Preliminary Draft[1]

The Effect of Trade Liberalization on Income Distribution in Vietnam - Dynamic Computable General Equilibrium Approach

By

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Abstract

Using the computable general equilibrium (CGE) framework, this paper explores the links between trade liberalization and income distribution among household groups in Vietnam. For this purpose, a multi-sector dynamic CGE model and the corresponding Social Accounting Matrix (SAM) have been developed. In this model, forward-looking economic agents are assumed to optimize their consumption and investment behaviors over a long time span. The model also comprises twenty-five sectors, eight household groups and thirteen factors of production, allows main sources of welfare change to be investigated. A new version of SAM was constructed in this study using the latest 2000 I-O Table. The result reveals that under the effect of trade liberalization, the total national welfare is negatively affected. Three out of four urban households gain while all rural household groups lose. Therefore, income gap between urban and rural households may become wider.

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1. Introduction

Trade liberalization and WTO accession - the key drivers of globalization – are the most recent concerns in Vietnam. Along with domestic reforms since the initiation of the *doi moi* in 1986, Vietnam has started opening up the economy and undertaking international trade commitments. Despite the recent market reforms, Vietnam's economy is still highly protected with the average tariff rate at 16.2 % in 2000 (Jensen and Finn Tarp, 2003). With the prospect of future accession to WTO and the continued reforms toward market liberalization, reduction of tariffs and protection will likely result in significant changes in Vietnam's production structure, relative prices, consumption behaviour, welfare, and so on.

In general, a reduction in barriers to international trade could give opportunities to accelerate growth, enhance productivity through the process of specialization, promote competition and create incentives for increasing efficiency (World Bank, 2002). Although it is widely proven that trade liberalization policies are likely to impact positively on the economic situation at the national level, their effects at the industry level and on the welfare of each household group may be different. Theoretically, industries with less protection may readily expanding production and develop faster while those that are not strong and competitive enough may face many difficulties in international competition. In addition, elimination of tariffs may significantly affect government revenue in developing countries, and then indirectly impact to each household group's income through the transfer process one way or another. As a result, the reduction of government budget, changes in the structure of the economy as well as the adjustment of the relative price system may favour certain categories of households while they hurting others. The benefits obtained by each household group from trade liberalization are not the same. If trade liberalization has a very adverse impact on the rural poor, it cannot be justified, at least from the standpoint of poverty reduction (Fujii, 2003). This point is especially important in a country like Vietnam, where a substantial portion of the population is still leading poor lives in rural areas. Thus, trade policy should take into account of both efficiency and equality, i.e. how the benefits of such a policy are distributed among households. Recently, the links between trade liberalization and income distribution in developing countries are being widely recognized more and more (Francois, 1997).

In the case of Vietnam, a number of questions are raised, regarding: how best the country could organize and facilitate a socialist-oriented market economy with high economic growth while narrowing sustainably the income distribution gap between people? Whether trade liberalization could enhance growth and promote equity? What policy

interventions are needed to make trade liberalization more equitable and sustainable? In an effort to answer these questions, many contributions have been made, such as studies of Huong (2002), Chan and Dung (2001, 2002), Jensen and Finn Tarp (2003), Fujii (2003), Roland-Holst et al (2003) and Binh (2002). Using the Computable General Equilibrium (CGE) frameworks, these papers focused on the distributional impact of tariff reduction on household welfare under a plausible revenue-neutral government budget closure. The databases for these studies mainly relied on the 1996 Input-Output Table for Vietnam and the 1997-1998 Vietnam Living Standard Survey.

The conclusions of the above mentioned studies are similar in the sense that trade liberalization helps improve the welfare of the whole nation, as supported by standard trade theories, but quite different regarding income distributional effect among households. Huong (2002) indicated that rural households gain relatively more than the urban ones, which help narrow the income gap between them. Income equality among rural household groups will also be improved. In contrast, Chan and Dung (2001, 2002) argued that trade liberalization is pro-rich and pro-urban, reflecting sharp differentiation on income between the urban and rural population. This conclusion is similar with the simulation results from Jensen and Finn Tarp (2003), who found that elimination of import tariffs increases rural poverty more visibly.

Giving contrasting results in previous studies, further investigation is required on whether trade liberalization will increase or decrease inequality in Vietnam. The goal of this study is to develop a dynamic CGE model and the corresponding Social Accounting Matrix (SAM) database for further analysis of the main factors which may have strong impacts on the welfare of eight different household groups under the trade liberalization process. The new version of 2000 SAM has been constructed based on the latest 2000 I-O Table and other sources of data. The model comprises twenty-five sectors of production, eight household groups and thirteen primary factors, in which labor is disaggregated into twelve categories. In the simulation, tariffs are reduced up to five percent, which is consistent with common WTO commitments, while indirect tax rates are allowed to adjust endogenously in order to satisfy a fixed government revenue target. Based on the dynamic CGE framework, this study identifies the nature of the impact and explores its links on the welfare of specific household groups.

The paper is organized as follows: Following this introduction, Section 2 provides an outline of the basic structure of the dynamic CGE model. Section 3 shows the analysis of the simulation results and Section 4 presents the conclusion.

2. The DCGE Model for Vietnamese Economy

The Dynamic CGE (DCGE) model presented in this paper is a multi-sectoral dynamic, competitive, small/price-taking open economy model. Our model draws up the works of Devarajan, S., and D.S.Go (1998); Diao, Yeldan and Roe (1998); Dervis, de Melo, and Robinson (1982); Vargas, Schreiner et al (1999); and Hosoe (2001). There are five entities forming the economy: producer, household, government, investment and the rest of the world. The model allows for quantification of income and welfare effects stemming from tariff reduction.

It is convenient to specify the model in terms of three blocks of equations, each of which describing a particular aspect of the equilibrium condition. These are: the dynamic (inter-temporal) equilibrium block, the intra-temporal equilibrium block, and the steady state equilibrium block.

2.1 The inter-temporal equilibrium block

2.1.1 *Consumption and savings of representative household*

The model contains eight household groups, characterized by location (rural/urban), and the employment status (farmer/self-employed/wage-worker/unemployed) of the head of household. The eight household groups are: rural farmers; rural self-employed; rural wage-earners; rural unemployment; urban self-employed; urban wage-earners and urban unemployment. The splitting of the aggregate household account into the eight household groups is a critical important feature of the model for investigating the income distribution of the economy.

The consumer's utility maximization problem is a two-level activity: At the first level, each representative household is assumed to own their labor as well as certain initial amount of financial wealth, and allocates income to consumption and savings to maximize an inter-temporal utility function over an infinite horizon. The household's discounted utility of temporal sequence of aggregated consumption over an infinite time horizon is:

$$\max \sum_{t=1}^{\infty} \left(\frac{1}{1+\rho} \right)^{t} u(U_t) \tag{1.1}$$

where ρ is positive and represents the rate of time preference, $u(.)$ is instantaneous felicity at each time period, U_t is instantaneous aggregate consumption. The form of the instantaneous felicity adopted here is a simple logarithmic function:

$$u_t = \ln(U_t) \tag{1.2}$$

The household maximize (1.1) subject to an inter-temporal budget constraint:

$$\sum_{t=1}^{\infty} \mu(t).CPI_t.U_t \leq \sum_{t=1}^{\infty} \mu(t)(Y_t - SAV_t - i^* DEBT_t) \tag{1.3}$$

where CPI_tU_t denotes the value of aggregate consumption expenditure, Y_t the household income; SAV_t the household savings; $i^* DEBT_t$ interest payments on outstanding foreign debt; r_s instantaneous interest rate at time s and $\mu(t)$ the discount factor from time t to time 0.

