



IMPACT OF IMPORT LIBERALISATION ON POVERTY: A DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM AND MICROSIMULATION ANALYSIS FOR GHANA

Obeng, C. K.

Department Of Economics, University of Cape Coast, Ghana

Abstract

The study examined the long run impact of import liberalization on the incidence, depth and severity of poverty at the national and household levels. The investigation was carried out using a recursive dynamic computable general equilibrium and a microsimulation model calibrated to the 2005 Social Accounting Matrix (SAM) of Ghana. In spite of the strong criticism against import liberalisation as being anti-growth and poverty enhancing, the results showed that the net effect of import liberalisation is a reduction in the incidence, depth and severity of poverty at the national and household levels in the long run. However, the benefits of import liberalisation accrue more to urban households than rural households. The study recommends that import liberalisation must continue to be part of the poverty alleviation strategy of government after 2015 and that government should focus poverty alleviation policies more in the rural areas.

Keywords: Computable General Equilibrium, Import Liberalization, Microsimulation, Social Accounting Matrix, Poverty

Introduction

The effect of import liberalisation on poverty has been and continues to be a hotly debated topic in development economics (while Omolo, 2011 and Khan, 2007 have adduced evidence in support of a positive relationship between the two variables, Rodrik, 2000; Rodriguez & Rodrik, 2001; Ravallion, 2001; Lubker, Smith & Weeks, 2002; Wei, 2002; Chen & Ravallion, 2004 have evidence in support of adverse effect of import liberalisation on poverty). This is because there is no historical antecedent linking import liberalisation to poverty and more importantly, the

theoretical link between them is unclear (Omolo, 2012; Winters, McCulloch, & McKay, 2004). Empirically, however, the channels through which trade liberalisation impact poverty have been identified as price and availability of goods, factor prices, government transfers, incentives for investment and innovation, terms of trade, and short-run risk (Winters, et al 2004 as cited in Bouet, 2006).

In explaining the link between import liberalisation and poverty, the argument has always been made that import liberalisation

reduces the prices of consumer goods (Weerahewa, 2004, 2006), raise real incomes, expand the availability of goods and thereby lift many poor households out of poverty. Another channel that has been identified is the employment channel. That is, through import liberalisation local firms import raw materials at lower cost, expand their operations and create employment for more people. The protagonists, on the other hand, argue that import liberalisation destroys local productive activities, increase unemployment and push many households that were above the poverty line, below it. They further argue that import liberalisation deny government revenue from tariffs on imports that could be used to provide services and support the vulnerable in society. Clearly, the effect of import liberalisation on poverty is an empirical issue and must be taken case by case.

Ghana offers an interesting case study because it is one of the fastest liberalizers in Africa (Economic Commission on Africa, 2004). In the late 1960s and earlier 1970s, Ghana operated liberal trade regime. But this was replaced in 1972 with a controlled regime with the government as a major producer. The policies of the period emphasized import substitution, underpinned by a restrictive foreign exchange rate regime, quantitative restrictions upon imports and price controls. Indeed, the country recorded its worst macroeconomic performance during this period (Killick, 2010). Specifically, GDP recorded negative growth rates, there were large budget deficits, and high inflation rate from the early 1970s to the early 1980s (Killick, 2010). The situation got so bad that the government had to embark upon a massive reform of the economy in April 1983.

As part of a comprehensive reform programme supported by the IMF and the World Bank, Ghana

liberalised her import trade. The liberalisation took the form of removal of quantitative restrictions on imports and replacing them with tariffs, and the reduction in the level and range of import tariffs. For instance, the simple average tariff rate fell from 32.6 percent for the period 1972-82 to 11.3 percent for the period 1990 -2003. There was also the liberalisation of the exchange rate, financial sector, and the labour market. The reduction in import tariff meant that imports of consumer goods were now cheaper for households. It also meant that firms that relied on import inputs could import raw materials at reduced cost. On the contrary, import liberalisation implied that cheaper imports of consumer goods have come to replace domestically produced goods forcing some local firms to collapse and raise the risk of adjustment and hence create unemployment, and increase poverty among the people.

Ghana succeeded in reversing the negative trends in macroeconomics indicators and she recorded sustained growth rate averaging 5 percent per annum, inflation reduced considerably, the huge fiscal deficit was brought within reasonable limits and the current account deficit was reduced. The period also witnessed an expansion in the range of imports as well as the absolute value of total imports with a lot of cheap imports of consumer goods coming in from the Asian countries. Meanwhile, the composition of the traditional sources of Ghana's merchandise imports, Nigeria, United Kingdom, USA, Cote d'Ivoire, Germany, Switzerland and Togo, remains intact.

The period also witnessed significant reduction in headcount poverty from about 52 per cent in 1991/92 to 28.5 per cent in 2005/2006. Poverty remains substantially higher in rural areas than urban areas, even though poverty fell by 23% in the rural areas as against 16% in the urban areas

for the period under consideration, and is disproportionately concentrated in the rural savannah. Despite the fact that the incidence of poverty has fallen, the depth of poverty for those who remain poor has remained relatively stable. The decline in poverty has been concentrated mostly in Western, Central, Volta, Eastern, Ashanti and Brong Ahafo, Northern, and Upper East regions. Only Accra experienced an increase in poverty. The poverty figure for Upper West region for 2005/06 was 21% higher than the figure for 1991/92 even though it represented a fall of 0.3% from the figure for 1998/99. Large poverty reductions have occurred among public sector workers, private sector employees in both the formal and informal sectors, and non-working households. The decline, however, is not evenly distributed according to ecological zones and regions.

Given that Ghana has adopted poverty alleviation as a kingpin of its development agenda in line with MDG 1, and she is likely to maintain this agenda Post 2015, there is a need to explore explicitly the link between import liberalisation and poverty using appropriate quantitative framework. Thus, the critical question that was answered in this study after considering the above issues is: What is the long run impact of trade liberalisation on poverty in Ghana? Specifically, the study investigated the macroeconomic impact of import liberalisation and the effect of import liberalisation on the incidence, depth and severity of poverty of households in Ghana. Performing one policy experiment, that is, gradual removal of taxes on imports, the objective of the study was achieved. The analysis was carried out for the period 2005 to 2020. The choice of the study period was informed by the availability of a comprehensive household dataset from the Ghana Living Standards Survey (GLSS 5). The motivation of the paper was driven by the desire

to contribute to the search for a poverty reduction strategy for Ghana and to assess the potential impact of the economic partnership agreement the country has agreed to sign with the European Union. The results show a positive impact on macroeconomic variables and a reduction in the incidence, depth and severity of household poverty.

