated over 1986-1991 for a baseline scenario and for two main scenarios of trade simulation shocks, classified as 'external shock *without* explicit domestic (Ghana) policy change' and 'external shock *with* explicit domestic (Ghana) policy change'. The simulations have been selected mainly to answer two questions: *first*, how does external economic perturbations in the EU and US influence Ghana's policy goals of GDP growth, (bilateral) export growth, the nominal current account balance and inflation; and *second*, which domestic policy instruments are most influential in "enhancing" these policy goals in the

liberalized world economy.

In Appendix C.1-C.3, own and cross-country elasticity effects of country specific simulations of government aggregate expenditure and tax reduction in Ghana's export and import tariffs on the linked trade model are summarized.

In Appendix C.1, Ghana's stimulus of her economy through increased government expenditure has little impact on the GDP's of Germany and UK (the average dynamic cross-elasticities are 3.02×10^{-5} and 1.47×10^{-4} respectively). The resultant increased domestic expenditure impact on imports in Ghana, however, significantly impacts on exports of these countries to Ghana. Germany and UK's expenditure stimulus impacts significantly on Ghana's GDP as a result of Ghana's export stimulus to these countries.[11] In elasticity terms, Germany and UK's economic stimulus effect on Ghanaian variables are larger than that of Ghana's.

Appendix C.2 and Appendix C.3 document the effect of export and import tax reduction in Ghana on the linked model respectively. The magnitudes in the estimated own and cross elasticities appear to indicate that a decrease in Ghana's export tax effect on the exchange rate have larger responses on the domestic and trading partner variables than the decrease in import tariff rate. Increased production resulting from the exchange rate incentive increases domestic export and real income in Ghana and hence increase export of Germany and UK to Ghana. However, the adoption of a less restrictive, or freer trade policies through the reduction of import tariff barriers demonstrate beneficial consequences for Ghana's nominal current account balance than the export tax reduction.

(A) ***External shock 'without domestic policy change' simulations***

Two policy simulations are conducted separately over 1986-1991 by modifying the exogenous variables in the model of Germany, UK as well as USA and Japan:

(*A*.1) A scenario of a depreciated German Mark to the US dollar by 10 percent over 1986-1991 only. This assumes the exchange rate of the US and UK appreciate against an EURO currency and the Japanese currency. Exogenized country specific unit value export and import in dollar terms change depending on the movement in that country's exchange rate but by

[11] These results are in agreement with the general conclusions reached in Sarpong (1997b), 'EEC and the Ghanaian Economy: a business fluctuation linear dependence test" Discussion Papers in Statistics and Quantitative Economics, Universität der Bundeswehr Hamburg, No. 74, March 1977.

less than the 10 percent nominal currency change[12]: unit value imports of Germany and Japan rise over the simulation period, those of UK and US fall; unit value export of Japan decrease and that of the US increase.

Table 11: **Assumptions imposed on some exogenous variables in the linked model** (percentages)

	PERCENT CHANGE IN UNIT VALUE OF EXPORT AND IMPORT						PERCENT CHANGE IN GDP AND IMPORT			
Year	UVMUK	UVMUS	UVMJP	UVMGE	UVEJP	UVEUS	GDPUS	GDPJP	MGUS	MGJP
1986	-1.6	-3.5	1.8	1.4	-0.5	0.2	-0.6	0.5	2.0	-0.1
1987	-4.2	-6.1	4.1	3.7	-2.4	1.3	-1.2	1.2	4.4	-0.8
1988	-4.7	-5.8	4.4	4.3	-3.0	1.8	-0.9	0.8	4.2	-1.1
1989	-4.9	-5.7	4.4	4.6	-3.4	2.4	-0.6	0.6	3.9	-1.1
1990	-5.0	-5.5	4.4	4.8	-3.7	3.0	-0.5	0.4	3.3	-1.0
1991	-5.0	-5.4	4.4	4.9	-4.0	3.5	-0.5	0.1	2.5	-0.9

NOTES: The magnitudes in the percentage changes are based on Brandsma, *et al* (1991): QUEST (1990 version) simulation results of 10 percent depreciation of the US dollar against other currencies, real interest rates fixed. For notations see list of variables in our model. The indices listed here are all in dollar base in our model.

Table 11 list the percentage changes imposed on these and other exogenous variables in the linked model. Non-oil exporting developing countries' unit value export index are unchanged. This scenario also assume that import of good of the US increase whilst that of Japan decrease (see Table 11). Overall, GDP of US decline since exports are curtailed; GDP of Japan rises.[13] Ghana's nominal domestic currency is unchanged.

The model simulation of the depreciated German Mark on the linked economies are summarized for Ghana in Table 12 and in Appendix D.1 for Germany and UK. Values are percentage differences from baseline of country-linked model simulation of 1986-1991, and the nominal current account balance is a ratio of the difference of the simulated value from baseline to baseline.

In Appendix D.1, the effect on Germany show a GDP growth impact

[12] There is the assumption that not all import and export of these economies are dollar denominated. Hence only a proportion of the currency devaluation effect show up in export and import prices. See Inada and Wescott (1994, p.16).

[13] Import of good and GDP of Japan and US, unit value import index of Japan, US, Germany and UK as well as unit value export index of Japan and US are exogenous to this model. The magnitudes in the percent changes in import and GDP of US and Japan are based on the QUEST (1990 version) linked simulations. See also the magnitudes in the changes of these variables in the simulation results of Inada and Wescott (1994) and Kinoshita (1989) for a 10 percent appreciation / depreciation of the US Dollar against the major currencies.

(percentage difference from baseline) of 0.556. In elasticity terms, the impact is similar to the unlinked simulation of a 10 percent depreciation of the Mark (Table 10B). Dollar indexed unit value export price fall on the average by 6.6 percentage point. The domestic currency counterpart increases on average by 2.8 percentage points. Domestic import price inflation is higher than that of export price hence growth in real imports are less than real exports. Real current account balance would improve (not shown) whilst the nominal deteriorate.

The cross effect on UK, Appendix D.1, is a slight GDP growth effect for the first two periods; import growth exceeds export growth hence a probable deterioration in real current account balance. Dollar indexed unit value export price falls on the average by 0.66 percentage points hence the domestic export price deflator falls probably due to price offsets on UK exports. See equation 41.

Table 12: **Impact of 10 percent German Mark depreciation over 1986-1991 against the Dollar, Sterling and Ghanaian currency on Ghana's economic variables**

(*percentage difference from baseline*)

Year	GDP	XGHUK	XGGER	XGJP	XGUS	GDE	PEDB$	PMDB$	PGDP	CABN [1]
1986	-0.004	0.404	1.799	1.812	-1.677	-0.014	-0.828	-2.362	-0.162	0.016
1987	-0.026	1.541	3.980	5.078	-3.354	0.003	-1.779	-2.431	-0.161	0.052
1988	-0.035	1.413	4.963	4.827	-2.647	-0.011	-1.867	-2.345	-0.146	0.247
1989	-0.047	1.314	5.475	4.009	-1.864	-0.017	-1.854	-2.195	-0.113	0.028
1990	-0.020	1.024	4.892	2.976	-1.659	0.207	-1.859	-2.250	-0.163	0.045
1991	0.046	0.600	4.485	1.611	-1.497	0.218	-1.853	-2.208	-0.276	0.049

NOTE: (1) Ratio of simulated difference from baseline to baseline. For notations see list of variables.

On the effect of this scenario on Ghanaian domestic variables (Table 12), dollar trade-weighted import price (PMDB$) and export price (PEDB$) fall, mitigating inflationary tendencies of the economy. However, the percentage changes in domestic inflation (PGDP) are less than the changes in PEDB$ that the real exchange rate on export production incentive appreciates. This dampens domestic output supply components of agriculture and industry. Consequently GDP declines. Real imports increase due to price effect rather than income effect. Real import increase by an average of 0.16 percentage points. Real exports increase (average of 0.77 percentage points) with the

relative decrease in domestic export price at the expense of her competitor export price ratio (average fall of -11.6 percentage points) and from foreign income growth (import growth in UK and Germany and GDP growth in Japan). On her policy goal variables, aggregate export growth, inflationary depression and improvement in the nominal current account balance are favorable. GDP growth targets are however dampened with an appreciated domestic currency in this simulation.

(*A*.2) The second scenario assume a German Mark and UK Pound Sterling, hereafter, M-P, and US dollar relationship in which the M-P appreciate, over 1986-1991 only, by 10 percent against the US dollar. The Ghanaian nominal currency is unchanged. The Japanese currency also appreciate by the same magnitude. The changed exogenous variables in Table 11 are at their reverse in this simulation. Table 13 for Ghana and Appendix D.2 for Germany and UK, summarize the effect of M-P and Japanese currency appreciation against the US dollar in the model.

Table 13: **Impact of 10 percent M-P appreciation over 1986-1991 against the Dollar on Ghana's economic variables**

(*percentage difference from baseline*)

Year	GDP	XGHUK	XGGER	XGJP	XGUS	GDE	PEDB$	PMDB$	PGDP	CABN [1]
1986	-0.043	-1.543	-1.321	-1.713	1.708	-0.012	-0.724	6.382	0.514	-0.051
1987	-0.159	-1.593	-2.415	-4.694	3.181	-0.070	-2.388	6.319	0.798	-0.213
1988	-0.245	-1.876	-3.495	-4.564	1.614	-0.092	-2.864	6.414	0.972	-1.336
1989	-0.305	-2.358	-4.267	-4.007	0.245	-0.087	-2.980	6.137	1.066	-0.107
1990	-0.412	-2.600	-4.107	-3.260	-0.401	-0.282	-3.200	6.335	1.266	-0.096
1991	-0.524	-2.802	-4.229	-2.212	-1.039	-0.318	-3.224	6.355	1.470	-0.128

NOTE: (1) Ratio of simulated difference from baseline to baseline. For notations see list of variables.

In Appendix D.2, the M-P appreciation impacts negatively on real GDP in Germany and UK by -0.49 and -0.27 percent respectively. These impacts are well comparable to QUEST (1990) similar simulations results (with real interest rates fixed) of -0.3 and -0.2 percent impacts on Germany and UK respectively. Over our simulation period, real GDP, real import and export growth decline in both countries. The percentage point declines in real export exceed that of real import. Nominal current account balance however improves for Germany and UK. Dollar indexed unit value export price of

Germany and UK are up on the average by 8.8 and 7.4 percentage points from baseline respectively. The domestic currency indexed unit export prices are down on the average by -2.1 and -2.3 percent respectively. These changes in domestic unit export price are well in line with QUEST (1990) simulation results for the respective country export deflators.