$$\mu(t) = \prod_{s=1}^{t} \frac{1}{1+r_s} \tag{1.4}$$

The Euler equation (derived from first order condition of utility maximization) implies that the marginal utility across two adjacent periods satisfies the following condition:

$$\frac{u'(U_{t+1})}{u'(U_t)} = \frac{CPI_{t+1}(1+\rho)}{CPI_t(1+r_{t+1})} \tag{1.5}$$

Households allocate their income flows among interest payments on outstanding foreign debt, consumption and savings. Thus, the current period budget constraint for the household is:

$$PCI_tU_t + SAV_t + i^* DEBT_t = Y_t \tag{1.6}$$

From Equations (1.5) and (1.6), a sequence of aggregate consumption and savings of each representative household are determined:

$$\frac{Y_{t+1} - SAV_{t+1} - i^* DEBT_{t+1}}{Y_t - SAV_t - i^* DEBT_t} = \left(\frac{1+r_{t+1}}{1+\rho}\right) \tag{1.7}$$

At the second level of the consumer's problem, the instantaneous aggregate consumption of each representative household is dispersed among its sectoral component:

$$U_t = \prod_j (C_{jt} - \eta_j)^{\alpha_j} \tag{1.8}$$

where C_{jt} represents the consumption level of good j at period t; η_{jr} is minimum levels of consumption , α_j is the marginal budget share for the commodity j. The maximization problem for each household group at the second level is presented at the section 2.2….???

Interest rate at each time period, r_t, is determined as follows:

$$r_t = (1+i^*)\frac{\varepsilon_t}{ER_t} - 1 \tag{1.9}$$

where i^* is the world interest rate; ER_t is the exchange rate at period t; ε_t is the expected exchange rate for the period $t+1$, such that:

$$\varepsilon_t = \varphi\left(\frac{ER_t}{\varepsilon_{t-1}}\right)\varepsilon_{t-1}$$

In this paper, the function of $\varphi(.)$ is chosen as $\varphi(x) = x^{\frac{1}{2}}$. Then

$$\varepsilon_t = \left(\frac{ER_t}{\varepsilon_{t-1}}\right)^{\frac{1}{2}}\varepsilon_{t-1} = \left(ER_t\varepsilon_{t-1}\right)^{\frac{1}{2}} = \sqrt{ER_t\varepsilon_{t-1}} \tag{1.10}$$

2.1.2 Firms and investment

Even though we assume that the households own the stock of capital, it is convenient to separate the investment behavior from household's consumption/saving decisions by constructing an independent investor that is presumed to maximize the inter-temporal profits of capital investment. The aggregate capital stock in each sector is managed by the independent investor who decides on investment and passes all profits to the households.

The investor chooses a time path of investment to maximize the discount profit of each sector over an infinite horizon:

$$MaxV_0 = \sum_{t=0}^{\infty}\mu(t)\left(wk_tK_t - J_t\right) \tag{1.11}$$

Subject to capital accumulation constraints:

$$K_{t+1} - K_t = I_t - \delta K_t \tag{1.12}$$

where δ is a constant capital depreciation rate; I_t addition to physical capital.

Due to an additional capital installation costs beyond the costs of the final goods used in capital good production, in order to achieve a certain level of net investment, I_t, the necessary investment outlays, $J_t(.)$ has the following form:

$$J_t = I_tPI_t\left(1+\frac{I_t}{K_t}\right) \tag{1.13}$$

where PI_t is the price of an investment basket. We assume that the technology to produce capital equipment exhibits constant return to scale, hence the unit cost to produce an investment unit is uniquely determined by the price of the *n* final goods:

$$PI_t = \sum\nolimits_j P_{jt}h_j \tag{1.14}$$

The Hamiltonian for this problem is

$$\mathcal{H} = \mu(t)\left[wk_tK_t - I_tPI_t\left(1+\frac{I_t}{K_t}\right)\right] + \lambda_t(I_t - \delta K_t) \tag{1.15}$$

The inter-temporal optimal conditions for the firm to invest require:

(i) *The control variable,* I_t *, is chosen to maximize* $\mathcal{H}$ *at each point in time:*

$$\frac{\partial H}{\partial I_t} = \mu(t)\left[- PI_t - 2PI_t\left(\frac{I_t}{K_t}\right)\right] + \lambda_t = 0$$

$$\mu(t).PI_t\left(1 + 2\frac{I_t}{K_t}\right) = \lambda_t$$

$$PI_t\left(1 + 2\frac{I_t}{K_t}\right) = \frac{\lambda_t}{\mu(t)} \tag{1.16}$$

Denote that

$$q_t = \frac{\lambda_t}{\mu(t)}$$

Then

$$PI_t\left(1 + 2\frac{I_t}{K_t}\right) = q_t \tag{1.17}$$

The left-hand side is the marginal cost of investment at period *t*, i.e., $J'(I_t)$.The right-hand side is the marginal value of capital in the same period, and such, gives the marginal benefit of investment. Thus the first-order condition of the maximum principle leads to a very simple investment rule: at every period of time, firms will invest up to the point that marginal cost equals marginal benefit.

From (1.17) it says that at each moment of time, the firm should carry out the amount of investment that satisfies the following equation:

$$I_t = \frac{K_t}{2}\left(\frac{q_t}{PI_t} - 1\right) \tag{1.18}$$

(ii) *The coastal variable* λ_t must obey the following condition:

$$\lambda_t - \lambda_{t-1} = -\frac{\partial H}{\partial K_t} = -\mu(t)\left[wk_t + PI_t\left(\frac{I_t}{K_t}\right)^2\right] + \lambda_t\delta$$

$$\frac{1}{\mu(t)}(\lambda_t - \lambda_{t-1}) = -wk_t - PI_t\left(\frac{I_t}{K_t}\right)^2 + \frac{1}{\mu(t)}\lambda_t\delta$$

$$q_t - q_{t-1}(1 + r_t) = -wk_t - PI_t\left(\frac{I_t}{K_t}\right)^2 + q_t\delta$$

The no-arbitrage condition could be expressed:

$$r_t q_{t-1} = wk_t + PI_t\left(\frac{I_t}{K_t}\right)^2 + (q_t - q_{t-1}) - \delta q_t \quad (1.19)$$

This condition indicates that the required return to capital (i.e., the marginal revenue of the added capital plus capital gain Δq net of depreciation loss δq_t) has to match the return to a perfectly substitutable asset of size q_{t-1}.

2.1.3 Foreign debt

In each time period, investment and domestic savings decisions are made independently and that foreign savings brings in the equality. The increase foreign debt has two components: Borrowing for investment and trade deficit, denote by TF_t Thus, foreign debt at time *t* is determined as follow:

$$DEBT_t = DEBT_{t-1} + \left[\sum_j J_{jt} - \sum_r SAV_{rt} - s^g T_t (1 - tr^p)\right] + TF_t \quad (1.20)$$

where

$$TF_t = ER_t\left(\sum_j PW_{jt}^m M_{jt} - \sum_j PW_{jt}^e E_{jt}\right) \quad (1.21)$$

2. 2 The intra-temporal (general) equilibrium block.

2.2.1 Producers

The economy in this model comprises of twenty-six production sectors, each of which uses labor, capital and intermediate inputs for production. Five of these sectors operate in agriculture and mining, fifteen in manufacturing and six in service. This classification captures major features and the interrelationship among important sectors of Vietnamese economy.