Previous Computable General Equilibrium (CGE) analysis of Ghana's trade policy reforms have been carried out within the static CGE framework with all pointing to the fact import liberalisation complemented with other policies alleviates poverty (Bhasin & Annim, 2005; Bhasin & Obeng, 2005a; 2005b; 2006, Bhasin, 2012). The current study is different from all the earlier ones in that while the former studies covered only one period, the current study is dynamic in nature and therefore covers a longer time period. Second, and more importantly, while the earlier studies eliminated all taxes on imports and exports, this study employed a gradual elimination of trade taxes.

The presentation of the rest of the paper follows this order: Section Two describes the research methodology, which covers the way the study was carried out and the model used. Section Three presents and discusses the results. Here, the presentation includes the macroeconomic effects of the policy simulation, national and household poverty. Finally, section Four concludes and presents the policy recommendations of the study.

Methodology

A study of the impact of import liberalisation on poverty requires the use of a model that can capture all the complexities involved in the linkage. With this in mind, the Dynamic Computable General Equilibrium and Microsimulation model was employed in this study. The following activities were systematically performed in pursuant of the objectives of the study: the dynamic computer general equilibrium model was run from 2005 to 2020, and the prices, incomes and commodity consumption and factor price changes for an aggregate household were fed into a microsimulation model for the disaggregated households in the survey. Household expenditures were accordingly updated and the standard poverty measures were then recalculated using the updated expenditure estimates and the poverty line.

Model

An abridged version of the model developed by Breisinger, Diao and Thurlow (2009) and documented in Lofgren, Harris and Robinson (2002) is presented below while the extended version (the numbering of the abridged model follow that of the extended model) is presented in the Appendix. In the model, production is characterized by a two-level nesting structure and involves combining factors and intermediate inputs. Equations 1 and 2, show the aggregate quantity of intermediates for an activity ($QINT_a$) as composed of the fixed shares of the individual intermediate commodities used in that activity's production ($QINT_{ca}$).

$$QINT_{ca} = ica_{ca} \times QINT A_a \quad 1$$

$$PINTA_a = \sum_{c \in C} PQ_c \times ica_{ca} \quad 2$$

Since intermediate commodities are purchased in the market, the aggregate price of the intermediate inputs ($PINTA_a$) for an activity is equal to the market price of each intermediate commodity (PQ_c) multiplied by its share (ica_{ca}) in total intermediate use.

Unlike the Leontief treatment of intermediates, factors are combined into a composite primary factor under a CES function as shown in equations 3 and 4, which combine the factor demands of an activity (QF_{fa}) into an aggregate quantity of value-added inputs for that activity (QVA_a).

$$QVA_a = \alpha_a^{va} \times \left(\sum_{f \in F} \delta_{fa}^{va} \times (\alpha_{fa}^{vaf} \times QF_{fa})^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad 3$$

$$W_f \times \overline{WFDIST}_{fa} = PVA_a \times QVA_a \times \left(\sum_{f \in F'} \delta_{fa}^{va} \times (\alpha_{fa}^{vaf} \times QF_{fa})^{-\rho_a^{va}} \right)^{-1} \times \delta_{fa}^{va} \times (\alpha_{fa}^{vaf})^{-\rho_a^{va}} \times (QF_{fa})^{-\rho_a^{va}-1} \quad 4$$

An activity's factor demand is driven by cost-minimization based on the relative prices of factors, such that their marginal revenue product equals their marginal cost. The marginal cost of the composite factor at the top of the factor demand nest for each sector is equal to its marginal revenue product, where marginal cost

is the economy-wide average wage (W_f) multiplied by a sector-specific distortion term ($WFDIST_{fa}$). Total factor productivity (TFP) is reflected by α_a^{va} and factor-specific productivity by α_{fa}^{vaf} .

The composite factor quantities and aggregate intermediate quantities are combined under a Leontief specification (Equations 7 and 8) to arrive at a final level of output for each activity (QA_a).

$$QVA_a = iva_a \times QA_a \quad 7$$

$$QINTA_a = int a_a \times QA_a \quad 8$$

The output of each commodity is then distributed across domestic and foreign markets. Under the small-country assumption, the price of an exported commodity, shown in equation 14, is equal to the commodity's world export price (pwe_c) multiplied by the exchange rate (EXR).

$$PE_{cr} = pwe_{cr} \times EXR - \sum_{c' \in CT} PQ_{c'} \times ice_c \quad 14$$

The demand for a commodity can either be satisfied by domestic or foreign supply. The price of an imported commodity (PM_c), shown in equation 20, is equal to the commodity's world import price (pwm_c) multiplied by the exchange rate (EXR) and any import tariffs (tm_c).

$$PM_{cr} = pwm_{cr} \times (1 + tm_{cr}) \times EXR + \sum_{c' \in CT} PQ_{c'} \times icm_{c'} \quad 20$$

Any additional transactions costs are added, and are equal to the share of these costs per commodity unit (icm_c) multiplied by the market price of these transaction commodities (PQ_c).

For those commodities that have both domestic and foreign supply, Equations 21 and 22 represent the constant elasticity of substitution (CES) or Armington function determining the final quantity and price of imported ($c QM$) and domestically supplied ($c QD$) commodities.

$$QQ_c = \alpha_c^q \times \left(\sum_{\tau} \delta_{c\tau}^q \times QM_{c\tau}^{-\rho_c^q} (1 - \sum_{\tau} \delta_{c\tau}^q) \times QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}} \quad 21$$

$$\frac{QM_{c\tau}}{QD_c} = \left(\frac{PD_c}{PM_c} \times \frac{\delta_c^q}{1 - \sum_{\tau} \delta_{c\tau}^q} \right)^{\frac{1}{1 + \rho_c^q}} \quad 22$$

These two commodities are combined to form a composite commodity (QQ_c) that is then supplied to the market. The elasticity of substitution, which is a transformation of ρ_c^q , represents the ease at which consumers are willing to shift demand between domestic and foreign products.