In Table 13, all four policy variable targets of Ghana: GDP growth, export growth, inflation declines and improvement in the nominal current account balance deteriorate with an appreciated european currency. Ghana's real exchange rate appreciate by about 3.5 percentage points, on the average, from baseline. This, among other factors, dampens the output supply components of agriculture, industry and services. Although Ghana's competitor export price ratio falls by -5.9 percentage points from baseline, declines in foreign demand and domestic output dominate to pull down exports. Real import and export are down on the average by -1.14 and -1.40 percentage points respectively.

From these two simulation scenarios, not taking into consideration explicit domestic policy changes in Ghana, exchange rate effects that cause growth shocks in the EU could and do project large impacts on the Ghanaian economy. The factors responsible can be attributable among others to the high import and export dependence of Ghana on UK and Germany, the relatively large demand elasticity of exports to Germany, UK and Japan and the importance of relative prices in Ghana's production structure.

How could domestic policy variables enhance the Ghanaian economy in a scenario as depicted by the M-P/Dollar movement? The next simulations focus on these effects rather than on the first external simulation for the reason that appreciation in M-P relative to the Dollar has the 'worst case' scenario for domestic variables. Under such a scenario, how domestic policy impact on the policy targets of Ghana relative to the baseline of 1986-1991 but as compared to the scenario of no policy change (Table 13) is a basis for our recommendations.

(B) ***External shock 'with domestic policy change' simulations***:

In simulation *A. 2*, contraction of economic activity in Germany, UK and Japan has a worsening effect on the Ghanaian economy and formulating appropriate domestic policies to mitigate such influence would enhance Ghana's economic growth as it is integrated to the world economy.

The scenario of M-P/Dollar is repeated by changing Ghana's import

tariff and export tariff separately or in combinations. Government increased expenditures are simulated separately. The M-P/Dollar simulations of "without" and "with" changed domestic policy variable results are reported relative to the baseline country-linked model simulation. Note that the difference between the "with" (Tables 14-19) and "without" (Table 13) values represent the effect of each policy variable change on Ghanaian economic policy goals for this simulation since the ratios have a common baseline. In Tables 15, 16 and 18 we report an aggregate elasticity (LRE) effect of each domestic policy variable on the economic targets for the scenario of M-P appreciation. In each simulation discussion, Table 13 is for comparison. The Ghanaian nominal exchange rate is unchanged throughout these experiments and all experiments are over 1986-1991. The real exchange rate changes depending on the changes in these policy instruments.

(B.1) ***Export tax reduction by 10 percent and by 50 percent in Ghana***

Export Tax (TX) is the variable altered under the present experiment. It directly and indirectly affect production and trade variables.

Table 14: **Effect of Export tax reduction by 10 percent on Ghana's economic target variables for an M-P appreciation (1986-1991)**

(*percentage difference from baseline*)

Year	GDP	GDP**	XGHUK	XGGER	XGJP	XGUS	XTGH	MTGH	GDE	PGDP	CABN [1]
1986	-0.009	0.034	-1.539	-1.310	-1.711	1.708	-0.171	-0.474	0.034	0.455	-0.050
1987	-0.059	0.100	-1.527	-2.208	-4.614	3.389	-0.491	-0.637	0.023	0.621	-0.211
1988	-0.129	0.116	-1.697	-2.929	-4.306	2.229	-0.716	-0.809	0.003	0.767	-1.337
1989	-0.139	0.116	-2.151	-3.613	-3.644	0.946	-0.997	-0.947	0.004	0.854	-0.110
1990	-0.286	0.126	-2.383	-3.422	-2.845	0.317	-1.959	-1.157	-0.168	1.042	-0.098
1991	-0.395	0.126	-2.572	-3.502	-1.756	-0.283	-1.939	-1.416	-0.199	1.240	-0.129

Notes: (1) Ratio of simulated difference from baseline to the baseline
Values are calculated as ((simulated/baseline) - 1) x 100. Applicable to Tables 15 - 19.
(**) Effect of Tax change on GDP: calculated as GDP in Table 13 minus GDP in Table 14

The direct effect is set to be on the real exchange rate confronting exports which stimulates production in agriculture and industry. Indirectly it stimulates, among others, exports through increased supply of exportables. Historically, TX (measured as the ratio of export tax revenue to total export) reached 61 percent in 1982 but dropped sharply to 26 percent in 1983. By 1991, TX stood at 6.7 percent. Hence a reduction of TX by 50 percentage points are within the economy's trade liberalization efforts.

Table 15: **Effect of Export tax reduction by 50 percent on Ghana's economic target variables for an M-P appreciation (1986-1991)**

(*percentage difference from baseline*)

Year	GDP	XGHUK	XGGER	XGJP	XGUS	XTGH	MTGH	GDE	PGDP	CABN [1]	GDP**
1986	0.125	-1.524	-1.269	-1.703	1.710	0.571	-0.281	0.210	0.220	-0.046	0.168
1987	0.337	-1.264	-1.376	-4.294	4.226	0.626	0.068	0.384	-0.075	-0.204	0.496
1988	0.324	-0.989	-0.669	-3.280	4.688	0.566	0.239	0.377	-0.030	-1.341	0.569
1989	0.283	-1.333	-1.009	-2.208	3.732	0.396	0.181	0.366	0.028	-0.124	0.588
1990	0.212	-1.525	-0.681	-1.199	3.188	-0.095	0.027	0.284	0.162	-0.105	0.624
1991	0.115	-1.659	-0.580	0.056	2.751	-0.103	-0.188	0.277	0.336	-0.137	0.639
LRE	*0.062*	*0.092*	*0.297*	*0.162*	*0.299*	*0.210*	*0.139*	*0.055*	*-0.11*		

NOTE: (1) Ratio of simulated difference from baseline to baseline. For notations see list of variables.

(LRE) Long run (sum) elasticity effect of policy variable for the simulation scenario. The elasticity is proportional change of the target variable to proportional change of the instrument variable.

(**) Effect of Tax change on GDP: calculated as GDP in Table 15 minus GDP in Table 13.

Tables 14 and 15 summarize the effect of separate 10 and 50 percentage point TX reduction respectively on the Ghanaian economy, conditioned on an appreciated M-P effect. Relative to Table 13 (our reference point) export tax reductions stimulate the Ghanaian economy. Except for the nominal current account balance which improves for only two periods (1986, 1987) for both tax reductions, GDP and export growth and inflationary reduction are all relatively favorably stimulated. However, it takes the larger reduction in export tax to stimulate the Ghanaian economy (GDP/GDE) out of the induced economic recession relative to baseline.

(B.2) ***Import Tariff (TM) reduction by 50 percent in Ghana***

The direct effect of import tariff reductions is on the real exchange rate

confronting import which, other factors held constant, appreciates to stimulate imports. A direct effect also is the resultant reduction in import prices. Historically, over 1980-1991, TM (measured as import revenue to total import) was highest at 20 percent in 1982, dropped to 8.3 percent in 1983 and in 1991 stood at 6.0 percent. Table 16 summarizes the effect of a 50 percentage point reduction in import tariffs for the effect of an M-P appreciation on the Ghanaian economy.

Relative to Table 13, and although all policy target variables improve, the major effect is on the nominal current account balance which improves for all years. Compared to a similar percentage point reduction in export tax, however, the benefits to Ghana in terms of export and GDP growths and inflation reduction of import tariff reductions are less in the simulated Ghanaian economic recession.

Table 16: **Effect of Import tax reduction by 50 percent on Ghana's economic target variables for an M-P appreciation (1986-1991)**

(*percentage difference from baseline*)

Year	GDP	XGHUK	XGGER	XGJP	XGUS	XTGH	MTGH	GDE	PGDP	CABN [1]	GDP**
1986	-0.028	-1.519	-1.267	-1.703	1.710	-0.322	-0.210	-0.039	0.210	-0.022	0.015
1987	-0.128	-1.532	-2.242	-4.636	3.272	-0.707	-0.445	-0.127	0.446	-0.126	0.031
1988	-0.213	-1.778	-3.210	-4.443	1.804	-0.935	-0.672	-0.167	0.600	-0.847	0.032
1989	-0.272	-2.252	-3.957	-3.853	0.438	-1.231	-0.808	-0.192	0.672	-0.058	0.033
1990	-0.371	-2.484	-3.772	-3.082	-0.193	-2.227	-1.041	-0.377	0.880	-0.059	0.041
1991	-0.480	-2.677	-3.860	-2.007	-0.791	-2.190	-1.351	-0.409	1.126	-0.086	0.044
LRE	*0.004*	*0.011*	*0.032*	*0.015*	*0.019*	*0.015*	*0.047*	*-0.01*	*-0.05*		

NOTE: (1) Ratio of simulated difference from baseline to baseline. For notations see list of variables.

(LRE) Long run (sum) elasticity effect of policy variable for the simulation scenario. The elasticity is proportional change of the target variable to proportional change of the instrument variable.

(**) Effect of Tax change on GDP: calculated as GDP in Table 16 minus GDP in Table 13.

(B.3) *Combined Scenario of 50 percentage point reduction on TX and TM*

A policy effect of a combination of reductions in import and export tariffs of 50 percentage points are summarized in Table 17. Relative to Table 13 and as compared to Tables 15 and 16, the combined effect of these trade liberalizing

policy are very favorable on stimulating the Ghanaian economy out of an externally influenced recession induced by an M-P currency appreciation. The nominal current account balance performance improve for all years. However, the nominal account relative to Table 16, deteriorate after the third period in the simulation.

Table 17: **Combined Effect of Export and Import tax reduction by 50 percent on Ghana's economic target variables for an M-P appreciation (1986-1991)**

(*percentage difference from baseline*)

Year	GDP	GDP**	XGHUK	XGGER	XGJP	XGUS	XTGH	MTGH	GDE	PGDP	CABN [1]
1986	0.139	0.182	-1.501	-1.215	-1.693	1.711	0.613	0.033	0.183	-0.084	-0.016
1987	0.369	0.528	-1.201	-1.198	-4.235	4.322	0.699	0.442	0.327	-0.426	-0.118
1988	0.356	0.601	-0.889	-0.370	-3.155	4.890	0.675	0.650	0.302	-0.400	-0.846
1989	0.318	0.623	-1.223	-0.681	-2.047	3.938	0.520	0.615	0.262	-0.364	-0.074
1990	0.255	0.667	-1.403	-0.322	-1.012	3.413	0.118	0.453	0.190	-0.224	-0.067
1991	0.162	0.686	-1.527	-0.182	0.274	3.024	0.120	0.119	0.188	-0.009	-0.095

NOTE: (1) Ratio of simulated difference from baseline to baseline. For notations see list of variables.
(**) Effect of Tax change on GDP: calculated as GDP in Table 17 minus GDP in Table 13.