Factors of production consist of one aggregate capital and twelve types of labor. The criteria used to disaggregate labor are: location (rural/urban), gender (male/female) and skill level (unskilled/medium-skilled/high-skilled). The amount supplied in each of the labor category is fixed. Within a period of time, although each type of labor is allowed to move perfectly across all the sectors, the sectoral capital stock is assumed to remain unchanged.

In each period of time, producers take the stock of capital and prices of input and output as given in determining the optimal level of labor required to maximize the payment to capital, which is defined residually after payments for intermediate inputs and labor:

$$\pi_j = wk_j K_j = P^*_j X_j (1 - t_j^i) - \sum_i P_i X_{ij} - \sum_l W_l L_{lj} \quad (2.1)$$

The model's variables and parameters are listed in the appendix. Value-added is assumed to be generated through the Cobb-Douglass technology, using primary factors of labor and capital:

$$V_j = \overline{A}_j \prod_t L_{tj}^{\beta_{tj}} \overline{K}_j^{\beta_{Kj}} \tag{2.2}$$

Aggregate output in each sector is produced using value-added and intermediate input under the Leontief technology. All the production technologies are assumed to be homogenous of degree one. From the optimizing problem of the Cobb-Douglass and Leontief functions, the demand for each of the twelve labor categories in each sector is determined. It is a function of the value added generated in the sector and the relative price of value added to the wage rate:

$$L_{tj} = \left(\frac{PV_j}{W_t} \right) \beta_{tj} V_j \tag{2.3}$$

2.2.2 Government

It should be noted that, in Vietnam currently, capital is not owned solely by the private sector. State-owned enterprises (SOEs) still play a critical role in capital intensive industries. The model assumes, however, that all capital income is distributed to households as if all capital stock were owned by the private sector. The income of SOEs is then paid back to the government through an incremental proportion on the direct capital tax rate. Therefore, direct tax on capital, which the households have to pay, also includes capital income distributed to the government from state-owned companies. Based on the above assumption, the main function of the government is to collect taxes, then distribute all for the requirement of government activities, transfer to the households and saving for investment in fixed share parameters. In particular, the government income comprises of direct taxes on labor, direct taxes on capital, indirect taxes on production, import tariffs, export duties, and transfer received from the rest of the world:

$$T = \sum_l W_l \overline{L}_l t_{Ll}^{\ d} + \left(\sum_j \pi_j \right) t_K^{\ d} + \sum_j X_j P_j^{\ *} t_j^{\ i} + \sum_j M_j PM_j t_j^{\ m} + \sum_j E_j PE_j t_j^{\ e} + ER.\overline{F}_g \tag{2.4}$$

In this model, to be able to afford the reduction in tariffs, indirect tax rates are allowed to vary endogenously in order to keep government revenue unchanged. Government's demand on each category of goods is determined by the government budget for consumption, fixed share of the good on the government consumption basket and the price index of the government purchasing basket:

$$G_j = \frac{k_j T(1-tr^p)(1-s^g)}{PG} \tag{2.5}$$

2.2.3 Household consumption

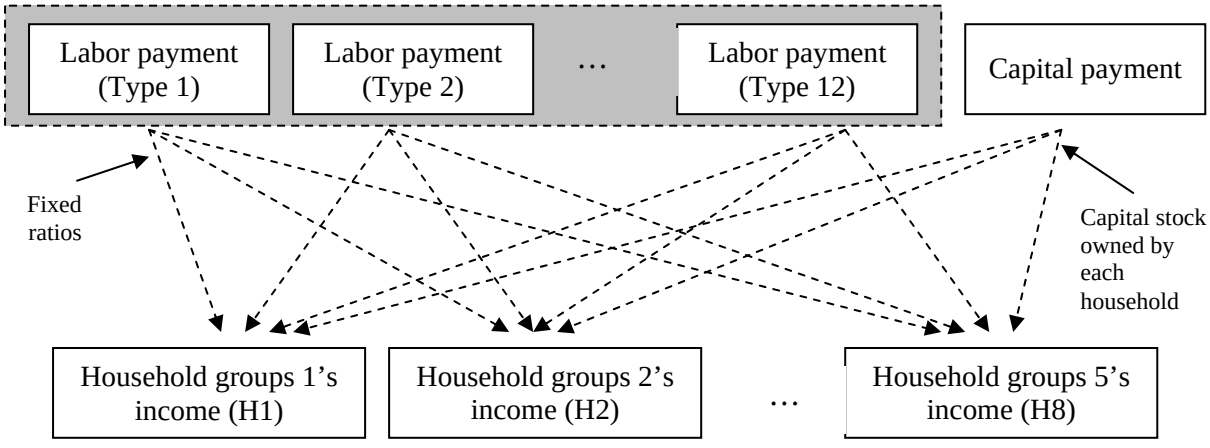
Each household group receives income from twelve labor categories, capital, transfers from government and from abroad:

$$Y_r = \sum_l \overline{L}_l W_l (1-t_{Ll}{}^d) d_{rl}{}^L + (\sum_j \pi_j)(1-t_K{}^d) d_r{}^K + Ttr^p d_r{}^T + ER.\overline{F}_{pr} \tag{2.6}$$

The household then spends all the disposable income for paying interest payments on outstanding foreign debt, consuming and saving. The budget constraint for household consumption is $Y_r - i^* DEBT_r - SAV_r$. This equals to disposable income less interest payments on outstanding foreign debt less the household's saving, which is identified by the Equation (1.6).

It is assumed that the labor payments in the twelve different categories are distributed among the eight different household groups in fixed ratios. However, capital income is paid based on the amount of capital stock owned by each household group at each time period. Therefore any change in a factor payment and savings behavior will directly impact the relative incomes of each household group. The distribution mechanism from thirteen primary factors to five household groups is illustrated in Figure 1.

Figure 1: **Distribution of factor payments to household income**



Consumer' problem is solved following the simplified version of Linear Expenditure System (LES). Given a fixed amount of disposable income, the household faces the following intra-temporal constrained maximization problem:

$$\text{Maximize } U_r = \prod_j (C_{jr} - \eta_{jr})^{\alpha^{jr}} \tag{2.7}$$

$$\text{Subject to } Y_r - i^* DEBT_r - SAV_r = \sum_j P_j C_{rj} \tag{2.8}$$

Solving the first order condition of the Lagrangean to this problem produces the household demand function as follows:

$$C_{jr} = \eta_{jr} + \frac{\alpha_{jr}}{P_j}\left[Y_r - i^* DEBT_r - SAV_r - \sum_j P_j \eta_{jr}\right] \tag{2.9}$$

Because of lacking data on minimum levels of consumption, η_{jr}, the model is used with an assumption that all the η_{jr} are equal to zero. Therefore, the household demand for each category of good is determined simply by the budget constraint, the average budget share and the composite price index:

$$C_{jr} = \frac{\alpha_{jr}\left(Y_r - i^* DEBT_r - SAV_r\right)}{P_j} \tag{2.10}$$

2.2.4 Investment

In section 2.1.2, we present the "*supply aspect*" of investment activity. Through investment process new plants, equipments… will be created, adding and improving the existing production capacity, which was seen as an increase in the capital stock of each sector. The new capital stock that is installed for sector *j* in period *t* is denoted as I_{jt}.