Factor employment in the production process generates factor incomes as shown in Equation 26.

$$YF_f = \sum_{a \in A} WF_f \times wfdist_{fa} \times QF_{fa} \quad 26$$

Total income for each factor (YF_f) is equal to its economy-wide wage (WF_f) multiplied by both the quantity employed (QF_{fa}) in each activity and its sector-specific wage distortion term ($WFDIST_{fa}$). Factor incomes are then either transferred to domestic institutions or to the rest of the world.

Direct payments from factors (YIF_{if}) only form part of the total income (YI_i) earned by domestic nongovernment institutions. As shown in equation 28, other income sources include transfers received from other institutions ($TRII_{ii'}$), CPI-indexed transfers from the government ($trnsfr_{igov} \times CPI$), and domestically-valued transfers from the rest of the world ($trnsfr_{irow} \times EXR$).

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{igov} \times cpi + trnsfr_{irow} \times EXR \quad 28$$

Fixed investment demand ($QINV_c$) across commodities is defined in equation 32 as the base-year quantity ($qinv_c$) multiplied by an adjustment factor ($IADJ$).

$$QINV_c = IADJ \times qinv_c \quad 32$$

By using an adjustment factor, which has a value of one in the base, the assumption is that the commodity composition of the investment bundle remains unchanged as the level of investment adjusts.

Another component of final demand is government consumption spending (Equation 33).

$$EG = \sum_{c \in C} PQ_c \times qg_c + \sum_{i \in INSDNG} trnsfr_{igov} \times cpi \quad 33$$

The total value of total government spending (EG) is equal to the market value of government consumption spending ($PQ_c \times qg_c$), as well as CPI-indexed transfers to other institutions ($trnsfr_{igov} \times CPI$).

Government expenditure is financed by government revenue (YG).

$$\begin{aligned} YG = & \sum_{i \in INSDNG} tins_i \times YI_i + \sum_{f \in F} tf_f \times YF_f \\ & + \sum_{a \in A} tva_a \times PVA_a \times QVA_a + \sum_{a \in A} ta_a \times PA_a \times QA_a + \sum_{c \in CMNR} tm_c \times pwm_c \times QM_c \times EXR \\ & + \sum_{c \in CE} te_c \times pwe_c \times QE_c \times EXR + \sum_{c \in C} tq_c \times PQ_c \times QQ_c + \sum_{f \in F} YF_{govf} + trnsfr_{govrow} \times EXR \end{aligned} \quad 34$$

As shown in equation 34, income-sources include direct taxes ($tins_i$), activity taxes (ta_a), import tariffs (tm_c), export tariffs (te_c), sales taxes (tq_c), factor income (YF_{gov_f}), and transfers received from the rest of the world ($trnsfr_{gov_row}$).

The general equilibrium is represented by the equality between supply and demand of goods and factors, and the investment-saving identity as shown in equations 35 to 39 in the Appendix.

In the dynamic module, a number of exogenous and endogenous changes take place over time that is important for capturing the growth process. Together these changes form a projected or

counterfactual growth path for the economy. These inter-period adjustments include population and labor force growth, capital accumulation, factor productivity changes, and changes in foreign capital inflows and government expenditure.

Allocation of investment in the dynamic module is done in such a way that sectors with a higher-than average profit rate receive a larger share of investment than their share in aggregate profits. This updating process involves four steps captured in equations 40 to 45.

$$AWF_{ft}^a = \sum_a \left[\left(\frac{QF_{fat}}{\sum_{a'} QF_{fa't}} \right) \times WF_{ft} \times wfdist_{fat} \right] \quad 40$$

$$\eta_{fat}^a = \left(\frac{QF_{fat}}{\sum_{a'} QF_{fa't}} \right) \times \left(\beta^a \left[\frac{WF_{ft} \times wfdist_{fat}}{AWF_{ft}^a} - 1 \right] + 1 \right) \quad 41$$

$$\Delta K_{fat}^a = \eta_{fat}^a \times \left(\frac{\sum_c PQ_{ct} \times qinv_{ct}}{PK_{ft}} \right) \quad 42$$

$$PK_{ft} = \sum_c PQ_{ct} \times \frac{qinv_{ct}}{\sum_{c'} qinv_{c't}} \quad 43$$

$$QF_{fat+1} = QF_{fat} \times \left(1 + \frac{\Delta K_{fat}^a}{QF_{fat}} - vf \right) \quad 44$$

$$QFS_{ft+1} = QFS_{ft} \times \left(1 + \frac{\sum_a K_{fat}}{QFS_{ft}} - vf \right) \quad 45$$

Equation 40 describes the first step at which the average economy-wide rental rate of capital (AWF_{aft}) is calculated for time period t . In the second

step (equation 41) each sector's share of the new capital investment (η_{fat}^a) is calculated by comparing its rental rate to the economy-wide

average. Equation 42 shows the third step of the updating procedure in which the quantity of new capital is calculated as the value of gross fixed capital formation divided by the price of capital (PK_{ft}). This is then multiplied by each sector's share of new capital (η_{fat}^a) to arrive at a final quantity allocated to each sector (ΔK_{fat}^a). The determination of the unit capital price is shown in Equation 43. In the final step the new aggregate quantity of capital (QFS_{ft+1}) and the sectoral quantities of capital (QF_{fat+1}) are adjusted from their previous levels to include new additions to the capital stock. Over and above these changes there is also a loss of capital to account for depreciation (νf).

Finally, the model is linked to a household expenditure survey by taking endogenous changes in commodity consumption from each aggregate household and adjusting the level of expenditure for the corresponding disaggregated households in the survey. As the data used to calibrate the model (that is, social accounting matrix) is constructed using the survey data, there is a direct mapping between commodities and households in the model and survey. Therefore changes in QH_{ch} from equation 31 (measured in base year prices) are used to update household expenditure in the survey. Standard poverty measures (including the poverty-growth elasticity) are then recalculated using the updated expenditure estimates and the poverty line.

It is essential to note that the empirical model represents a small open economy that has no influence on international markets and it is calibrated to the Social Accounting Matrix (SAM) of Ghana for the year 2005. There are three production sectors, three factors of production and nine categories of households. The model is presented in four blocks, including production and prices; institutional incomes and domestic

demand equations, equilibrium conditions and macroeconomic closure and factor accumulation and allocation equations.