(B.4) *Increase in Government real expenditures by 1 and 5 percent of GDP*

Real government aggregate consumption expenditures are increased by an amount equal to 1 and 5 percent respectively of the historical real GDP over 1986-1991. We assume increased government expenditures are met through grants from abroad and not through increased taxes or borrowing from the central bank. The effects are summarized in Tables 18 and 19 respectively.

In the model, the direct effect of this change is on the aggregate domestic expenditure and a stimulation of production in agriculture and industry. Indirectly the change diffuses through import, gross capital formation, service output, and onto other sectors. A 1 percent and 5 percent real GDP additions to government real expenditures are respectively equivalent to about 10.5 and 53.0 percent of annual increase in the volume of government real expenditures.

Table 18: **Effect of Increased Government expenditure by 1 percent of GDP on Ghana's economic target variables for an M-P appreciation (1986-1991)**

(*percentage difference from baseline*)

Year	GDP	XGHUK	XGGER	XGJP	XGUS	XTGH	MTGH	GDE	PGDP	CABN [1]	GDP*
1986	0.410	-1.493	-1.183	-1.687	1.712	-0.257	0.130	1.207	-0.279	-0.067	0.453
1987	0.140	-0.814	0.096	-3.669	6.018	-0.126	0.067	1.229	0.272	-0.246	0.299
1988	0.737	-1.256	-1.560	-3.458	3.462	-0.348	0.639	1.593	-0.749	-1.858	0.982
1989	0.739	-0.605	1.362	-1.314	6.330	0.572	1.259	1.641	-0.766	-0.162	1.044
1990	0.822	-0.689	2.042	0.224	6.048	1.389	1.370	1.834	-0.899	-0.123	1.234
1991	0.903	-0.535	3.096	2.074	6.577	1.763	1.568	1.941	-1.035	-0.166	1.427
LRE	*0.513*	*0.723*	*2.357*	*1.244*	*2.376*	*1.103*	*1.137*	*0.982*	*-0.887*		

NOTE:

(1) Ratio of simulated difference from baseline to baseline. For notations see list of variables.

(LRE) Long run (sum) elasticity effect of policy variable for the simulation scenario. The elasticity is proportional change of the target variable to proportional change of the instrument variable.

(*) Effect of expenditure change on GDP: calculated as GDP in Table 18 minus GDP in Table 13.

Table 19: **Effect of Increased Government expenditure by 5 percent of GDP on Ghana's economic target variables for an M-P appreciation (1986-1991)**

(*percentage difference from baseline*)

Year	GDP	GDP**	XGHUK	XGGER	XGJP	XGUS	XTGH	MTGH	GDE	PGDP	CABN [1]
1986	2.329	2.372	-1.285	-0.606	-1.580	1.731	0.188	2.913	6.124	-3.539	-0.133
1987	1.512	1.671	2.533	11.39	0.762	18.80	2.775	4.016	6.522	-2.096	-0.398
1988	4.694	4.939	1.543	7.539	1.569	12.32	2.779	7.874	8.343	-7.240	-3.987
1989	4.987	5.292	6.621	26.96	10.26	34.07	9.076	11.73	8.634	-7.707	-0.385
1990	5.919	6.331	7.282	30.60	15.38	35.99	18.81	13.48	10.59	-9.117	-0.227
1991	6.895	7.419	9.102	38.53	21.17	43.42	21.49	16.01	11.47	-10.57	-0.309

NOTE:

(1) Ratio of simulated difference from baseline to baseline. For notations see list of variables.

(*) Effect of expenditure change on GDP: calculated as GDP in Table 19 minus GDP in Table 13.

As Tables 18 and 19 demonstrate, the economy is favorably stimulated. However, the deterioration in the nominal current account balance is relatively large in these scenarios compared to the other fiscal policy simulations. For sustained bilateral export growth performance, government real expenditures would have to increase by more than 1 percent of real GDP per annum.

The elasticities associated with the policy instruments of export tax reduction (Table 15), import tariff reduction (Table 16) and increases in government expenditure (Table 18) show government expenditure effects are larger than the other fiscal policy instruments. An increase (decrease) in government expenditure has a strong impact on the expansion (contraction) of the Ghanaian economy, particularly in the supply sectors of agriculture and industry to increase export volumes. However, its effect on the nominal current account is detrimental. This provides a rationale for increased government expenditures on the directly productive sectors of agriculture and industry that enhance production to export.

Linked to increased government expenditures are the general tax structure of the economy. If, as a result of insufficient government tax collection to finance increased expenditures (assuming grants from abroad are curtailed) and hence is to rely on an increase in export and import taxes, the policy may give rise to undesirable economic effects in her liberalized economic environment. The simulation results here provide a rationale for the government's proposal to re-introduce the value added tax as a tax-system correction mechanism for the over-reliance on export and import taxes.

From our simulation exercise, increased government expenditure seem to be relatively more effective in pulling the Ghanaian economy out of recession, other factors held constant, as indicated by the magnitudes in the calculated elasticities. There is, however, a threshold of effectiveness issue involved here. It may be the case that both tax schedules would have to be reduced by more than the simulated amount. Additionally, government real expenditures may not be able to expand by the 10 percent per annum as indicated. Between 1980-1985, real government expenditures increased by an average of -0.17 percent per annum. Between 1986-1991 it grew by an average of 6.2 percent per annum. On the other hand the indicated export tax rate fell from 38 percent in 1980 to 7 percent in 1991 whilst the import counterpart has been fairly stable, falling from 9 percent in 1980 to 6 percent in 1991.

Hence increased government expenditure effectiveness to generate the largest elasticities in terms of our stated economic objectives notwithstanding, it should not be considered the ultimate fiscal policy instrument in stimulating the Ghanaian economy in the integrated world system under the present economic conditions of budget deficit. This is because increased government expenditures (not originating from grants from abroad) are heavily dependent on domestic export and import tax

structures. Until an effective tax system is put in place to generate increased government revenues which will then make it relative effective in stimulating the economy, reductions in export and import tariffs presently are relatively more economic growth enhancing for the stated Ghanaian economic objectives in the integrated world system.

7.0 **Summary and conclusion**

In this study of Ghana integrated to the world economy, we focus primarily on Ghana-UK-Germany trade axis partly because of Ghana's relative dependence on the EU for her international trade. The study employs "representative" country macroeconometric models of these economies, using data over 1970-1991, including bilateral trade links among them and with the USA and Japan, to quantitatively analyze and draw policy inference of the international transmission mechanism of macroeconomic disturbance effects in the trade axis. Specifically, the study addresses the issue: how does external economic perturbations in the EU in particular influence Ghana's policy goals of GDP and bilateral export growth, the nominal current account and inflation; and, which Ghanaian fiscal policy instruments are most influential in enhancing these policy goals in the liberalized world economy.

The Ghanaian side of the model developed is characterized by interaction of supply components of agriculture, industry and services and the demand components of gross domestic expenditures, implicitly considering the input-output type of production process. Thus supply-side responses are incorporated into the Ghanaian model since output growth is a major determinant of exports and is relevant for the Ghanaian side of the trade linkage. The economies in the model are linked through trade flows and prices. Ghana is not an export competitor to UK, Germany, USA or Japan. However, she competes with other non-oil developing economies in the markets covered here. Hence Ghana's export price relative to the non-oil developing countries are crucial in the Ghanaian trade flows. Real exchange rates confronting Ghanaian export, foreign import and export price as well as domestic price structures influence Ghana's export price and are factored into the Ghanaian model. In addition the interaction of an aggregated export and import tax are brought explicitly into the model.

The UK and Germany models are assumed to share similar general theoretical specifications and categorizations of GNP components, but have

different magnitudes in their estimated parameters hence makes their response to shocks quite different. In all, the estimated equations are in the Keynesian fashion.

Using the baseline period of 1980-1991, qualitative and quantitative measures of model simulation as well as multiplier properties of the stand-alone and linked models are evaluated. In general the model is well able to predict variations of the major variables in the link. However, the performance of the linked system will improve as more structural models are added to the system.

Three simulations, two fiscal (government expenditure and tax changes) and one exchange rate policy, are performed with the stand-alone models. In the government expenditure increase (1 percent of base line real GDP), the impact multipliers on GDP in UK and Germany are 1.08 and 1.62 and are compared to results obtained elsewhere on UK and Germany. On Ghana, the impact on supply GDP is 0.61 and on gross expenditures, 1.31. In general, the elasticity of this simulation on UK and Germany's GDP are larger than that on Ghana. On Ghana, although increases in government expenditures generate the larger of elasticities relative to the other policy changes for bilateral exports and others, the current account balance position is relatively worse under this scenario.

Tax and nominal exchange rate changes on the economies produce expected results. For example, export tax reduction in Ghana depreciates the real exchange rate (nominal exchange rate unchanged) and hence stimulates production and export. Tax decreases in Germany and UK stimulates private consumption and impacts favorably on the aggregate economy. Nominal exchange rate devaluations results in a full pass-through to the GDP price deflator in Ghana. In Ghana, bilateral exports increase. Import falls. However, the nominal current account balance remains in deficit in the impact year due partly to the effect of devaluation on import prices in excess of export price changes.

Using the linked model, two separate scenarios of trade simulation shocks classified as "external shock without explicit Ghanaian policy change" and "with explicit Ghanaian policy change" were performed. The "without" simulations assumed, firstly, a separate scenario of a depreciated German Mark, to represent the EURO currency, to the US dollar over 1986-1991. The UK and Japanese currencies were assumed to appreciate and depreciate respectively for the same period. Secondly, a separate scenario

assumed a German Mark and UK Pound Sterling/US dollar relationship in which the German and UK currencies appreciate over 1986-1991. The Japanese currency is also assumed to appreciate.

The first "without" simulation on Ghana depicts a negative growth in supply GDP as a result of a real appreciation of the Ghanaian exchange rate that dampens supply side sectors. However, export growth, lowering of inflation as measured by growth in the GDP deflator and improvements in the nominal current account balance are favorable. The second "without" scenario effect on the economy is more severe: GDP growth, export growth, inflation declines and improvement in the nominal current account balance all deteriorate.

From these simulations, the question was asked: how could domestic policy variables enhance the Ghanaian economy as depicted by the 'worse case scenario' of Mark and Sterling appreciation against the US Dollar? The scenario of "without" was repeated for the Mark and Sterling appreciation but by changing Ghana's import tariff rate and export tax rate separately or in combinations. Government increased expenditures were also simulated separately for the Mark and Sterling appreciation effect. We conjectured that the difference between the "with" and "without" simulations represent the effect of each policy variable change on Ghana's economic policy goals for this simulation.