Beside the "*supply aspect*", investment activity also has a "*demand aspect*". The "*demand aspect*" of investment requires final goods from each of *n* sectors for production and installation new capital. The share of each commodity in total investment expenditure is assumed to be fixed. The investment demand of each category of commodity is thus a function of the budget constraint for investment, fixed share of the commodity in the investment basket and the investment price index.

$$Inv_j = \frac{h_j \sum_j J_j}{PI}$$

2.2.5 Imports

Based on the assumption of standard, small /price-taking open economy, the world prices of imported and exported goods remain exogenously fixed in terms of foreign currency, while the prices of domestic goods are endogenously generated from the model simulation. In the model, aside from factor and commodity markets, there is a foreign exchange market, in which the exchange rate is determined endogenously through the

fluctuation of trade deficit. For simplicity, it is also assumed that foreign transfers to the government and households are fixed. Therefore, although the international prices of goods remain unchanged, the prices of imported goods in terms of domestic currency are fluctuated according to the exchange rate adjustment. Following Armington (1969), domestic and imported goods are imperfect substitutes. A constant elasticity of substitution (CES) function is used to represent the relationship between the demands for them. Each domestic institution allocates its total demand between the domestic and imported goods so as to minimize the total expenditure, subject to the CES function:

$$\text{Minimize } P_j Q_j = PD_j D_j + PM_j M_j$$

$$\text{Subject to } Q_j = \overline{B}_j \left[\delta_j D_j^{\frac{\sigma_j - 1}{\sigma_j}} + (1-\delta_j) M_j^{\frac{\sigma_j - 1}{\sigma_j}} \right]^{\frac{\sigma_j}{\sigma_j - 1}}$$

Given the amount of aggregate demand for each category of goods, price ratios and elasticity of substitution determine the demand levels for domestically produced and imported commodities:

$$M_j = \overline{B}_j^{\sigma_j - 1} (1-\delta_j)^{\sigma_j} \left(\frac{PM_j}{P_j} \right)^{-\sigma_j} Q_j$$

$$D_j = \overline{B}_j^{\sigma_j - 1} \delta_j^{\sigma_j} \left(\frac{PD_j}{P_j} \right)^{-\sigma_j} Q_j$$

2.2.6 Exports

Total sectoral outputs are sold in both domestic and foreign markets. By assuming that there is no re-exporting of imported products, exported goods consist only of domestically produced commodities. The export price, in terms of domestic currency, is also a function of the exchange rate. The fluctuation in the export prices will affect the levels of supply for export and domestic consumption. The relationship between export and supply for domestic consumption is assumed to be represented by a constant elasticity of transformation (CET) function. Each firm allocates its output between domestic and export markets so as to maximize revenue, subject to the CET function:

$$\text{Maximize } P_j^* X_j = PD_j S_j + PE_j E_j$$

$$\text{Subject to } X_j = \overline{N}_j \left[\gamma_j S_j^{\frac{1+\phi_j}{\phi_j}} + (1-\gamma_j) E_j^{\frac{1+\phi_j}{\phi_j}} \right]^{\frac{\phi_j}{1+\phi_j}}$$

Given the amount of total output in each sector, price ratios and elasticity of transformation determine the levels of output exported and sold in the domestic market.

$$E_j = \overline{N}_j^{-1-\phi_j}(1-\gamma_j)^{-\phi_j}\left(\frac{PE_j}{P_j^*}\right)^{\phi_j} X_j$$

$$S_j = \overline{N}_j^{-1-\phi_j}\gamma_j^{-\phi_j}\left(\frac{PD_j}{P_j^*}\right)^{\phi_j} X_j$$

2.2.7 Market Clearing and Equilibrium Prices

In the model, there are twelve labor markets (l = 12), twenty-five commodity markets (n = 25) and one foreign exchange market, where the wage rate for each type of labor, the domestic commodity prices and the exchange rate are determined. The equilibrium set of prices is obtained when all the markets are cleared, i.e. when all the excess demands, which are functions of the wage rates, prices of domestic commodities and the exchange rate, become zero.

According to Walras's law, if $l + n$ out of $l + n + 1$ excess demands are zero, the remaining one must be zero. As a result, the system cannot be solved to give a unique solution. This is a problem that many CGE models face. In general, there are two ways to solve this. One is to choose either one of goods, labor or foreign exchange as a numeraire and fix its price to be one. The other is to introduce a price-normalization rule, in which it fixes the weighted average of all commodity prices to be one. The model adopts the latter to solve for a set of equilibrium prices. However, because all the excess demands are functions of relative prices and are homogenous of degree zero in prices, excess demands do not change when all prices change by the same proportion. Thus, absolute price levels cannot be obtained and only the relative prices are determined via simulation. The complete set of the model's equations is presented in the appendix.

2.3 The steady state equilibrium block.

To arrive at a solution, both the inter-temporal and general equilibrium conditions have to be satisfied simultaneously. At every point of time, the usual general equilibrium conditions require that:

(i) Material balance in the demand and supply of all goods (in the good markets)

(ii) The demand for each category of labor equal its total supply (labor markets)

(iii) The balance in the inflow and outflow of foreign currency (exchange market)

Under the steady state equilibrium path, the following constraints must be satisfied:

$$I_{jT} = \delta_j K_{jT} \tag{3.1}$$

Equation (3.1) implies that investment just covers the depreciated capital; hence the stock of capital for each sector remains constant.

$$\left[\sum_j J_{jT} - \sum_r SAV_{rT} - s^g T_T (1 - tr^p)\right] + TF_T = 0 \tag{3.2}$$

Equation (3.2) implies that at steady-state, foreign debt is constant. Furthermore, if the economy experiences a trade deficit in the steady state (i.e., $TF_T > 0$), then its total national savings (i.e., household savings plus government savings) has to be bigger than the requirement for investment. i.e., $\sum_j J_{jT} - \sum_r SAV_{rT} - s^g T_T (1 - tr^p) < 0$.

$$r_T = \rho \tag{3.3}$$

Equation (3.3) implies that at the steady state, consumption level is constant and thus household savings also remains unchanged.

3. The Model Simulation and Results

3.1 The Model Calibration and Analytical Framework

Applying the CGE model requires data on SAM and some other sources for calibrating process. Therefore, one of the most important tasks of this study is the identification and organization of data into a SAM. The availability of the 2000 Input-output Table of Vietnam in mid-2003 has given an opportunity to construct the SAM for the year 2000. The structure and theoretical underlying of the new 2000 SAM follow closely that of Isard (1998), CIEM/NIAS (2001), Tarp (2002) and Nielsen (2002). In the SAM, there are twenty-five production activities with twenty-five counterpart commodities, thirteen factors, eight household groups, one government account with five types of taxes included, one investment/savings account, and one account related to foreign trade and capital flows. All of these accounts are combined in a 76x76 matrix.

When all the price variables are assumed equal to one, all the parameters in the model are computed so that the current economy is in equilibrium. Calibration for most of the functions in the model is relatively straightforward. However, at present, relevant elasticity estimates for the Vietnamese economy are not available yet. The model, therefore, used the value of the elasticity of substitution and transformation based on Arndt, C., S. Robinson and F. Tarp (2002). All other parameters of the model, such as depreciation rates, tax rates, government savings rate, distribution coefficients, average budget shares of household

consumption, production elasticities of labor and capital, and so on, have been determined completely, based on data from the SAM. In addition, during the simulation the world interest rate is kept fixed at 7.2%. The first two columns in Table 1 illustrate the major tax rates by sector. The last two columns present the elasticity of substitution and that of transformation, obtained from referenced literature.