The model is in three parts, namely, the static part, the dynamic module and the microsimulation module. The static module works on the principle that Ghana imports and taxes both consumer goods and intermediate inputs which are used for consumption purposes and production of import-competing substitutes and exports, respectively. The import –competing producing firms are heavily protected by the tariffs on imports. With the removal of the tariffs, imports become cheaper and consumers demand more of imports. Demand for imports increase while that for the locally produced import-substitute falls. Meanwhile, exports become competitive because of the removal of the tariff on imported intermediate inputs and so exports increase. In the short run, government revenues will fall, affecting adversely its transfer payments to households. In the long run, however, government revenue will increase because both import base and exports will rise. It should also be noted that households receive remittances both from within the economy and from abroad. The effect of the decline in government transfers to households will, therefore, depend on how much remittances households receive from both internal and external sources. These dynamics in the economy will affect prices of goods, the quantities produced and supplied, exports, employment, earnings of factors of production, household income, consumption, savings and the balance of payments position of the country. The results that will be obtained from this exercise will give us the base effect that is the counterfactual. From here, poverty analysis can be carried out but this study had a long term perspective and so we implemented the dynamic component of the model. It is worth noting that the dynamic module

is run concurrently but it has been separated for pedagogical purposes.

The dynamic module is solved one period at a time through updating such variables as investment spending and population growth rate to reflect changes that have taken place in the static model. This is done when the policy simulation is implemented. The results obtained constitute what will happen when the economy is shocked. The difference between the base outcomes and the simulated results are presented in percentages.

The poverty effects of the policy simulations were carried out in the microsimulation model. The microsimulation model was constructed using the expenditures of all the households in the 2005/2006 living standard survey for Ghana. In the CGE model, however, households are aggregated and do represent larger household categories identified in the survey based on expenditure and location. As the relevant data for the CGE is the 2005 SAM for Ghana, which is constructed with data from the survey, there is a direct mapping between commodities and households in the model and survey. The endogenous changes in prices, incomes and commodity consumption from each aggregate household coming from the policy simulation to the CGE is used to adjust the level of expenditure for the corresponding disaggregated households in the survey. The incidence, depth and severity of poverty at the national level and for each household category are recalculated using the updated expenditure estimates and the poverty line.

Data sources

The main source of data for this thesis is the 2005 Social Accounting Matrix (SAM) of Ghana. The SAM reflects a snapshot of all the goods and

services that have been produced and the flow of incomes and expenditures in Ghana for the year 2005. It also captures inflow of resources from the rest of the world to Ghana as well as payments from Ghana to the rest of the world. The SAM also contains detailed information on the demand and production structure of 59 sectors, made up of 27 agricultural sub-sectors, 22 industrial sub-sectors and 10 service sub-sectors. There is also information on three factors of production (land, labour and capital) and the incomes and expenditures of nine household categories. Finally, the SAM contains information on the sources of government revenue and expenditure. The SAM was constructed from a wide range of data sources. In building the SAM, use was made of the national accounts provided by the Ghana Statistical services (GSS), Crop and livestock data supplied by the Ministry of Food and Agriculture (MOFA), mining, manufacturing and energy sector data from the 2003 Industrial census (GSS), households income and consumption data from 2005/06 Ghana Living Standards survey (GLSS5), and export and import data at the commodity-level provided by the Bank of Ghana, MOFA and GSS.

Policy simulation

The main policy experiment carried out was a gradual reduction of import tariff rate by 6% per annum. The 6 per cent reduction in import tariff rate was arrived at because the target was to reduce the average import tariff rate of 16 per cent to zero by 2010.

Results

Macroeconomic effects

The first objective of the study was to examine the macroeconomic impact of a gradual elimination of import tariffs. This section of the report pursues

the first objective. The impact of gradual elimination of imports tariffs on key macroeconomic variables such as absorption - private consumption, government consumption, investment and stock change-, exports, imports, GDP, and exchange rate are summarized in Table

1. All the figures are expressed as percentages of the base values. The simulated results (Import Liberalisation) are derived after a policy experiment has been implemented.

Table 1: Macroeconomic Indicators

Variable	Base	Import Liberalisation (%)
Absorption	258508.79	8.39
Private Consumption	168893.02	9.10
Government consumption	33168.71	3.59
Fixed investment	56398.47	10.70
Stock change	48.58	2.19
Exports	64163.34	17.22
Imports	-115304.17	10.27
GDP (factor cost)	177235.57	9.40

Source: Simulation results, 2014

The results show that in the long run gradual removal of import taxes (Trade liberalisation) leads to increase in absorption. As shown in Table 1, absorption increases by about 8.4 percent over the base scenario. There is also an increase of about 9.1 percent in private consumption. Increase in private consumption is sustained by rise in imports. Other components of absorption have equally been affected positively by the policy experiments. For instance, government consumption increases by about 4.0 percent, and investment rises by about 11.0 percent. The rise in absorption is an indication that import tariff elimination (trade liberalisation) enhances overall welfare in Ghana for the study period of 2005 - 2020. Other components of aggregate demand that have seen improvements as a result of the policy

shock are exports and imports. Exports increase by about 17.2 percent while imports rise by about 10.3 percent. The increase in absorption, exports and imports has reflected in the positive change in GDP at factor cost. There is an increase of about 9.4 percent in GDP at factor cost. The finding supports the results of Acharya (2010), Diallo et al (2010), Wong et al (2008), Feraboli (2007), Bchir et al (2005) and Cattaneo et al (1999).

The improvement in the macroeconomic variables is justified in the sense that tariff removal improves the competitiveness of the economy of Ghana. Tariff reduction results in a decrease in import prices that makes imports cheaper than domestic import-competing substitutes. Consumers therefore, shift from the domestic import-competing substitutes to demand more of

imported goods and services. The import-competing sectors, which were initially heavily protected, will see a decline in output and employment.

The increase in imports causes depreciation of the local currency because the current account is assumed fixed. Again, the fall in the prices of imported inputs reduces domestic costs of production. These two effects lead to a reduction in the domestic costs of production for the expanding sectors of the economy. Output in these expanding sectors will rise, employment will grow, and the productive factors from the declining sectors will, *ceteris paribus*, relocate to these growing sectors.

The reduction in costs of production and the depreciation of the local currency lead to increase in competitiveness of the export sector. As a result of the increase in the domestic price of exports, the export industry expands, investment increases, production of exportables increase, export of goods and services rise, employment in the export sector rises, incomes increase (Omolo,2011 ;Acharya 2010 ; Cattaneo et al 1999); this creates a multiplier effect of incomes and expenditures leading to further increase in GDP. Examples of expanding exports sectors include non-traditional exports such as fruit, tree nuts, vegetable and industrial crops, and traditional exports like cocoa, forestry products, fish products and wood products.