In elasticity terms, the Mark and Sterling appreciation simulation *with* the changed domestic policy instruments show government expenditure effects are larger than the other fiscal policies in stimulating the Ghanaian economy, although the nominal current account balance for this simulation is the worst over the 1986-1991 period. Although there seem to be a threshold of effectiveness issue involved here for the fact that the import and export tariffs may have to be changed by more than the simulated amount or that government real expenditures may not be able to expand by the magnitude simulated, increased government expenditure effectiveness generates the larger of elasticity response in terms of most of our stated economic objectives. This notwithstanding, reductions in domestic trade tariffs of export and import taxes are relatively more economic growth enhancing for the stated economic objectives of GDP and export growth, reduction in the inflationary rate and improvements in the nominal current account balance in the integrated world system. In the linked model, we have not considered tariff and non-tariff barriers to trade in the developed markets.

As a policy frame, the proposal to replace the sales tax with a value-added tax and the continuing reform of the export and import tariff structures, implying fiscal policy is still a prominent government policy instrument in enhancing Ghana's integration to the world economy, should be vigorously pursued. Similarly calls for rationalization in government expenditures to curtail budgetary deficits to strengthen central bank monetary and interest rate policies should be intensified. However, the simulation provides a rationale for increased government expenditures on the directly productive sectors of agriculture and industry that enhances production to export.

In sum, trade liberalization needs to be combined with country appropriate macroeconomic policy and de-regulations. With exchange rates liberalized the restriction of trade through import and export tariffs and quantitative restrictions (other than restrictions based on environmental pollution considerations) should be minimized. Also there should be a restructuring of the tax system to making it responsive to the liberalized world trading system and to the increased domestic economic activity.

For a "deepening" of Ghana's integration into the world economy, her commitments to the international trade system provides a signal of policy stability and intent to potential foreign investors. In addition, sustained economic policies that encourage economic growth offers additional security, and, in combination, gives the country an edge as she seeks to attract foreign investment for her rapid and sustained economic development endeavours. The importance of outward-orientation, in particular, of the role of exports in the rapid economic growth of East Asian economies are noteworthy for Ghana to pursue an open and stable domestic and international economic system.

To the EU and the other developed economies, the awareness that the collective growth of developing countries help enlarge their own markets should spur their interest to adopt policies that support countries pursuing trade liberalization by widening their access to EU/DC markets, goods, technology and investment. Ghana is on the right path to "lock-in" the harmonization of her domestic (trade) policies to that of world institutions and needs the financial and investment support of the developed economies, particularly the EU to enhance her economic growth and development. It is hoped the EU measures towards the criteria for common currency as well as having to support the development of the Eastern European countries would not diminish the assistance offered to Ghana and

other ACP countries in the next phase of the Lome Convention.

There are features of the Ghanaian economy that need further elaboration for an improved trade linkage to the rest of the world. These include the importance of the domestic monetary and tax sectors in a liberalized trading environment. In addition, the supply block in the Ghanaian model is a simple one and in future work, will address the constraints of land, weather, capital, productivity and foreign exchange limitations. An expansion of the model to include the Ghanaian economy's relationship to the other ECOWAS economies (producers of similar commodities such as cocoa) and more trading partners in the EU (the regions' traditional trading partner), and to include the USA and Japan will enhance the policy inferences to be drawn from the linked model.

Nevertheless, the result of the simulations of the linked economies are encouraging and in line with those one would expect on Ghana. By expanding the model to include more sectors and trading countries, we can meaningfully articulate the importance deepening world trade integration has on Ghana in the framework of a macroeconometric country trade-linked model.

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APPENDIX A

Estimated equations and list of variables

Country specific estimated equations are reported under country headings. The trade linked equations and identities are grouped together under the bilateral trade section. The estimation procedure is OLS. AR is a first order autoregressive procedure. Values in parenthesis reported under estimated equation parameters are the t-statistics. $\bar{R}^2$ is the adjusted coefficient of determination. D.W. and F-stat are the Durbin-Watson and F statistic respectively. F-stat measures the over-all significance of the estimated equation.

GHANA

(1) **Private consumption**:

$$CPGH = 265.453 + 0.509(YDGH) - 1.743\left(\frac{PCPGH - PCPGH_{t-1}}{PCPGH_{t-1}}\right) + 0.441(CPGH_{t-1})$$

(1.45) (5.09) (-2.23) (3.65)

$$- 246.94(D87)$$

(-4.63)

$\bar{R}^2$ =0.945 D.W.=1.98 F-stat=91.96 (1970-1991)

(2) **Gross capital formation**

$$GCFGH = 70.851 + 0.129(GDPGH-GDPGH_{t-1}) + 0.183(MTGH) + 0.212(MTGH_{t-1})$$

(1.89) (2.30) (2.64) (2.50)

$$- 0.113(STKGH_{t-1}) + 3.304(TREND)$$

(-1.07) (2.07)

$\bar{R}^2$ =0.891 D.W.=2.18 Fstat=35.29 (1970-1991)

(3) **Aggregate real imports**

$$\log(MTGH) = -17.14 + 1.84\log(GDPGH) + 1.00\log(GDPGH_{t-1}) - 0.225\log\left(\frac{PMGH}{PGDPGH}\right)$$

(-2.97) (2.706) (1.39) (-2.05)

$$+ 0.159(D8) + 0.156(D83)$$

(3.20) (1.48)

$\bar{R}^2$ =0.848 D.W.=1.74 Fstat=19.64 (AR=0.768, t=5.88) (1971-1991)

(**) **Aggregate tax revenue**

$$TXGH = -118.44 + 0.0672(GDPGH*PGDPGH) + 0.654(TXGH_{t-1})$$

(-0.09) (3.22) (3.01)

$\bar{R}^2$ =0.994 D.W.=1.83 Fstat=1078.0 (AR = -0.578, t=-1.95) (1970-1991)

(4) **Price deflator for GDP**

$$\log(PGDPGH) = 8.30 - 1.76\log(GDPGH) + 0.176\log(PMGH) + 0.930\log(M2GH_{t-1})$$

(3.35) (-5.71) (2.80) (12.81)

$\bar{R}^2$ =0.997 D.W.=1.96 Fstat=1949.27 (1971-1991)

(5) **Price deflator for private consumption**

$\log(PCPGH) = 0.035 + 0.9988\log(PGDPGH)$
(0.47) (58.11)

$\bar{R}^2$ =0.999 D.W.=1.27 Fstat=18061.9 (AR = 0.675, t=3.77) (1971-1991)

(6) **Price deflator for gross capital consumption**

$\log(PDEPRGH) = 0.27 + 0.152\log(PMGH) + 0.475\log(PMGH_{t-1}) + 0.36\log(PGDPGH)$
(7.02) (2.71) (10.6) (7.72)

$\bar{R}^2$ =0.999 D.W.=2.18 Fstat=4786.1 (1971-1991)

(7) **Unit value export, Ghana cocoa**

$\log(UEGHCOC) = 0.043 + 0.32\log(PGDPGH) + 0.542\log(UEGHCOC_{t-1}) + 0.928(D83)$
(0.26) (2.11) (4.04) (3.32)

$\bar{R}^2$ =0.98 D.W.=2.33 Fstat=198.2 (AR = -0.0888, t=-0.436) (1972-1991)

(8) **Value added in agriculture sector**

$YAGH = 1090.07 + 0.0771(CPGH_{t-1}) + 0.482(CGGH_{t-2}) - 227.1(DYA) + 103.6(D74)$
(17.02) (3.78) (4.08) (-15.5) (3.64)
$+ 0.147(XTGH_{t-1}) - 25.15(D90) + 121.95(REERX)$
(4.19) (-1.62) (3.26)

$\bar{R}^2$ =0.964 D.W.=2.66 Fstat=67.1 (AR=-0.092, t=-0.72) (1971-1991)

(9) **Value added in service sector**

$YSGH = -585.5 + 0.137(CPGH) + 69.87(POPGH) + 94.6(D83) + 0.304(YSGH_{t-1})$
(-7.46) (2.86) (5.14) (5.25) (2.85)
$+ 0.391(GCFGH) + 0.130(XTGH)$
(2.805) (2.06)

$\bar{R}^2$ =0.987 D.W.=2.03 Fstat=228.0 (AR=-0.483, t=-2.14) (1971-1991)

(10) **Value added in industry sector**

$$\log(YIGH) = 2.41 + 0.002\left(\frac{CGGH - CGGH_{t-1}}{CGGH_{t-1}}\right) + 0.25\log(GCFGH) + 0.45\log(YIGH_{t-1})$$
(3.38) (1.40) (2.17) (3.28)
$-0.011(TREND) + 0.075\log(REERX_{t-1})$
(-2.78) (2.40)

$\bar{R}^2$ =0.90 D.W.=2.80 Fstat=37.1 (1971-1991)

Important identities (National income identities and aggregate export, etc)

$GDEGH \equiv CPGH + CGGH + GCFGH + (XTGH - MTGH)$

$GDPGH \equiv YAGH + YIGH + YSGH$

$STKGH \equiv GDPGH - GDEGH$

$GNPGH \equiv GDPGH - FYGH$

$$FYGH \equiv \frac{NFIGH}{PGDPGH}$$

$NIGH \equiv GNPGH - DEPGH$

$POILI \equiv POIL\$*GEXR$

$$DEPGH \equiv \frac{DEPRNGH}{PDEPRGH}$$

$$YDGH \equiv NIGH - \frac{TXGH}{PGDPGH} + TYGH$$

$$TYGH \equiv \frac{TRANFGH}{PGDPGH}$$

XTGH ≡ XGGER+XGHUK+XGUS+XGJP+XGROW

CABNGH ≡ XTGH*PXGH - MTGH*PMGH

(11) **Import price of Ghana**

log(PMGH) = 0.430 + 0.402log(PMDB$*(GEXR*(1+TM)) + 0.370log(POIL$*GEXR)
(9.34) (4.67) (5.91)
+ 0.801(DX86) - 0.366(DX90) + 0.188log($PMGH_{t-1}$)
(5.24) (-2.89) (2.67)

$\bar{R}^2$ =0.997 D.W.=2.53 Fstat=1211.7 (1971-1991)

(12) **Export price of Ghana**

log(PXGH) = 0.1963 + 0.2806log(PEDB$*GEXR) + 0.509log(UEGHCOC)
(2.12) (2.79) (4.78)
+ 0.227log($PXGH_{t-1}$) - 0.324(DX90)
(3.38) (-2.46)