Table 1: **Base Year Tax rates and Elasticity Parameters for the Model**

No	Sector	Import tax rate[a]	Indirect tax rate[a]	Elasticity[b]	
				CES	CET
1	Crops cultivation	5.34	5.12	1.20	0.59
2	Livestock and poultry	1.55	2.66	1.20	0.59
3	Forestry	0.02	17.01	0.74	0.5
4	Fishery	12.94	3.67	0.42	0.9
5	Mining and quarrying	2.43	4.10	0.5	0.9
6	Processed seafood and by products	14.26	4.66	0.56	0.87
7	Alcohol, beer, water, soft drinks	18.07	12.34	0.56	0.87
8	Cigarettes and tobacco products	34.23	37.80	0.56	0.87
9	Other food manufactures	8.65	3.28	0.33	0.57
10	Material and construction	7.07	3.61	0.56	0.87
11	Chemical manufacturing	2.92	2.70	0.56	0.87
12	Home appliances and its spare parts	15.69	2.20	0.56	0.87
13	Vehicles	14.30	3.03	0.56	0.87
14	Machinery and equipment	3.26	2.75	0.56	0.87
15	Textile, garment	3.53	3.87	0.56	0.87
16	Leather	3.91	3.50	0.56	0.87
17	Other manufacturing products	3.20	2.29	0.56	0.87
18	Gasoline, lubricants (already refined)	18.79	4.51	0.56	0.87
19	Electricity and gas, water	0	4.80	0.56	0.87
20	Trade	0	7.14	0.56	0.87
21	Hotels, restaurants	0	5.09	2.84	1.85
22	Transport services and tourism	0	4.99	2.84	1.85
23	Communication services	0	5.06	2.84	1.85
24	Financial services	0	10.16	2.84	1.85
25	Public services and other services	0	4.34	2.84	1.85

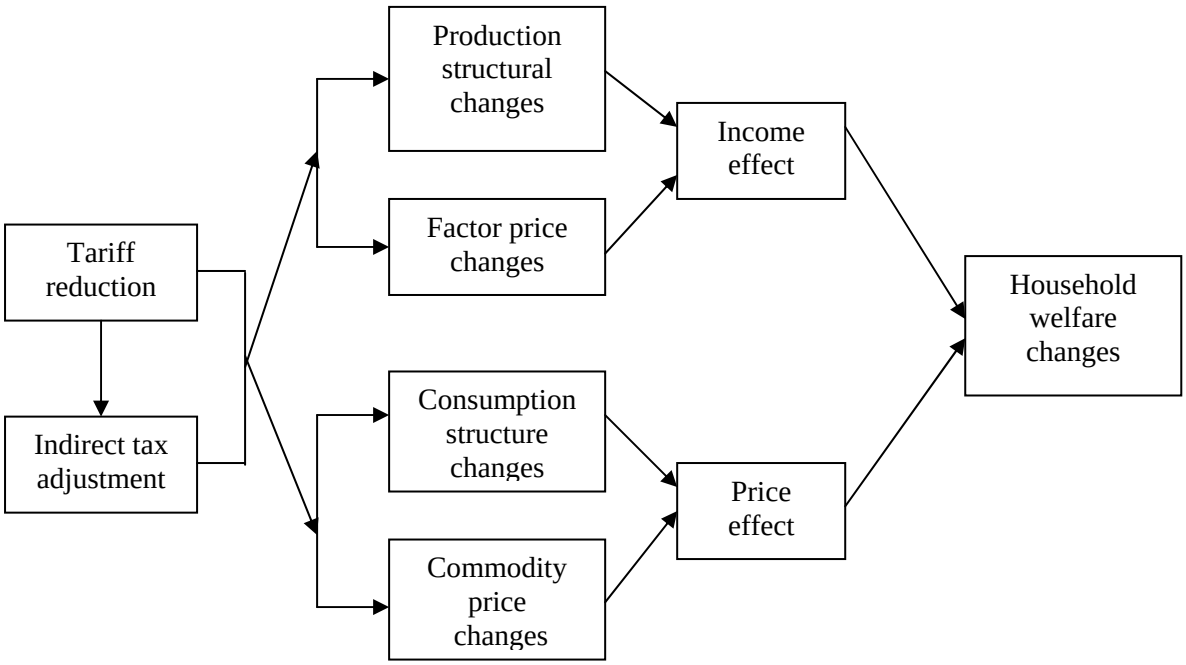
Source: [a]Author's calculations from the 2000 I-O Table (GSO, 2003).
[b]Adopted from literature

The import tariff schedule reveals that Vietnam's 2000 tariff structure still explicitly restricts the import of consumption goods while encouraging imports for production and investment. This special feature of Vietnam's tariff structure, on the one hand, clearly benefits import-substitute industries. Most consumption goods that can be produced domestically, therefore, have to bear high protected tariffs. Alcohol and tobacco products, whose consumption are not encouraged in Vietnam, also imposed very high tax rates. On the

other hand, for promotion of industrialization and exports, low tariff schedule on raw material and equipment has been implemented.

In this study, consistent with common WTO commitments, tariffs of more than 5 % are reduced to 5 %. Besides, in order to satisfy a fixed government revenue target, indirect tax rates are allowed to adjust endogenously. All other parameters remain the same during the simulation. Figure 2 illustrates main factors that may affect the welfare of each household group. Theoretically, welfare changes under the effect of trade liberalization depend on the nature and level of the initial protection, the role of each household group in production, their consumption patterns, and the nature and degree of openness examined (Francois and Kenneth, 1997).

Figure 2: **Determinants of Tariff Reduction on Welfare through the Model Simulation**



As mentioned above, the initial tariff structure of Vietnam aims to restrict the import of consumption goods rather than intermediate inputs. In addition, from the model simulation, total government revenue is estimated to fall by about 8.51 % due to tariff reduction. Because this loss may cause many critical problems, it is likely made up by raising indirect taxes, which may also distort the economy in another way. In the production aspect, replacing tariffs by indirect taxes will lead to changes in the structure of the economy. For this reason, some categories of labor may now become redundant while the others may be in shortage. Based on the assumption that the supply of each category of labor is fixed, relative wage rates will change. Changes in factor prices will influence each of the

thirteen factor payments, and then indirectly affect the nominal income of each household group. In the consumption aspect, trade liberalization undoubtedly has a significant impact on the relative prices of goods. Relative reduction in the prices of some products may favour certain categories of households while relative increase in the prices of some other products may hurt the others. As price-takers, households have to adjust their consumption behaviour due to the change in the price system. As a result, benefits that each household group can obtain from trade liberalization are not the same.

One of the strengths of CGE model is that it allows the analysis of factors that may impact on the welfare of each household group. The following discussion will focus on investigating the main sources of the welfare change, namely "*income effect*" and "*price effect*", as well as their components, which are mentioned in Figure 2.

3.2 The Effect of Trade Liberalization on Industrial Structure

Economists would agree that trade liberalization often implies large shifts between industries. Reallocation process will occur so that resources are used in a more efficient way. Therefore activities of various industries are strongly influenced. In principle, changes in industrial output due to the effect of tariff reduction are not only determined by the initial level of protection and the degree of openness, but also by the destination of imported goods, i.e. for production or final consumption. In addition, other elements such as elasticity of substitution between the domestic and imported goods; the transformation elasticity between export and domestic consumption; the proportion of imported value in total input cost; the capacity of the sector to respond to the change and so on, should be taken into account. However, detailed examination of the influence of each individual factor on the industrial output induced by tariff reductions is not within the scope of this paper.