These are the sectors in which Ghana has comparative advantage and, more importantly, are also labour intensive activities. Consequently, employment of unskilled and semi-skilled labour rises. Since labour income is the main source of

income for majority of households in the country, household incomes rise and poverty rate decrease.

It is not only the exports sector that expands in response to the policy shock. Other non-tradable sectors of the economy of Ghana equally expand in response to the policy shock. These sectors include administration, health, water, education, trade, transport and communication, real estate, mining, trading, other services, etc. Majority of the sectors have expanded to provide supporting services to the export sector (backward linkages). Examples of these services include road transport, business services including telecommunication, public sector services, water and electricity, health and education. The expansion of the service sector which includes retail trade is significant in that it provides employment for many people. Construction contracts because as a non-tradable it had benefited enormously from the tariff protection. These results suggest that additional trade liberalisation brings welfare gains to Ghana. The findings confirm those of Wang and Zhai (1998) for China, Siddique et al (2008) for Pakistan, but contradict that of Pradhan and Sahoo (2008) for India.

Poverty Analysis

The second objective of the study was to investigate the impact of import liberalisation on national and household poverty. In pursuant of this objective, tariff on import was gradually removed and the impact on incidence, depth and severity of poverty at both the national and household levels were analyzed. Table 2 reports the poverty outcome of gradual import tariff removal at the national level.

Table 2: National Poverty

	Base			Import Liberalisation		
	P0	P1	P2	P0	P1	P2
National	28.5	9.6	4.6	27.4	9.0	4.3
Urban	10.8	3.1	1.3	7.4	2.0	0.8
Rural	39.2	13.5	6.6	39.0	13.2	6.3

Source: Simulation Results, 2014

The Table shows that all the poverty measures fall at the national level for the policy shock. Under trade liberalisation, the incidence of poverty falls from the base value of 28.5 percent to 27.4 percent in 2020. The depth of poverty, which measures how far the poor are from the poverty line, also decreases from 9.6 percent in the base to 9.0 percent in 2020. Equally, the severity of poverty declines from 4.6 percent in the base to 4.3 percent in 2020. In relative terms, the incidence of poverty reduces by 1.1 percent, the depth falls by 0.6 percent and the severity of poverty declines by about 0.3 percent. The outcome clearly suggests that trade liberalisation has the potential to better the circumstances of the poor in Ghana, in the long run. This finding confirms the findings of Omolo (2011), Raihan (2010) and Nahar and Siriwardana (2009), who found that trade liberalisation has a positive impact on poverty.

Across all locations, all poverty indicators also decline. For urban areas, the headcount poverty decreases from 10.8 percent in the base scenario to 7.4 percent in 2020, while the poverty gap falls from 3.1 percent in the base to 2.0 percent in 2020. Finally, the severity of poverty falls from 1.3 percent in the base to 0.8 percent in 2020. In the rural areas, on the other hand, the percentage of people living below the poverty line goes down from 39.2 percent in the base scenario to 39.0 percent in 2020. The poverty gap decreases from 13.5 percent in the base scenario to 13.2 percent in 2020, while the severity of poverty falls from 6.6 percent in the base to 6.3 percent in 2020.

In terms of the change in poverty indicators, the fall in the incidence of poverty, the depth of poverty and severity of poverty is higher in the urban area than in the rural area. For instance, while the incidence of poverty falls by a margin of 3.4 percent in the urban area, it falls by 0.2% in the rural area. The depth of poverty for urban area falls by 1.1 percent, while it declines by 0.3 percent in the rural area. Finally, the severity of poverty also changes by a higher percentage in the urban area than in the rural. Specifically, while the severity of poverty falls by 0.5 percent in the urban areas, it decreases by 0.3 percent in the rural areas.

The analysis done above shows that trade liberalisation favours urban households more than it does rural households. The results confirm the findings of Annabi et al (2005) for Senegal, Siddique et al (2008) for Pakistan, Adjovi et al (2008) for Benin, but contradict the result of Aredo, Fekadu and Workneh (2007) who found that a complete elimination of tariff increases poverty at the national level in Ethiopia.

Two plausible reasons can be assigned for the observed changes in poverty measures after the implementation of the gradual removal of import tariffs. The first reason is that most of the goods whose prices decline after removing import tariffs are consumer goods consumed mainly by the urban population. It therefore stands to reason that the urban areas benefit more from poverty than the rural areas that consume less of these goods.

Second, the levels of poverty in the rural areas are so high that the positive change in income and hence consumption is not enough to take many people out of poverty. In other words, the poor in the rural areas are so far away from the poverty line such that the positive change in income and hence consumption is not enough to reduce poverty significantly. Contrary, the poor in the urban areas are very close to the poverty line such that the slightest increase in income and hence consumption makes a significant impact on urban poverty.

At the household level, generally, poverty is prevalent in rural households than in urban households. Again, poverty is higher in the northern households than any other households. Northern households have the highest incidence of poverty in both urban and rural areas. For northern rural households, poverty levels have been very high so that even though poverty

generally reduces with trade liberalisation, the level of poverty in the northern rural households still remains high. For example, the poverty headcount decreases from 68.3 percent in the benchmark to 66.5 percent in 2020 for the policy shock and the depth of poverty falls from 31.4 percent in the benchmark to 29.4 percent in 2020. Finally, the severity of poverty declines from 17.8 percent in the benchmark to 16.3 percent in 2020. Strikingly, the urban north tops in all the measures of poverty for the urban households. For instance, the incidence of poverty reduces from 31.9% to 25%, the depth of poverty reduces from 10.9% to 8.1% and the severity of poverty declines from 4.9% to 3.3%. It is also worthy of note that the highest reduction in the incidence of poverty occurs in the rural coastal household. Here, the poverty headcount decreases from 24.0 percent in the benchmark to 16.1 percent in 2020 under the policy scenario (refer to Table 3).