$\bar{R}^2$ =0.997 D.W.=2.02 Fstat=1571.3 (1971-1991)

GERMANY

(13) **National Income**

NYGE = 952.8012 + 1.205(GDPGE) - 0.457($GDPGE_{t-1}$) + 0.0745($NYGE_{t-1}$)
(2.653) (9.291) (-2.198) (0.374)

$\bar{R}^2$ =0.992 D.W.=1.96 Fstat=849.81 (1971-1991)

(14) **Private Consumption**

$$\frac{CPGE}{POPGE} = 6.30 + 0.18\left(\frac{YDGE}{POPGE}\right) + 0.813\left(\frac{CPGE_{t-1}}{POPGE_{t-1}}\right) - 0.7587\left(\frac{PCPGE - PCPGE_{t-1}}{PCPGE_{t-1}}\right)$$

(1.31) (3.62) (20.48) (-3.624)

$\bar{R}^2$ =0.995 D.W.=1.74 Fstat=1360.34 (1971-1991)

(15) **Gross capital formation**

GCFGE = 5050.4 + 0.262(GDPGE) +0.546($GCFGE_{t-1}$) - 1.534(KSTGE)
(2.033) (3.847) (3.77) (-2.868)
+ 254.15(TREND) - 164.8(D7485)
(2.274) (-2.777)

$\bar{R}^2$ =0.964 D.W.=1.48 Fstat=108.5 (1971-1991)

(16) **Changes in stock**

STKGE = 145.712 + 0.1310(GDPGE-$GDPGE_{t-1}$) - 0.024($KSTGE_{t-1}$)
(2.08) (3.04) (-2.26)

$\bar{R}^2$ =0.31 D.W.=1.62 Fstat=5.56 (1971-1991)

(17) **Capital Stock**

KSTGE = 27.022 + 0.045($GDPGE_{t-1}$) + 0.918($KSTGE_{t-1}$)
(0.675) (6.368) (76.57)

$\bar{R}^2$ =0.999 D.W.=1.03 Fstat=107605.6 (1971-1991)

(18) **Export of services**

$XSGE = 49.16 + 0.203(XGGE) + 953.33(D90) + 2150.56(D91)$

(0.588) (10.61) (12.45) (27.62)

$\bar{R}^2$ =0.993 D.W.=1.84 Fstat=740.2 (AR=0.3558, t=1.15) (1971-1991)

(19) **Import of goods**

$$MGGE = -3238.94 + 0.478(GDPGE) - 746.788\left(\frac{PMGE}{PGDPGE}\right)$$

(-5.17) (25.7) (-1.302)

$\bar{R}^2$ =0.971 D.W.=1.18 Fstat=338.4 (1971-1991)

(20) **Import of services**

$$\log(MSGE) = -4.776 + 0.798\log(GDPGE) - 0.563\log\left(\frac{PMGE}{PGDPGE}\right) + 0.565\log(MSGE_{t-1})$$

(-2.47) (2.49) (-3.27) (3.03)

$\bar{R}^2$ =0.949 D.W.=1.78 Fstat=125.9 (1971-1991)

Important identities

YDGE ≡ NYGE - TAXGE

$$TAXGE \equiv \frac{TAXGNE}{PGDPGE}$$

GDPGE ≡ CPGE+CGGE+GCFGE+STKGE+(XGSGE-MGER)

XGSGE ≡ XGGE+XSGE

MGER ≡ MGGE+MSGE

XGGE ≡ XGGEGH+XGGEUK+XGGEUS+XGGEJ+XGGEROW

POILGE ≡ POIL$*EXRGE

CABNGE ≡ XGSGE*PXGE - MGER*PMGE

(21) **Unit labour cost**

$$ULCGE = 21.504 + 0.853(PCPGE) - 0.634\left(\frac{GDPGE - GDPGE_{t-1}}{GDPGE_{t-1}}\right)$$

(3.68) (13.5) (-2.97)

$\bar{R}^2$ =0.984 D.W.=1.67 Fstat=399.3 (AR = 0.566, t=2.75) (1972-1991)

(22) **Producer price**, Industrial output

$$PPGE = -0.95 + .37(PMGE) + .28(ULCGE) + 0.17\left(\frac{GDPGE - GDPGE_{t-1}}{GDPGE_{t-1}}\right) + 0.37(PPGE_{t-1})$$

(-0.65) (8.97) (5.10) (1.474) (6.296)

$\bar{R}^2$ =0.998 D.W.=1.21 Fstat=2151.3 (1971-1991)

(23) **Private consumption price deflator**

$PCPGE = 7.949 + 0.882(PGDPGE)$

(0.61) (7.56)

$\bar{R}^2$ =0.996 D.W.=1.29 Fstat=2696.3 (AR=0.8501, t=6.01) (1971-1991)

(24) **Aggregate output price deflator**

$PGDPGE = 28.587 + 0.160(PPGE) + 0.297(PGDPGE_{t-1}) + 1.714(TREND)$

(3.91) (2.61) (1.44) (3.37)

$\bar{R}^2$ =0.999 D.W.=1.19 Fstat=5159.5 (1971-1991)

(25) **Import price deflator**

$$PMGE = 30.214 + 1.8635(PFIGE) + 0.1085(POILGE) + 1.4317(TREND)$$
$$(8.035) \quad (4.170) \quad (2.963) \quad (6.346)$$

$\bar{R}^2$ =0.990 D.W.=1.97 Fstat=494.76 (AR =0.609, t=3.218) (1971-1991)

(26) **Export price deflator**

$$PXGE = 2.089 + 0.590(UVEGE) - 0.518(UVEGE_{t-1}) + 0.919(PXGE_{t-1})$$
$$(1.67) \quad (7.25) \quad (-3.23) \quad (5.70)$$

$\bar{R}^2$ =0.996 D.W.=2.58 Fstat=1774.99 (1971-1991)

(27) **Unit value export (dollar base)**

$$UVEGE\$ = 2.7228 + 0.8602\left(\frac{PPGE}{EXRGE}\right) + 2.045(PCOMGE\$) - 1.463(PCOMGE\$_{t-1})$$
$$(1.29) \quad (16.57) \quad (2.682) \quad (-2.78)$$

$\bar{R}^2$ =0.997 D.W.=1.69 Fstat=1800.7 (AR=0.245, t= 0.70) (1972-1991)

UNITED KINGDOM (UK)

(28) **Private consumption**

$$\frac{CPUK}{POPUK} = 2.86 + 0.125\left(\frac{YDUK}{POPUK}\right) + 0.845\left(\frac{CPUK_{t-1}}{POPUK_{t-1}}\right) + 1.617(DCPUK)$$
$$(1.75) \quad (1.71) \quad (17.5) \quad (4.90)$$
$$- 0.138\left(\frac{PCPUK - PCPUK_{t-1}}{PCPUK_{t-1}}\right)$$
$$(-4.89)$$

$\bar{R}^2$ =0.991 D.W.=1.87 Fstat=555.0 (1972-1991)

(29) **Gross capital formation**

$$GCFUK = -150.7 + 0.381(GDPUK) + 0.372(GCFUK_{t-1}) - 0.546(KSTUK)$$
$$(-4.47) \quad (8.2) \quad (4.4) \quad (-6.58)$$

$\bar{R}^2$ =0.967 D.W.=1.60 Fstat=199.6 (1971-1991)

(30) **Changes in stock**

$$STKUK = 18.01 + 0.245(GDPUK-GDPUK_{t-1}) - 0.022(KSTUK_{t-1}) + 0.32(STKUK_{t-1})$$
$$(0.65) \quad (4.92) \quad (-1.13) \quad (2.00)$$

$\bar{R}^2$ =0.555 D.W.=2.25 Fstat=9.32 (1971-1991)

(31) **Capital stock**

$$KSTUK = 107.803 + 0.0503(GDPUK_{t-1}) + 0.791(KSTUK_{t-1}) + 3.88(TREND)$$
$$(2.24) \quad (9.71) \quad (14.44) \quad (2.21)$$

$\bar{R}^2$ =0.999 D.W.=1.88 Fstat=48460.4 (1971-1991)

(32) **Import of good**

$$\log(MGUK) = -6.88 + 1.50\log(GDPUK) - 0.14\log\left(\frac{PMUK}{PGDPUK}_{t-1}\right) + 0.20\log(MGUK_{t-1})$$
$$(-6.73) \quad (7.55) \quad (-2.27) \quad (2.00)$$

$\bar{R}^2$ =0.989 D.W.=1.78 Fstat=605.6 (1971-1991)

(33) **Import of services**

$$\log(MSUK) = -5.783 + 1.317\log(GDPUK) - 0.395\log\left(\frac{PMUK}{PGDPUK}\right)$$

(-2.398) (3.86) (-1.90)

$\bar{R}^2$ =0.915 D.W.=2.20 Fstat=72.3 (AR=0.684, t=3.621) (1971-1991)

(34) **Export of services**

$$XSUK = 80.675 + 0.237(XGUK) - 28.211(DXSUK)$$

(9.949) (18.4) (-6.69)

$\bar{R}^2$ =0.943 D.W.=1.92 Fstat=175.7 (1970-1991)

(35) **National income**

$$NYUK = 43.087 + 0.9274(GDPUK) - 0.841(GDPUK_{t-1}) + 0.865(NYUK_{t-1})$$

(0.53) (9.25) (-5.21) (5.99)

$\bar{R}^2$ =0.987 D.W.=1.57 Fstat=501.5 (1971-1991)

Important identities

YDUK ≡ NYUK - TAXUK

$$TAXUK \equiv \frac{TAXNUK}{PGDPUK}$$

GDPUK ≡ CPUK+CGUK+GCFUK+STKUK+(XGSUK-MUK)

XGSUK ≡ XGUK+XSUK

MUK ≡ MGUK+MSUK

XGUK ≡ XGUKGH+XGUKGE+XGUKUS+XGUKJ+XGUKROW

CABNUK ≡ XGSUK*PXUK - MUK*PMUK

(36) **Unit labour cost**

$$ULCUK = 8.49 - 0.253\left(\frac{GDPUK - GDPUK_{t-1}}{GDPUK_{t-1}}\right) - 0.543\left(\frac{GDPUK - GDPUK_{t-1}}{GDPUK_{t-1}}\right)_{t-1}$$

(5.73) (-1.17) (-2.44)

$$+ 0.529(ULCUK_{t-1}) + 0.428(PCPUK)$$

(2.91) (2.57)