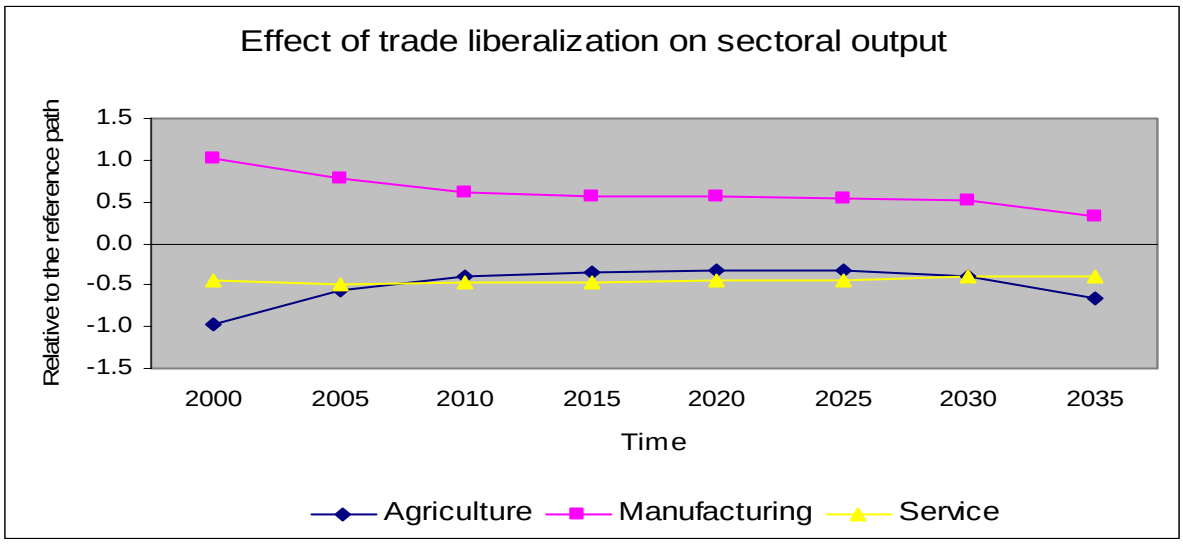
The empirical results reveal that trade liberalization will have a strong impact on many sectors in Vietnam. Some sectors can expand their production, in terms of output and export volumes, and may take the opportunity to grow quickly, while some others are forced to contract due to international competition.

In general, the expansion of the manufacturing sector comes at the expense of agricultural and service sectors where we can observe 0.65% and 0.4% decrease in production in the long run, respectively. (Figure 3)

Most of highly protected sectors will face the risk of output reduction. However, highest negative impacts could be seen in a less protected one – the leather sector. Its output

decreases by about 6 % in the long run compared to the base line scenario, followed by processed seafood and by products sector with a reduction in output by 5.25 %.

Figure 3: **Effect of trade liberalization on sectoral output**

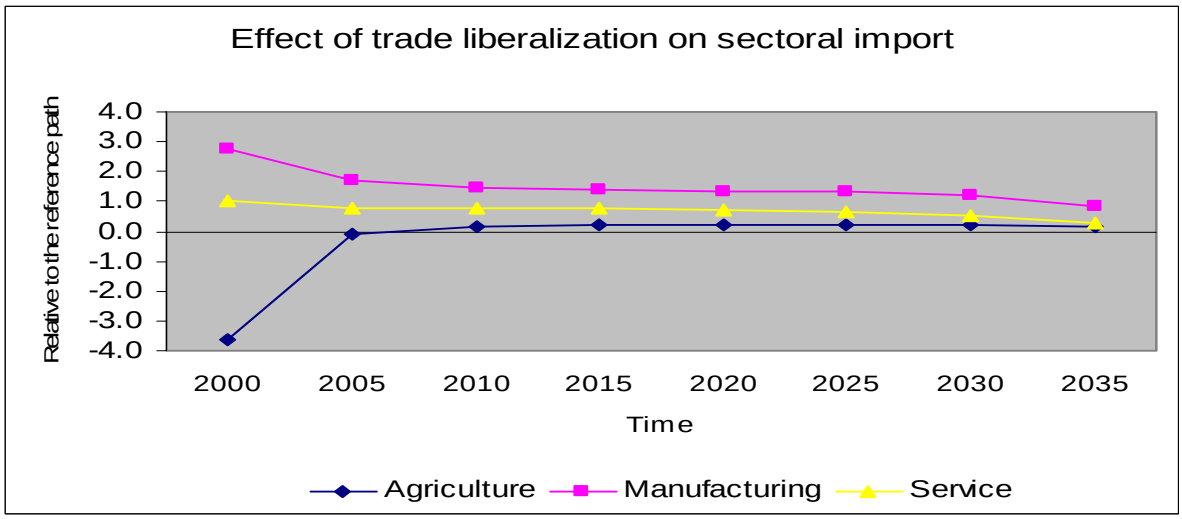


Source: *Author's calculations from the model simulation*

Some less protected industries may enjoy the opportunity to expand their production, especially mining and quarrying; machinery and equipment; and other manufacturing products sectors.

Parallel with the reduction in their output, long-run increase in imports in agricultural and service sectors has been recognized (Figure 4). Therefore, unless effective reaction measures are taken, these sectors may incur huge losses in competing against giant multinational enterprises.

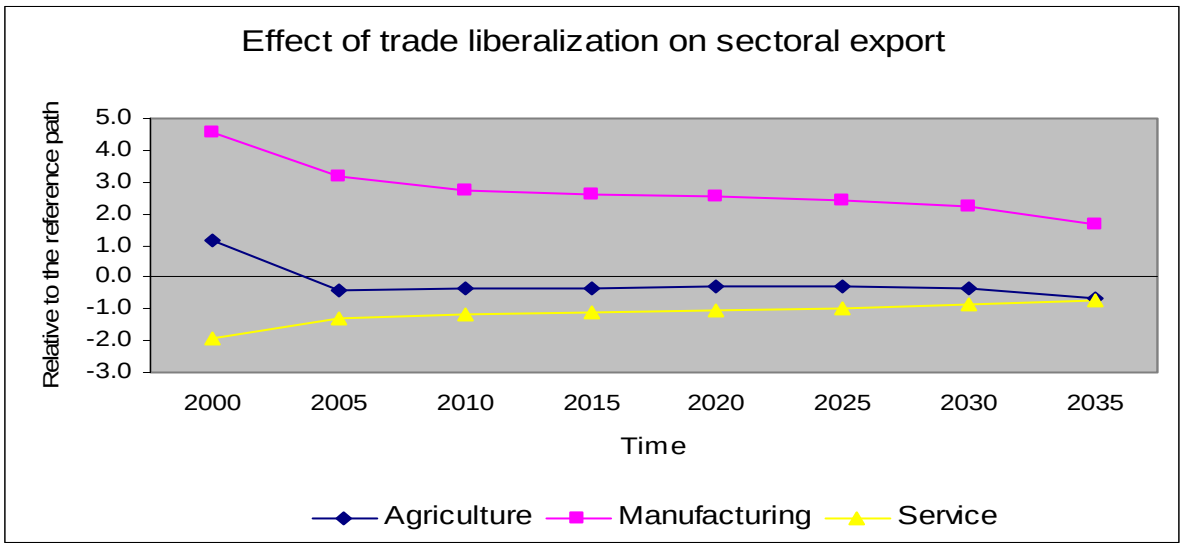
Figure 4: **Effect of trade liberalization on sectoral import**



Source: *Author's calculations from the model simulation*

In contrast, the increase in import of manufacturing sector, accompany with high export volume and output expanding in the long run may be a good signal (Figure 5).

Figure 5: **Effect of trade liberalization on sectoral export**



Source: *Author's calculations from the model simulation*

In summary, in the long run most of the highly protected manufacturing sectors are forced to reduce production considerably. Some of the less protected sectors can take this opportunity to expand their operations. Mining and quarrying; machinery and equipment sectors enjoy the highest benefit while leather and seafood sectors may incur the highest losses. Many sectors in agriculture and service have to contract. At the economy-wide level, both import and export are increased but total national output declines.