Table 3: Trade liberalisation and household poverty

Household	Base			Import Liberalisation		
	Po	P1	P2	Po	P1	P2
Accra	10.6	2.9	1.1	7.3	1.6	0.6
Urban Coastal	5.5	0.9	0.2	2.8	0.4	0.01
Urban Forest	6.9	1.7	0.7	4.3	1.1	0.5
Urban South	21.6	7.6	4.0	15.2	5.9	3.1
Urban North	31.9	10.9	4.9	25.0	8.1	3.3
Rural Coastal	24.0	5.3	1.8	16.1	3.5	1.1
Rural Forest	27.7	6.8	2.4	33.3	7.4	3.1
Rural South	36.7	8.4	2.8	32.9	6.9	2.3
Rural North	68.3	31.4	17.8	66.5	29.4	16.3

The analysis so far shows that there are significant differences in the incidence of poverty, depth of poverty and severity of poverty even though poverty rates generally decrease for each household (Siddiqui et al, 2008; Cororaton, 2008; Akapaiboon, 2007). For instance, poverty rates are much higher in the Northern households compared to households in the other locations. The Urban North households record the highest poverty headcount among the urban households and the Rural North households also experience the highest incidence of poverty among rural households.

One major reason why trade liberalisation has the lowest impact on poverty in the Northern region is that two of the major commodities of the region, rice and poultry, actually contracted. Other reasons cited for the region's poor poverty record are its geographical disadvantages, including relatively low and variable rainfall, savannah vegetation, and the inaccessibility of large parts of the region which has less well-developed rural road networks compared to those in the rest of the country (ODI & CEPA, 2005; Breisinger et al, 2008) and a deliberate colonial government policy to under-develop the region so, it could serve as a source of cheap labour for the south (Shepherd & Gyimah-Boadi, 2004 as cited in AL-Hassan & Diao, 2007). The stark inequality between the north and the south of Ghana needs to be addressed in order to make a significant progress in poverty alleviation.

The finding that urban households benefit more from import tariff liberalisation than rural households corroborates the results of Nwafor et al (2007), Bibi and Chatti (2006), Siddique et al (2008), Siddique (2009), and Adjovi et al (2008),

but contradicts the findings of Nahar and Siriwardana (2009), Chitiga and Mabugu (2005) and Bautista and Thomas (1997), Pradhan and Sahoo (2008) and Decaluwe et al (1999). In conclusion, import tariff liberalisation reduces poverty at the household level in the long run. In particular, trade liberalisation reduces the incidence, depth and severity of poverty. However, urban households benefit more than their rural counterparts.

Conclusions and Policy Recommendations

The study investigated the impact of import liberalisation on poverty in Ghana using a dynamic CGE framework. Two specific objectives were pursued. The first specific objective was to explore the effect of import liberalisation on macroeconomic indicators. Secondly, the study sought to investigate the impact of import liberalisation on the incidence, depth and severity of poverty at both the national and household levels.

In pursuance of these objectives and to be able to capture both the direct and indirect effects of import liberalisation in Ghana, a recursive dynamic computable general equilibrium (DCGE) and a microsimulation model calibrated to the 2005 Social Accounting Matrix (SAM) built with the most recent household survey data, Ghana living Standards survey (GLSS5), was used for the study for the period 2005 to 2020. One main policy simulation, gradual import tariff reduction, was carried out in this study to evaluate the poverty impacts of import liberalisation in Ghana.

The results of the study revealed that import liberalisation produces positive impacts on macroeconomic indicators. Specifically, GDP,

private consumption, government consumption, investment, exports and imports increased as a result of the gradual removal of import tariff. The second most important results observed is that import liberalisation is poverty-reducing. That is, the incidence of poverty, depth of poverty and severity of poverty decrease at the national, regional and household levels when all import taxes are removed. This means that while import liberalisation reduces the number of poor people in the population, it improves on the conditions of the poor as exemplified by the reduction in the depth of poverty and severity of poverty. However, the north-south poverty divide and the rural-urban poverty dichotomy still persist.

This finding is due to the fact that urban households, generally, are net consumers of imported goods and services than rural households. In addition, the urban areas have the necessary economic infrastructure and so are economically vibrant, thereby offering huge opportunities for people to participate in international trading activities. The study recommends that import liberalisation must continue to be part of the poverty alleviation strategy of government for Ghana after 2015 and that government must focus poverty alleviation policies more in the rural areas.

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APPENDIX

Mathematical Specification of computable general equilibrium model

Production and price equations

$$QINT_{ca} = ica_{ca} \times QINT A_a$$

1

$$PINTA_a = \sum_{c \in C} PQ_c \times ica_{ca} \quad 2$$

$$QVA_a = \alpha_a^{va} \times \left(\sum_{f \in F} \delta_{fa}^{va} \times (\alpha_{fa}^{vaf} \times QF_{fa})^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad 3$$

$$W_f \times \overline{WFDIST}_{f^a} = PVA_a \times QVA_a \times \left(\sum_{f' \in F'} \delta_{fa}^{va} \times (\alpha_{fa}^{vaf} \times QF_{fa})^{-\rho_a^{va}} \right)^{-1} \times \delta_{fa}^{va} \times (\alpha_{fa}^{vaf})^{-\rho_a^{va}} \times (QF_{fa})^{-\rho_a^{va}-1} \quad 4$$

$$QF_{fa} = \alpha_{fa}^{van} \times \left[\sum_{f' \in F} \delta_{ff'a}^{van} \times QF_{f'a}^{-\rho_{fa}^{van}} \right]^{\frac{1}{\rho_{fa}^{van}}} \quad 5$$

$$W_{f'} \times WFDIST_{f'a} = W_f \times WFDIST_{fa} \times QF_{fa} \times \left[\sum_{f'' \in F} \delta_{ff''a}^{van} \times QF_{f''a}^{-\rho_{fa}^{van}} \right]^{-1} \times \delta_{ff'a}^{van} \times QF_{f'a}^{\rho_{fa}^{van}-1} \quad 6$$

$$QVA_a = iva_a \times QA_a \quad 7$$

$$QINTA_a = int_a \times QA_a \quad 8$$

$$PA_a \times (1-ta_a) \times QA_a = PVA_a \times QVA_a + PINTA_a \times QINTA_a \quad 9$$

$$QXAC_{ac} = \theta_{ac} \times QA_a \quad 10$$

$$PXAC_{ac} = \sum_{c \in C} \times PXAC_{ac} \times \theta_{ac} \quad 11$$

$$QX_c = \alpha_c^{ac} \times \left(\sum_{a \in A} \delta_{ac}^{ac} \times QXAC_{ac}^{-\rho_a^{ac}} \right)^{-\frac{1}{\rho_c^{ac}-1}} \quad 12$$