$\bar{R}^2$ =0.995 D.W.=1.41 Fstat=935.06 (1972-1991)

(37) **Producer price,** manufacturing output

$$PPUK = -0.18 + 0.07(PMUK) + 0.32(ULCUK) - 0.005\left(\frac{GDPUK - GDPUK_{t-1}}{GDPUK_{t-1}}\right)_{t-1}$$

(-0.18) (1.88) (3.89) (0.05)

$$+ 2.25(TREND) + 0.26(PPUK_{t-1})$$

(4.78) (2.60)

$\bar{R}^2$ =0.999 D.W.=2.17 Fstat= 5539.9 (1972-1991)

(38) **Private consumption price deflator**

$$PCPUK = 5.481 + 0.742(PGDPUK) + 0.212(PCPUK_{t-1})$$

(2.37) (9.94) (2.47)

$\bar{R}^2$ =0.999 D.W.=1.93 Fstat= 20680.3 (AR=0.760, t=4.756) (1971-1991)

(39) **Aggregate output price deflator**

$$PGDPUK = -9.72 + 0.926(PPUK) + 0.195(PGDPUK_{t-1})$$
$$(-0.95) \quad (4.52) \quad (1.19)$$

$\bar{R}^2$ =0.999 D.W.=1.39 Fstat= 5215.7 (AR=0.824, t=4.94) (1972-1991)

(40) **Import price deflator**

$$PMUK = 3.07 + 2.0287(PFIUK) - 1.6771(PFIUK_{t-1}) + 0.862(PMUK_{t-1})$$
$$(1.6) \quad (3.288) \quad (-2.897) \quad (4.61)$$

$\bar{R}^2$ =0.991 D.W.=1.96 Fstat= 699.8 (1971-1991)

(41) **Export price deflator**

$$PXUK = 1.305 + 0.993(UVEUK)$$
$$(2.02) \quad (116.58)$$

$\bar{R}^2$ =0.999 D.W.=1.94 Fstat= 9821.7 (AR= 0.156, t=0.65) (1971-1991)

(42) **Unit value export, UK**

$$UVEUK\$ = 3.292 + 0.592(PPUK \cdot EXRUK) + 0.181(POIL\$) + 0.682(PCOMUK\$)$$
$$(2.31) \quad (14.08) \quad (14.7) \quad (3.23)$$

$\bar{R}^2$ =0.998 D.W.=2.12 Fstat= 3284.1 (1970-1991)

Bilateral export trade relations (bilateral trade in goods)

(43) *Ghana to Germany*

$$\log(XGGER) = -59.24 - 1.08\log\left(\frac{PXG\$}{UVENODC}\right) + 2.71\log(MGGE)$$
$$(-5.74) \quad (-5.45) \quad (2.26)$$
$$+ 5.19\log(GDPGH_{t-1}) - 0.161(TREND) + 0.54(DGHGE)$$
$$(7.08) \quad (-3.29) \quad (2.45)$$

$\bar{R}^2$ =0.893 D.W.=2.48 Fstat=34.40 (1971-1991)

(44) *Ghana to UK*

$$\log(XGHUK) = -31.84 - 0.373\log\left(\frac{PXG\$}{UVENODC}\right) + 3.90\log(MGUK)$$
$$(-5.97) \quad (-2.08) \quad (4.03)$$
$$+ 1.59\log(GDPGH_{t-1}) - 0.217(TREND) + 0.380(DUKGH)$$
$$(2.16) \quad (-5.42) \quad (2.71)$$

$\bar{R}^2$ =0.819 D.W.=1.25 Fstat=19.08 (1971-1991)

(45) *Ghana to USA*

$$\log(XGUS) = -52.69 - 0.034\log\left(\frac{PXG\$}{UVENODC}\right) + 2.82\log(GDPUS)$$
$$(-4.89) \quad (-0.12) \quad (1.82)$$
$$+ 5.996\log(GDPGH_{t-1}) - 0.1696(TREND)$$
$$(5.83) \quad (-3.25)$$

$\bar{R}^2$ =0.68 D.W.=1.94 Fstat=11.7 (1971-1991)

(46) *Ghana to Japan*

$$\log(XGJP) = -41.39 - 0.202\log\left(\frac{PXG\$}{UVENODC}\right) - 0.125\left(\frac{PXG\$}{UVENODC}\ t\text{-}1\right) + 3.49\log(GDPJP)$$

(-2.83) (-1.99) (-1.15) (1.95)

$$+2.23\log(GDPGH_{t-1}) - 0.181(TREND) + 0.357\log(XGJP_{t-1}) + 0.326(DJPGH)$$

(4.41) (-2.17) (1.63) (3.27)

$\bar{R}^2$ =0.90 D.W.=2.19 Fstat=26.6 (1972-1991)

(47) *Ghana to Rest of the world*

$$\log(XGROW) = 6.13 + 0.12\log(XGROW_{t-1}) - 0.08(TREND) + 0.16\log(REERX)$$

(8.67) (1.05) (-8.71) (3.13)

$$+ 0.71(DROWGH)$$

(7.37)

$\bar{R}^2$ =0.84 D.W.=2.02 Fstat=25.8 (1972-1991)

(48) *Germany to UK*

$$\log(XGGEUK) = -0.825 + 1.304\log(MGUK) - 0.482\log\left(\frac{PXGE}{EXRGE} \cdot \frac{1}{PMUK \cdot EXRUK}\right)$$

(-0.78) (5.29) (-2.61)

$$- 1.124\log(MGUK_{t-1}) + 0.837\log(XGGEUK_{t-1})$$

(-5.73) (9.18)

$\bar{R}^2$ =0.992 D.W.=1.97 Fstat=642.3 (1971-1991)

(49) *Germany to US*

$$\log(XGGEUS) = -6.855 + 1.315\log(MGUS) - 0.395\log\left(\frac{PXGE}{EXRGE} \cdot \frac{1}{PMUS}\right)$$

(-4.10) (5.74) (-2.61)

$$+ 0.438\log(XGGEUS_{t-1}) - 0.046(TREND)$$

(2.71) (-2.83)

$\bar{R}^2$ =0.964 D.W.=1.82 Fstat=103.54 (AR=0.503, t=2.09) (1972-1991)

(50) *Germany to Japan*

$$\log(XGGEJ) = 0.820 + 1.68\log(MGJP) - 0.254\log\left(\frac{PXGE}{EXRGE} \cdot \frac{EXRJP}{PMJP}\right) - 1.59\log(MGJP_{t-1})$$

(0.53) (6.09) (-1.87) (-4.81)

$$+ 0.970\log(XGGEJ_{t-1})$$

(7.23)

$\bar{R}^2$ =0.975 D.W.=1.89 Fstat=193.6 (1971-1991)

(51) *Germany to Ghana*

$$\log(XGGEGH) = -4.972 + 1.003\log(MTGH) - 0.638\log\left(\frac{PXGE}{EXRGE} \cdot \frac{1 + TM}{PMG\$}\right)$$

(-4.43) (5.92) (-4.93)

$$- 0.098(TREND) + 0.431(D83)$$

(-3.01) (3.80)

$\bar{R}^2$ =0.828 D.W.=2.27 Fstat=20.20 (AR=0.694, t=5.51) (1971-1991)

(52) *Germany to Rest of the world*

$$\log(XGGEROW) = 7.7397 + 0.03748(TREND)$$

(131.7) (9.51)

$\bar{R}^2$ =0.971 D.W.=2.10 Fstat=334.1 (AR =0.558, t=3.11) (1971-1991)

(53) *UK to Germany*

$$\log(XGUKGE) = -3.2304 + 0.5912\log(MGGE) - 0.288\log((PXUK \cdot EXRUK)(\frac{EXRGE}{PMGE}))$$

(-2.47) (2.93) (-2.18)

$$+ 0.694\log(XGUKGE_{t-1})$$

(6.59)

$\bar{R}^2$ =0.990 D.W.=1.26 Fstat= 631.98 (1971-1991)

(54) *UK to US*

$$\log(XGUKUS) = -0.973 + 0.662\log(MGUS) - 0.365\log((PXUK \cdot EXRUK)/PMUS)$$

(-0.62) (3.06) (-1.317)

$$+ 0.074(DUKUS) + 0.0151(TREND)$$

(2.69) (0.88)

$\bar{R}^2$ =0.96 D.W.=1.13 Fstat= 97.7 (AR=0.770, t=5.11) (1971-1991)

(55) *UK to Ghana*

$$\log(XGUKGH) = -4.395 + 0.802\log(MTGH) - 0.385\log((PXUK * EXRUK).(\frac{1+TM}{PMG\$}))$$

(-4.68) (5.10) (-3.02)

$$+0.470(D83) - 0.275(D89) - 0.043(TREND)$$

(4.25) (-1.95) (-2.14)

$\bar{R}^2$ =0.712 D.W.=2.39 Fstat= 9.25 (AR=0.582, t=2.83) (1971-1991)

(56) *UK to Japan*

$$\log(XGUKJ) = -3.233 + 1.429\log(MGJP) + 0.1704\log(UVEUK\$) - 0.835\log(\frac{PMJP}{EXRJP})$$

(-1.45) (4.30) (0.50) (-2.59)

$$+ 0.228\log(XGUKJ_{t-1}) - 0.095(DUKJ)$$

(1.14) (-2.18)

$\bar{R}^2$ =0.943 D.W.=1.997 Fstat= 53.71 (AR= 0.787, t=5.53) (1972-1991)

(57) *UK to Rest of the world*

$$\log(XGUKROW) = 5.932 + 0.0271(TREND)$$

(79.83) (6.02)

$\bar{R}^2$ =0.966 D.W.=2.01 Fstat= 288.7 (AR= 0.683, t= 4.89) (1971-1991)

Trade Linkage identities

$$REERX \equiv (GEXR*(1-TX))*\frac{PEDB\$}{PGDPGH}$$

$$REERM \equiv (GEXR*(1+TM))*\frac{PMDB\$}{PGDPGH}$$

$$PEDB\$ \equiv 0.203(UVMUK\$)+0.061(UVMGE\$)+0.082(UVMUS)+0.097(UVMJP\$)$$

$$PMDB\$ \equiv 0.298(UVEUK\$)+0.136(UVEGE\$)+0.069(UVEUS)+0.072(UVEJP\$)$$

$$PMG\$ \equiv \frac{PMGH}{GEXR(1+TM)}$$

$$PXG\$ \equiv \frac{PXGH}{GEXR}$$

$$PFIGE\$ \equiv .0798(UVEUK\$)+.0693(UVEUS)+.0449(UVEJP\$) + 0.0003(\frac{UEGHCOC}{GEXR})$$