3.3 The Effect of Trade Liberalization on Wage Rate and Household Income

In CGE models, absolute price level is usually not determined explicitly. However, the relative price level can be observed. By setting all initial price levels equal to one and using the price-normalization rule, in which it fixes the weighted average of all commodity prices to be one, new equilibrium prices which are greater than one indicate that they increased via the simulation. In contrast, prices which are lesser than one mean they decreased. In addition, the differentiation between prices also reflects their relative changes.

As analyzed in the previous section, the fall in the total national output due to the production reduction in the agriculture and service sectors may lead to a relative change in wage rates. This is because of the imbalance between the demand for and supply of labor after trade liberalization. In addition, industries differ in terms of their cost structures and of their way in combining different types of labor, therefore the effects of production structure change on each category of labor are not the same. Because there is a huge reduction in the

outputs of agricultural sectors, and also because male play a critical role in agriculture production, wage rates received by rural male labor may be forced to decrease by a higher rate than that of urban ones (Figure 6A and 6C). In both rural and urban areas, females' wage rates are increased, except the case of rural unskilled female (Figure 6B and 6D). Moreover, among twelve categories of labor, urban medium-skilled females are the only one who can see their wage rate increasing significant in the long run.

Figure 6A:

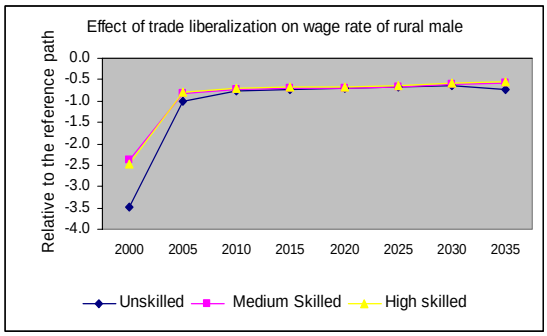


Figure 6B:

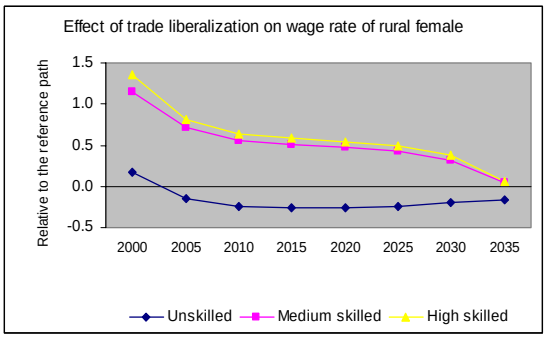


Figure 6C:

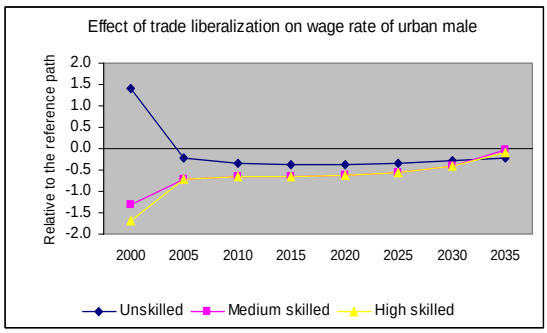
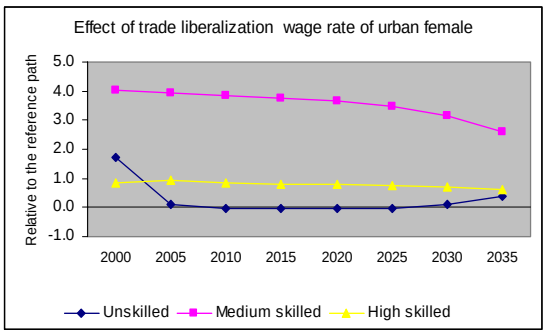


Figure 6D:



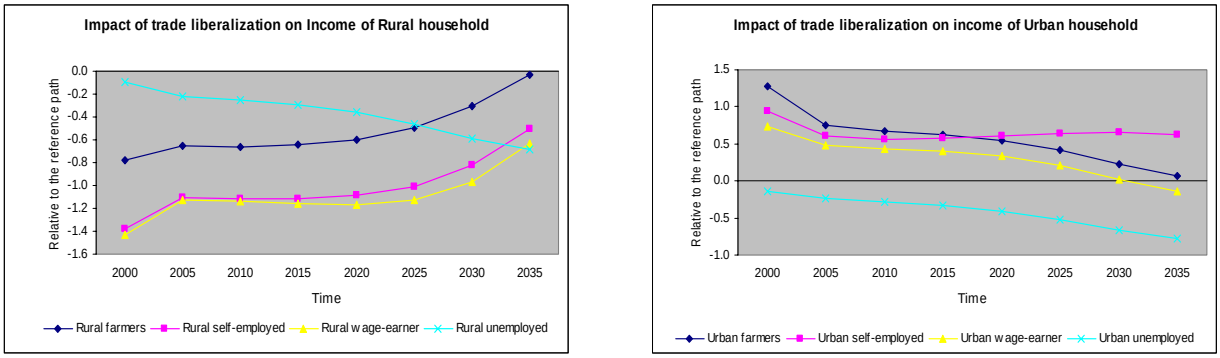
Source: *Author's calculations from the model simulation*

Because it is assumed that the supply of each labor category is constant, the above mentioned changes in wage rates may affect directly the income of each type of labor and then pass its impact on to the income of each household group through the distribution in fixed ratios, as depicted in Table 2a. The Table shows a bridge between the factor payments and the household income as well as the pattern in which receipts from transfers are distributed among household groups. This table is particularly useful to see how the income of each household is affected by changes in factor prices, given that the endowment of each factor is assumed to be kept fixed over the period under consideration.

Table 2b shows that initial income of each household is acquired from fifteen different sources (i.e. labor income of twelve categories, capital income, government transfer and foreign transfer), in which labor income forms the major source of total earnings. It

should be noted that male creates the larger source of labor income for rural households while the contribution of the rural female is still relatively smaller. Meanwhile, in the case of urban households, male and female play nearly the same role in income generation. And because male suffers a negative impact from trade liberalization while the female do not, rural households may face more difficulties than urban ones in terms of labor income reduction. Besides, capital income is an important source to all the households. The decrease (or increase) in the total output will also have a negative (positive) effect on the total profit, which is in turn distributed to each household group according to the ratio of capital stock owned by each of them.

Figure 7: **Impact of trade liberalization on income of household**



Source: *Author's calculations from the model simulation*

The impacts of trade liberalization on the income of each household group can be described in Figure 7. Rural households' income decline more significantly than that of the urban counterpart. Besides, among rural people, in the long run rural wage-earner and unemployed households have to incur a larger income loss than the two other rural household groups. However, in the urban area, self-employed household can enjoy a significant increase in their income.