$$PXAC_{a^c} = PX_c \times QX_c \left(\sum_{a \in A'} \delta_{ac}^{ac} \times QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \times \delta_{ac}^{ac} \times QXAC_{ac}^{-\rho_c^{ac}-1} \quad 13$$

$$PE_{cr} = pwe_{cr} \times EXR - \sum_{c' \in CT} \times PQ_c \times ice_{c'c} \quad 14$$

$$QX_c = \alpha_c^t \times \left(\sum_{\tau} \delta_{cr}^t \times QE_{cr}^{\rho_c^t} + (1 - \sum_{\tau} \delta_{cr}^t) \times QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \quad 15$$

$$\frac{QE_{cr}}{QD_c} = \left(\frac{PE_{cr}}{PD_c} \times \frac{1 - \sum_{\tau} \delta_{cr}^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t-1}} \quad 16$$

$$QX_c = QD_c + \sum_{\tau} QE_{cr} \quad 17$$

$$PX_c \times QX_c = PD_c \times QD_c + \sum_{\tau} PE_{cr} \times QE_{cr} \quad 18$$

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \times icd_{c'c}$$

$$PM_{cr} = pwm_{cr} \times (1 + tm_{cr}) \times EXR + \sum_{c' \in CT} PQ_{c'} \times icm_{c'c} \quad 20$$

$$QQ_c = \alpha_c^q \times \left(\sum_{\tau} \delta_{c\tau}^q \times QM_{c\tau}^{-\rho_c^q} (1 - \sum_{\tau} \delta_{c\tau}^q) \times QD_c^{-\rho_c^q} \right)^{\frac{1}{\rho_c^q}} \quad 21$$

$$\frac{QM_{c\tau}}{QD_c} = \left(\frac{PD_c}{PM_c} \times \frac{\delta_c^q}{1 - \sum_{\tau} \delta_{c\tau}^q} \right)^{\frac{1}{1 + \rho_c^q}} \quad 22$$

$$QQ_c = QD_c + \sum_{\tau} QM_{c\tau} \quad 23$$

$$PQ_c \times (1 - tq_c) \times QQ_c = PD_c \times QD_c + \sum_{\tau} PM_{c\tau} \times QM_{c\tau} \quad 24$$

$$cpi = \sum_{c \in C} PQ_c \times cwts_c \quad 25$$

Institutional incomes and domestic demand equation

$$YF_f = \sum_{a \in A} WF_f \times wfdist_{fa} \times QF_{fa} \quad 26$$

$$YIF_{if} = shif_{if} \times [YF_f - trnsfr_{rowf} \times EXR] \quad 27$$

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{igov} \times cpi + trnsfr_{irow} \times EXR \quad 28$$

$$TRII_{ii'} = shii_{ii'} \times (1 - mps_{i'}) \times (1 - tins_h) \times YI_{i'} \quad 29$$

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih} \right) \times (1 - mps_h) \times (1 - tins_h) \times YI_h \quad 30$$

$$PQ_c \times QH_{ch} = PQ_c \times \gamma_{ch}^m + \beta_{ch}^m \times \left(EH_h - \sum_{c' \in C} PQ_{c'} \times \gamma_{c'h}^m \right) \quad 31$$

$$QINV_c = IADJ \times qinv_c \quad 32$$

$$EG = \sum_{c \in C} PQ_c \times qg_c + \sum_{i \in INSDNG} trnsfr_{igov} \times cpi \quad 33$$

$$YG = \sum_{i \in INSDNG} tins_i \times YI_i + \sum_{f \in F} tf_f \times YF_f \\ + \sum_{a \in A} tva_a \times PVA_a \times QVA_a + \sum_{a \in A} ta_a PA_a \times QA_a + \sum_{c \in CMNR} tm_c \times pwm_c \times QM_c \times EXR \\ + \sum_{c \in CE} te_c \times pwe_c \times QE_c \times EXR + \sum_{c \in C} tq_c \times PQ_c \times QQ_c + \sum_{f \in F} YF_{govf} + trnsfr_{govrow} \times EXR \quad 34$$

System constraints and macroeconomic closures

$$QQ_c = \sum_{a \in A} QINT_{ac} + \sum_{h \in H} QH_{ch} + qg_c + QINV_c + qdst_c \quad 35$$

$$\sum_{a \in A} QF_{fa} = QFS_f \quad 36$$

$$YG = EG + GSAV \quad 37$$

$$\sum_{\tau \in CMNR} pwm_{cr} \times QM_{cr} = \sum_{\tau \in CENR} pwe_{c\tau} \times QE_{c\tau} + \sum_{i \in INSD} trnsfr_{irow} + fsav \quad 38$$

$$\sum_{i \in INSDNG} mps_i \times (1 - \overline{tins}_i) \times YI_i + GSAV + EXR \times fsav = \sum_{c \in C} PQ_c \times QINV_c + \sum_{c \in C} PQ_c \times qdst_c \quad 39$$

Factor accumulation and allocation equations (applies to capital only)

$$AWF_{ft}^a = \sum_a \left[\left(\frac{QF_{fat}}{\sum_{a'} QF_{fa't}} \right) \times WF_{ft} \times wfdist_{fat} \right] \quad 40$$

$$\eta_{fat}^a = \left(\frac{QF_{fat}}{\sum_{a'} QF_{fa't}} \right) \times \left(\beta^a \left[\frac{WF_{ft} \times wfdist_{fat}}{AWF_{ft}^a} - 1 \right] + 1 \right) \quad 41$$

$$\Delta K_{fat}^a = \eta_{fat}^a \times \left(\frac{\sum_c PQ_{ct} \times qinv_{ct}}{PK_{ft}} \right) \quad 42$$

$$PK_{ft} = \sum_c PQ_{ct} \times \frac{qinv_{ct}}{\sum_{c'} qinv_{c't}} \quad 43$$

$$QF_{fat+1} = QF_{fat} \times \left(1 + \frac{\Delta K_{fat}^a}{QF_{fat}} - \nu f \right) \quad 44$$

$$QFS_{ft+1} = QFS_{ft} \times \left(1 + \frac{\sum_a K_{fat}}{QFS_{ft}} - \nu f \right) \quad 45$$