PFIGE ≡ PFIGE$*EXRGE

UVEGE ≡ UVEGE$*EXRGE

$$PFIUK\$ \equiv .1497(UVEGE\$)+.1172(UVEUS)+.0489(UVEJP\$)+ 0.0012(\frac{UEGHCOC}{GEXR})$$

PFIUK ≡ PFIUK$ / EXRUK

UVEUK ≡ UVEUK$ / EXRUK

PCOMGE$ = 0.0856*UVEUK$ + 0.1036*UVEUS + 0.0147*UVEJP$

PCOMUK$ = 0.1139*UVEGE$ + 0.1494*UVEUS + 0.0130*UVEJP$

LIST OF VARIABLES

endogenous

CABNGE	Nominal current account balance, Germany
CABNGH	Nominal current account balance, Ghana
CABNUK	Nominal current account balance, UK
CPGE	Private final consumption expenditures, Germany, 1985 mil. DM
CPGH	Private final consumption expenditures, Ghana, 1985 mil. Cedis
CPUK	Private final consumption expenditures, UK, 1985 mil. pound
GCFGE	Real gross fixed capital formation, Germany
GCFGH	Real gross fixed capital formation, Ghana
GCFUK	Real gross fixed capital formation, UK
GDEGH	Real gross domestic expenditures, Ghana, 1985 mil. Cedis
GDPGE	Real gross domestic product, Germany, 1985 mil. DM
GDPGH	Real gross domestic product, Ghana, 1985 mil. Cedis
GDPUK	Real gross domestic product, UK, 1985 mil. pound
GNPGH	Real gross national product, Ghana
KSTGE	Real aggregate capital stock, Germany, billion 1985 DM
KSTUK	Real aggregate capital stock, UK, billion 1985 pound
MGER	Real imports of goods and services, Germany
MGGE	Real aggregate imports of goods, Germany
MGUK	Real imports of goods, UK
MSGE	Real imports of services, Germany
MSUK	Real imports of services, UK
MTGH	Aggregate real imports of good and services, Ghana
MUK	Real import of goods and services, UK, million pound
NIGH	Real national income, Ghana
NYGE	Real national income, Germany
NYUK	Real national income, UK
PCOMGE$	Competitor's export price facing Germany
PCOMUK$	Competitor's export price facing UK
PCPGE	Price deflator of CPGE, 1985=100
PCPGH	Price deflator of CPGH, 1985=100
PCPUK	Price deflator of CPUK, 1985=100
PDEPRGH	Price deflator for DEPGH, 1985=100
PEDB$	Import trade weighted price of Ghana exports, dollar base
PFIGE	Export weighted price of imports, Germany, DM base
PFIGE$	Export weighted price of imports, Germany, dollar base
PFIUK	Export weighted price of imports, UK, pound base
PFIUK$	Export weighted price of imports, UK, dollar base
PGDPGE	Aggregate GDP price deflator, Germany, 1985=100
PGDPGH	Aggregate GDP price deflator, Ghana, 1985=100
PGDPUK	Aggregate GDP price deflator, UK, 1985=100
PMDB$	Export trade weighted price of Ghana imports, dollar base

PMGE	Price deflator for imports, Germany, 1985=100
PMGH	Price deflator for imports, Ghana, 1985=100
PMUK	Price deflator for imports, UK, 1985=100
POILGE	Nominal petroleum price index, Germany
POILI	Nominal petroleum price index, Ghana
PPGE	Producer price index (industrial output), Germany, 1985=100
PPUK	Producer price index (manufacturing output), UK, 1985=100
PXGE	Price deflator for Germany exports
PXGH	Price deflator for Ghana exports
PXUK	Price deflator for UK exports
REERM	Real exchange rate for imports, Ghana
REERX	Real exchange rate for exports, Ghana
STKGE	Changes in Stock, Germany
STKGH	Changes in Stock, Ghana
STKUK	Changes in Stock, UK
TAXGE	Real aggregate tax revenue, Germany
UEGHCOC	Unit export index (domestic currency) of Ghana Cocoa, 1985=100
ULCGE	Unit labour cost index, Germany, 1985=100
ULCUK	Unit labour cost index, UK, 1985=100
UVEGE	Unit value index of exports, Germany, deutsche mark (DM) base
UVEGE$	Unit value index of exports, Germany, dollar base
UVEUK	Unit value index of exports,UK, sterling pound base, 1985=100
UVEUK$	Unit value index of exports, UK, dollar base
XGGE	Real aggregate export of goods, Germany
XGGEGH	Bilateral export of goods, Germany to Ghana
XGGEJ	Bilateral export of goods, Germany to Japan
XGGER	Bilateral export of goods, Ghana to Germany
XGGEROW	Bilateral export of goods, Germany to rest of the world
XGGEUK	Bilateral export of goods, Germany to UK
XGGEUS	Bilateral export of goods, Germany to USA
XGHUK	Bilateral export of goods, Ghana to UK
XGJP	Bilateral export of goods, Ghana to Japan
XGROW	Bilateral exports of Ghana to rest of the world
XGSGE	Real export of goods and services, Germany
XGSUK	Real export of goods and services, UK
XGUK	Real export of goods, UK
XGUKGE	Bilateral export of goods, UK to Germany
XGUKGH	Bilateral export of goods, UK to Ghana
XGUKJ	Bilateral export of goods, UK to Japan
XGUKROW	Bilateral export of goods,UK to rest of the world
XGUKUS	Bilateral export of goods, UK to USA
XGUS	Bilateral export of goods, Ghana to USA
XSGE	Real export of services, Germany
XTGH	Real aggregate export of goods and services, Ghana
YAGH	Real agricultural output, Ghana, 1985 million Cedis
YDGE	Real disposable national income, Germany
YDGH	Real disposable national income, Ghana
YDUK	Real disposable national income, UK
YIGH	Real industrial output, Ghana, 1985 mil. Cedis
YSGH	Real service output, Ghana, 1985 mil Cedis

exogenous

CGGE	Real Government final consumption expenditures, Germany
CGGH	Real Government final consumption expenditures, Ghana
CGUK	Real Government final consumption expenditures, UK
D7485	Dummy to account for fluctuation, GCF in Germany

D8	Dummy, fluctuations in Ghana imports:(72, 79, 82, 84 =1, else =0)
D83	Dummy, Ghana's economic adjustment (70-72, 78-79, 83 ~ =1)
D89	Dummy for steep decline in bilateral export, UK to Ghana.
D90	Dummy for steep rise in XSGE in 1990
D91	Dummy for steep rise in XSGE in 1991
DCPUK	Dummy, steep increase in UK's private consumption data 1985-88
DGHGE	Dummy for steep rise in Ghana-Germany trade in 1991-1992
DJPGH	Dummy for fluctuations in Ghana-Japan trade data
DUKGH	Dummy for fluctuations in Ghana-UK trade data
DUKJ	Dummy to account for fluctuation in bilateral trade, UK to Japan
DX86	Dummy, 1986 =1 else = 0
DX90	Dummy for 1990, 1991 = 1 else = 0
DXSUK	Dummy to account for fluctuations in UK service export data
DEPGH	Real capital consumption allowance, Ghana
DEPRNGH	Nominal capital consumption allowance, Ghana
EXRGE	Nominal exchange rate, Germany, DM per unit dollar
EXRJP	Nominal exchange rate, Japan, Yen per unit dollar
EXRUK	Nominal exchange rate, UK, US dollar per unit sterling pound
FYGH	Real net factor income, Ghana
GEXR	Nominal exchange rate, Ghana, Cedis per US dollars
M2GH	Broad Money Supply, Ghana
MJP	Real imports of goods and services, Japan, billion Yen
MGJP	Real import of goods, Japan, billion Yen
MUS	Real import of goods and services, USA, million dollars
NFIGH	Nominal net factor income, Ghana
PMJP	Price deflator for imports, Japan, 1985=100
PMUS	Price deflator for imports, USA, 1985=100
POIL$	Average end of year price of crude petroleum, dollar base index
POPGE	Population, Germany
POPGH	Population, Ghana
POPUK	Population, UK
TAXGNE	Nominal aggregate tax revenue, Germany
TAXNUK	Nominal aggregate tax revenue, UK
TM	Import duty rate, Ghana
TRANFGH	Nominal private transfers from abroad, Ghana
TREND	Time trend, 1,2,3...
TX	Export duty rate, Ghana
TXGH	Nominal aggregate tax revenue excluding grants, Ghana
UVEJP$	Unit value index of exports, Japan, dollar base
UVENODC	Unit value index exports of non-oil developing country, dollar base
UVEUS	Unit value index of exports, US, dollar base
UVMGE$	Unit value index of imports, Germany, dollar base
UVMJP$	Unit value index of imports, Japan, dollar base
UVMUK$	Unit value index of imports, UK, dollar base
UVMUS	Unit value index of imports, USA, dollar base

APPENDIX B

Data sources

The sample period of 1970-1991 used in the estimation is due largely to official data reportage lags in Ghana's bilateral trade flows. In subsequent improvements, the data will be enlarged for the linked countries.

GHANA

(1) Quarterly Digest of Statistics, Government of Ghana, various issues

(2) Ewusi, Kodwo (1986), Statistical Tables on the Economy of Ghana: 1950-1985, ISSER, University of Ghana.

(3) Direction of Trade Statistics Yearbook, The IMF, various issues.

(4) International Financial Statistics Yearbook, 1995 and 1996.

UK, GERMANY, USA, JAPAN

(1) OECD. Quarterly National Accounts Statistics, various issues

(2) OECD. Flows and Stocks of Fixed Capital.

(3) OECD. Main Economic Indicators, various issues.

(4) International Financial Statistics Yearbook, 1995 and 1996.

(5) Direction of Trade Statistics Yearbook, The IMF, various issues.

(Supplemented by)

UK

(1) CSO Annual Abstracts of Statistics, UK, various issues.

(2) National Accounts Statistics, United Nations, various issues.

GERMANY

(1) Statistisches Jahrbuch für die Bundesrepublik Deutschland, various issues.

USA

(1) Statistical Abstracts of the United States of America, 1975.

JAPAN

(1) Gaikoku Boeki Gaikyo. The Summary Report on Trade of Japan. Published by Japan Tariff Association, various issues.

Appendix C.1: Own and Cross-Elasticity effect of a 1 percent increase of GDP on government expenditures in Ghana, Germany and UK

YEAR	GHANA								GERMANY								UK							
	GDP (1)	GDP (1,2)	GDP (1,3)	MT	X(1) (PD)	X(1) (EL)	X(2) (PD)	X(2) (EL)	GDP (2)	GDP (2,1)	GDP (2,3)	MT	X(3) (PD)	X(3) (EL)	X(4) (PD)	X(4) (EL)	GDP (3)	GDP (3,1)	GDP (3,2)	MT	X(5) (PD)	X(5) (EL)	X(6) (PD)	X(6) (EL)
1980	0.067	0.000	0.000	0.098	0.001	0.098	0.000	0.078	0.227	0.003	0.011	0.394	0.013	1.234	0.005	0.263	0.352	0.012	0.015	0.518	0.320	2.15	0.266	0.696
1981	0.102	0.000	0.000	0.231	0.001	0.232	0.000	0.185	0.231	0.009	0.020	0.418	0.011	1.261	0.009	0.449	0.364	0.036	0.019	0.617	0.224	2.68	0.351	0.838
1982	0.130	0.000	0.000	0.288	0.002	0.289	0.001	0.230	0.241	0.010	0.027	0.448	0.008	1.355	0.012	0.594	0.378	0.040	0.022	0.645	0.269	2.85	0.382	0.859
1983	0.149	0.000	0.000	0.351	0.002	0.353	0.001	0.281	0.236	0.013	0.031	0.438	0.021	1.308	0.015	0.676	0.375	0.048	0.023	0.648	0.240	2.87	0.397	0.846
1984	0.113	0.000	0.000	0.283	0.002	0.284	0.001	0.226	0.225	0.016	0.034	0.415	0.012	1.241	0.016	0.718	0.361	0.043	0.023	0.634	0.190	2.82	0.415	0.811
1985	0.104	0.000	0.000	0.257	0.002	0.258	0.001	0.205	0.212	0.014	0.035	0.391	0.013	1.172	0.017	0.734	0.349	0.042	0.022	0.615	0.261	2.72	0.427	0.775
1986	0.107	0.000	0.000	0.258	0.002	0.259	0.001	0.206	0.196	0.017	0.034	0.353	0.020	1.046	0.018	0.719	0.314	0.045	0.021	0.572	0.208	2.53	0.428	0.708
1987	0.127	0.000	0.000	0.317	0.001	0.319	0.001	0.254	0.177	0.020	0.033	0.319	0.015	0.955	0.018	0.683	0.297	0.049	0.018	0.534	0.378	2.36	0.412	0.650
1988	0.116	0.000	0.000	0.273	0.001	0.274	0.001	0.218	0.162	0.020	0.032	0.288	0.014	0.882	0.018	0.633	0.281	0.057	0.016	0.506	0.271	2.25	0.405	0.610
1989	0.122	0.000	0.000	0.299	0.002	0.300	0.001	0.239	0.145	0.018	0.031	0.256	0.014	0.791	0.018	0.563	0.285	0.053	0.015	0.510	0.241	2.28	0.398	0.612
1990	0.141	0.000	0.000	0.333	0.001	0.335	0.001	0.266	0.131	0.024	0.030	0.222	0.047	0.690	0.018	0.506	0.287	0.063	0.012	0.518	0.398	2.32	0.382	0.618
1991	0.160	0.000	0.000	0.378	0.001	0.380	0.001	0.302	0.116	0.035	0.030	0.192	0.052	0.637	0.018	0.447	0.292	0.081	0.010	0.528	0.363	2.38	0.373	0.624

Notes **GDP (i,j) = cross elasticity effect of country i on country j 's GDP : Ghana (1) Germany (2) UK (3) : For example, GDP(1,2) is the cross elasticity of Ghanaian expenditure shock on Germany's GDP and GDP(2,1) is the cross elasticity of Germany's expenditure shock on Ghana's GDP.**

MT = Total imports of country i

X = Bilateral export :

(1) Germany to Ghana
(2) UK to Ghana
(3) Ghana to Germany
(4) UK to Germany
(5) Ghana to UK
(6) Germany to UK

PD: cross multiplier
EL: cross elasticity

Appendix C.2: Own and Cross-Elasticity: 1 percent decrease in export tax in real exchange rate of Ghana on domestic variables and on exports of Germany and UK to Ghana

YEAR	GDP	YAGH	YIGH	YSGH	XT	MT	XGHGE	XGHUK	CABN	XUKGH	XGEGH
				own elasticity effect					Δ	***cross elasticity***	
1980	0.005	0.006	0.002	0.005	0.051	0.007	0.002	0.001	0.002	0.006	0.007
1981	0.017	0.005	0.055	0.011	0.034	0.029	0.032	0.010	-0.000	0.023	0.029
1982	0.020	0.007	0.046	0.024	0.196	0.046	0.099	0.031	0.013	0.037	0.046
1983	0.053	0.028	0.165	0.034	0.095	0.097	0.127	0.040	-0.001	0.078	0.097
1984	0.040	0.022	0.115	0.028	0.118	0.111	0.305	0.095	-0.001	0.089	0.111
1985	0.036	0.023	0.087	0.027	0.123	0.091	0.237	0.074	-0.001	0.073	0.092
1986	0.032	0.017	0.084	0.025	0.090	0.082	0.215	0.067	-0.001	0.066	0.082
1987	0.030	0.021	0.065	0.024	0.082	0.075	0.200	0.064	-0.002	0.061	0.076
1988	0.026	0.017	0.059	0.022	0.075	0.068	0.184	0.058	-0.036	0.055	0.068
1989	0.023	0.015	0.049	0.020	0.070	0.060	0.162	0.051	-0.001	0.048	0.060
1990	0.022	0.014	0.044	0.021	0.094	0.055	0.142	0.045	-0.000	0.044	0.055
1991	0.022	0.015	0.039	0.021	0.083	0.053	0.135	0.043	-0.000	0.043	0.054

Note Δ **Ratio of change between shock variable and baseline variable to baseline variable. Negative sign indicate deterioration.**

Appendix C.3: Own and Cross-Elasticity: 1 percent decrease in import tax rate of Ghana on domestic variables and on exports of Germany and UK to Ghana

YEAR	GDP	YAGH	YIGH	YSGH	XT	MT	XGHGE	XGHUK	CABN	XUKGH	XGEGH
				own elasticity effect					Δ	***cross elasticity***	
1980	0.0003	0.0006	0.0007	0.0005	0.0007	0.0069	0.0012	0.0004	0.002	0.0253	0.0398
1981	0.0006	0.0001	0.0019	0.0005	0.0018	0.0101	0.0040	0.0013	0.004	0.0291	0.0449
1982	0.0009	0.0001	0.0032	0.0007	0.0033	0.0164	0.0087	0.0037	0.005	0.0497	0.0770
1983	0.0008	0.0003	0.0037	0.0000	0.0034	0.0104	0.0095	0.0031	0.001	0.0203	0.0301
1984	0.0004	0.0002	0.0027	-0.0004	0.0031	0.0109	0.0090	0.0036	0.001	0.0300	0.0462
1985	0.0003	0.0001	0.0026	-0.0005	0.0026	0.0105	0.0064	0.0024	0.001	0.0294	0.0453
1986	0.0002	0.0000	0.0025	-0.0005	0.0023	0.0083	0.0065	0.0021	0.001	0.0206	0.0313
1987	0.0003	0.0001	0.0021	-0.0005	0.0018	0.0069	0.0050	0.0019	0.001	0.0182	0.0279
1988	0.0003	0.0001	0.0019	-0.0004	0.0017	0.0070	0.0039	0.0017	0.057	0.0196	0.0301
1989	0.0004	0.0001	0.0021	-0.0002	0.0019	0.0077	0.0049	0.0017	0.001	0.0209	0.0321
1990	0.0006	0.0002	0.0023	0.0002	0.0031	0.0076	0.0052	0.0018	0.001	0.0193	0.0294
1991	0.0006	0.0002	0.0022	0.0002	0.0036	0.0065	0.0021	0.0018	0.001	0.0156	0.0239

Note Δ **Ratio of change between shock variable and baseline variable to baseline variable. Negative sign indicate deterioration.**

Appendix D.1: Impact of a depreciated German Mark to the US Dollar and UK Sterling by 10 percent over 1986-1991 only on Germany and UK variables

(*percentage difference from baseline*)

YEAR	GERMANY						UK					
	GDPGE	MGER	XGSGE	CABN[1]	PMGER	PXGER	GDPUK	MUK	XGSUK	CABN[1]	PMUK	PXUK
1986	0.556	0.171	0.859	-0.058	3.603	1.275	0.052	0.209	0.168	0.154	-2.393	-0.785
1987	0.900	0.599	1.557	-0.007	3.327	1.585	0.011	0.417	0.317	0.134	-2.446	-0.737
1988	1.108	0.858	1.848	0.002	3.307	1.720	-0.041	0.372	0.255	0.108	-2.371	-0.675
1989	1.241	0.999	1.973	-0.010	3.515	1.849	-0.043	0.345	0.261	0.133	-2.263	-0.580
1990	1.148	0.870	1.616	-0.001	3.358	1.885	-0.076	0.287	0.201	0.234	-2.397	-0.583
1991	1.042	0.689	1.292	-0.004	3.363	1.903	-0.159	0.165	0.037	0.261	-2.362	-0.538

Note (1) Ratio of simulated difference from baseline to baseline. Negative sign indicate deterioration.

Appendix D.2: Impact of an appreciated M-P to the US dollar by 10 percent over 1986-1991 only on Germany and UK variables

(*percentage difference from baseline*)

YEAR	GERMANY						UK					
	GDPGE	MGER	XGSGE	CABN[1]	PMGER	PXGER	GDPUK	MUK	XGSUK	CABN[1]	PMUK	PXUK
1986	-0.494	-0.211	-0.810	0.062	-2.832	-0.664	-0.272	-0.242	-0.587	0.057	-2.871	-2.218
1987	-0.749	-0.525	-1.312	0.006	-2.596	-1.202	-0.487	-0.305	-0.844	0.052	-3.118	-2.336
1988	-0.891	-0.709	-1.490	-0.002	-2.514	-1.287	-0.527	-0.340	-0.856	0.071	-3.272	-2.129
1989	-0.991	-0.804	-1.573	0.007	-2.730	-1.438	-0.595	-0.416	-0.924	0.092	-3.637	-2.409
1990	-0.900	-0.680	-1.261	0.003	-2.570	-1.407	-0.636	-0.463	-0.925	0.123	-3.536	-2.402
1991	-0.803	-0.524	-0.991	0.003	-2.543	-1.429	-0.621	-0.457	-0.828	0.184	-3.690	-2.303

Note (1) Ratio of simulated difference from baseline to baseline. Negative sign indicate deterioration.