Mathematical Presentation of CGE Model – sets, parameters, and variables

Symbol Explanation

Sets

$a \in A$	Activities
$\alpha \in AEES (\subset A)$	Activities with a CES function at the top of the technology nest
$a \in ALEO (\subset A)$	Activities with a Leontief function at the top of the technology nest
$c \in C$	Commodities

$c \in CD(\subset C)$	Commodities with domestic sales of domestic output
$c \in CDN(\subset C)$	Commodities not in CD
$c \in CE(\subset C)$	Exported Commodities
$c \in CEN(\subset C)$	Commodities not in CE
$c \in CM(\subset C)$	Aggregate imported commodities
$c \in CX(\subset C)$	Commodities with domestic production
$f \in F$	Factors
$i \in INS$	Institutions (domestic and rest of the world)
$i \in INSDNG(\subset INSD)$	Domestic nongovernmental institutions
$h \in H(\subset INSDNG)$	Households

Equation parameters

cpi	Consumer price index
$cwts_c$	Weight of commodity c in the CPI
ica_{ca}	Quantity of c as intermediate input per unit of activity a

Mathematical Presentation of DCGE Model – sets, parameters, and variables (Continued)

$icd_{cc'}$	Quantity of commodity c as trade input per unit of c' produced and sold domestically
$ice_{cc'}$	Quantity of commodity c as trade input per exported unit of c'
$icm_{cc'}$	Quantity of commodity c as trade input per imported unit of c'
$int a_a$	Quantity of aggregate intermediate input per activity unit
iva_a	Quantity of value-added per activity per activity unit
mps_i	Base savings rate for domestic institution i
α_a^a	Efficiency parameter in the CES activity function
α_a^{va}	Efficiency parameter in the CES value-added function
α_a^{ac}	Shift parameter for domestic commodity aggregation function
α_c^q	Armington function shift parameter
α_c^t	CET function shift parameter
β^a	Capital sectoral mobility factor
β_{ch}^m	Marginal share of consumption spending on marketed commodity c for household h
δ_a^a	CES activity function share parameter

Mathematical Presentation of DCGE Model – sets, parameters, and variables (Continued)

δ_{ac}^{ac}	Share parameter for domestic commodity aggregation function
δ_{cr}^q	Armington function share parameter
ν_f	Capital depreciation rate
$mps01_i$	0 -1 parameter with 1 for institutions with potentially fixed direct tax rates
pwe_c	Export price (foreign currency)
$shif_{if}$	Share for domestic institution i in income of factor f
$shii_{i'}$	Share of net income of i' to i
ta_a	Tax rate for activity a
$tins_i$	Exogenous direct tax rate for domestic institution i

Equation parameters

$tins01_i$	0 -1 parameter with 1 for institutions with potentially flexed direct tax rates
tm_c	Import tariff rate
te_c	Export tariff rate
tq_c	Rate of sales tax
ta_a	Tax rate for activity a
δ_{cr}^t	CET function share parameter

Mathematical Presentation of DCGE Model – sets, parameters, and variables (Continued)

δ_{fa}^{va}	CES value-added function share parameter for factor f in activity a
γ_{ch}^m	Subsistence consumption of marketed commodity for household h
θ_{ac}	Yield of output c per unit of activity a
ρ_a^a	CES production function exponent
ρ_a^{va}	CES value-added function exponent
ρ_c^{ac}	Domestic commodity aggregation function exponent
ρ_c^q	Armington function exponent
ρ_c^t	CET function exponent
η_{fat}^a	Sector share of new capital

Exogenous variables

$fsav$	Foreign savings (FCU)
mps_t	Marginal propensity to save for domestic non-government institution
pwm_c	Import price (foreign currency)
pwe_c	Export price (foreign currency)
$qdst_c$	Quantity of stock change
qfs_f	Quantity supplied of factor

Mathematical Presentation of DCGE Model – sets, parameters, and variables (Continued)

qg_c	Government consumption demand for commodity
$qinv_c$	Base-year quantity of private investment demand
$trnsfr_{if}$	Transfer from factor f to institution i
$wfdist_{fa}$	Wage distortion factor for factor f in activity a

Endogenous variables

AWF_{ft}^a	Average capital rental rate in time period t
$IADJ$	Investment adjustment factor
EG	Government expenditure
EH_h	Consumption spending for household
EXR	Exchange rate (LCU per unit of FCU)
$QINTA_a$	Quantity of aggregate intermediate input

Endogenous variables

$QINT_{ca}$	Quantity of commodity c as intermediate input to activity a
$QINV_c$	Quantity of investment demand for commodity
QM_{cr}	Quantity of imports of commodity c
QE_c	Quantity of exports of commodity c
QA_a	Quantity of activity a
PA_a	Activity price (unit gross revenue)

Mathematical Presentation of DCGE Model – sets, parameters, and variables (Continued)

$GSAV$	Government savings
QF_{fa}	Quantity demanded of factor f from activity a
QH_{ch}	Quantity consumed of commodity c by household h
QHA_{ach}	Quantity of household home consumption of commodity c from activity a for household h
PM_{cr}	Unit price of capital in time period t

PQ_c	Import price (domestic currency)
PVA_a	Composite commodity price
PX_c	Value-added price (factor income per unit of activity)
$PXAC_{ac}$	Aggregate producer price for commodity a
QA_a	Producer price of commodity c for activity a
QD_c	Quantity (level) of activity
QE_{ct}	Quantity sold domestically of domestic output
QQ_c	Quantity of goods supplied to domestic market (composite supply)
QVA_a	Quantity of (aggregate) value-added
PD_c	Demand price for commodity produced and sold domestically
PE_{cr}	Supply price for commodity produced and sold domestically
$PINTA_a$	Export price (domestic currency)
Mathematical Presentation of DCGE Model – sets, parameters, and variables (Continued)	
PK_{ft}	Aggregate intermediate input price for activity a
QX_c	Aggregate quantity of domestic output of commodity
$QXAC_{ac}$	Quantity of output of commodity c from activity a
$TRII_{ii'}$	Transfers from institution i' to i (both in the set INSDNG)
WF_f	Average price of factors
YF_f	Income of factor f
YG	Government revenue
YI_i	Income of domestic non-government institution
YIF_{if}	Income to domestic institution i from factor f
K_{fat}^a	Quantity of new capital by activity a for the period t