All the above analysis focuses on investigating how changes in production structure affects factor prices and then lead to changes in income of each household group. Trade liberalization encourages consumers to switch significantly to imported goods. This prompts many major domestic sectors to reduce their production because of both international competition and the increase in indirect taxes to make up for the losses of tariff revenue. Wage rates decrease due to many types of labor becoming redundant. Falling in wage rates of male labor will directly lead to the reduction in the labor income, which accounts for approximately 60% of total income of each household group. Capital income falls too. As a result, household income will decline. Among them, rural households suffer a more serious

Table 2a**: Distribution Income among the Household Groups**

Household groups	Labor income												Capital income	Gov. transfer	Abroad
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12			
Rural farmers	60.30	49.87	36.54	70.47	61.20	62.39	0.00	0.00	0.00	0.00	0.00	0.00	45.76	23.37	17.85
Rural self employed	25.03	34.47	11.13	15.75	11.40	10.79	0.00	0.00	0.00	0.00	0.00	0.00	10.81	13.43	7.39
Rural wage earning	14.67	15.66	52.33	13.77	27.40	26.82	0.00	0.00	0.00	0.00	0.00	0.00	3.13	13.33	1.57
Rural unemployment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	8.14	2.44
Urban farmers	0.00	0.00	0.00	0.00	0.00	0.00	14.22	4.38	1.69	16.35	3.58	1.31	2.09	7.01	1.76
Urban self employed	0.00	0.00	0.00	0.00	0.00	0.00	50.01	37.46	26.02	43.05	38.51	17.13	31.93	4.42	36.32
Urban wage earning	0.00	0.00	0.00	0.00	0.00	0.00	35.77	58.17	72.29	40.60	57.91	81.56	6.23	21.57	23.40
Urban unemployment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	8.72	9.27

Table 2b: **Share of Income Categories in Total Income of Each Household**

Household groups	Labor income												Capital income	Gov. transfer	Abroad
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12			
Rural farmers	26.74	3.17	0.21	19.18	2.19	0.31	0.00	0.00	0.00	0.00	0.00	0.00	41.89	4.11	2.20
Rural self employed	32.10	7.13	0.21	16.15	1.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	32.23	7.69	2.97
Rural wage earning	32.22	5.55	1.69	24.18	5.47	0.74	0.00	0.00	0.00	0.00	0.00	0.00	15.99	13.08	1.08
Rural unemployment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	81.49	17.17
Urban farmers	0.00	0.00	0.00	0.00	0.00	0.00	28.67	4.41	0.97	26.34	2.60	0.46	20.80	13.38	2.36
Urban self employed	0.00	0.00	0.00	0.00	0.00	0.00	15.99	5.98	2.37	10.99	4.43	0.96	50.24	1.34	7.71
Urban wage earning	0.00	0.00	0.00	0.00	0.00	0.00	16.29	13.24	9.36	14.77	9.50	6.52	13.96	9.29	7.07
Urban unemployment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	56.63	42.23

Source: Author's calculations from the 2000 SAM (CIEM, NIAS 2004)

L1 : Rural Male Unskilled (RMU)
L2 : Rural Male Medium-skilled (RMM)
L3 : Rural Male High-skilled (RMH)
L4 : Rural Female Unskilled (RFU)
L5 : Rural Female Medium-skilled (RFM)
L6 : Rural Female High-skilled (RFH)
L7 : Urban Male Unskilled (UMU)
L8 : Urban Male Medium-skilled (UMM)
L9 : Urban Male High-skilled (UMH)
L10: Urban Female Unskilled (UFU)
L11: Urban Female Medium-skilled (UFM)
L12: Urban Female High-skilled (UFH)

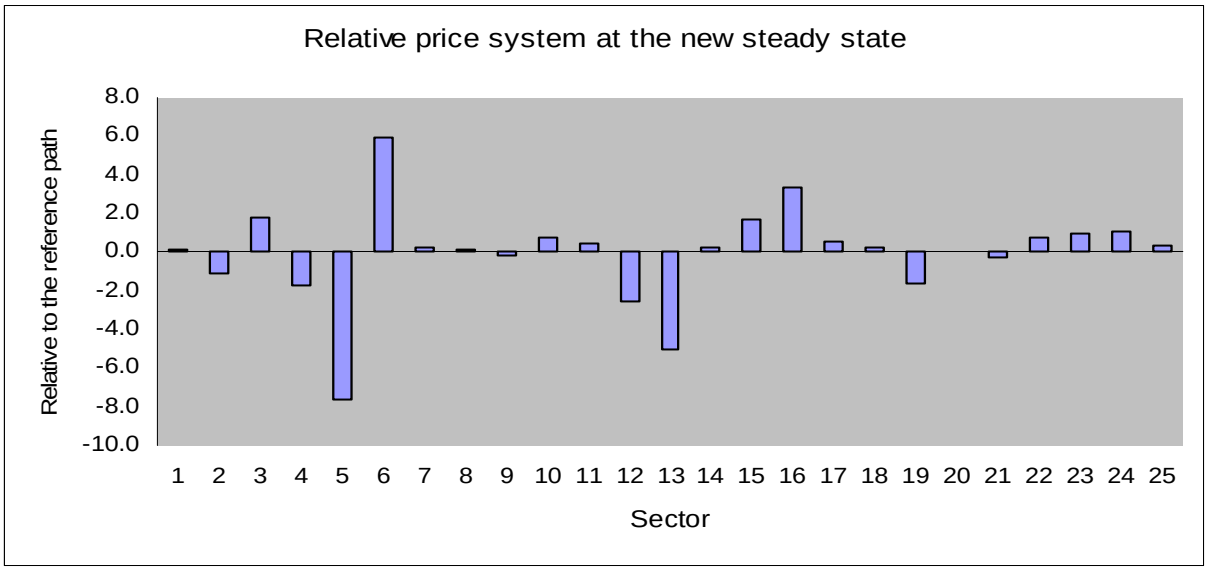
income reduction than their urban counterpart because of their dependence on the income of male laborers, whose wage rates decreases remarkably.

3.4 The Effect of Trade Liberalization on Good Prices and Household Preference

Although trade liberalization creates a negative effect on household income, it may bring positive effects by reducing significantly prices of many categories of goods and services. As shown in Figure 8, the relative price system in the new steady state change remarkably compared with initial based year. In the long run, some goods and services will become cheaper relatively. It is the case of mining and quarrying; vehicles; home applicants and its spare part; fishery; electricity, gas and water. Some other goods and services become more expensive relatively. These are: processed seafood; leather; textile and garment; transportation, communication and financial service.

The matching between price data and household consumption data is further investigated to understand how changes in relative price system can affect the welfare of each household group. Table 3 shows the share of each good in the total consumption for each household group before trade liberalization. How important the consumption good price changes are for each household group can be determined by these figures.

Figure 8: **Relative price system at the new steady state**



In general, food consumption accounts for a very large share in total consumption of all rural and urban farmer households. Spending on food is also the highest priority in the case of urban wage-earner households but compared with rural counterpart these shares are smaller. In a developing country like Vietnam, these large shares of food are widely recognized. Thus, the significant reduction in prices of food becomes a critical condition to

improving the welfare of the people, especially for those in the rural areas. However, as indicated in Figure 8, trade liberalization does not give much positive impact on changing the position of food price (sector 9) in the relative price system.

Table 3: **Share of Each Good in Total Consumption** (at base year)

No	Sectors	H1	H2	H3	H4	H5	H6	H7	H8
1	Crops cultivation	7.84	5.32	5.53	10.54	5.19	3.78	3.43	2.82
2	Livestock and poultry	7.79	5.99	5.73	2.31	6.92	5.72	5.41	3.84
3	Forestry	0.48	0.45	0.43	0.32	0.93	0.45	0.29	0.29
4	Fishery	3.71	3.25	3.78	1.15	3.51	3.45	2.81	2.76
5	Mining and quarrying	0.04	0.04	0.05	0.05	0.05	0.03	0.02	0.10
6	Processed seafood	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01
7	Alcohol, beer, water, soft drinks	3.64	3.63	2.91	0.97	2.97	4.32	2.91	4.47
8	Cigarettes and tobacco products	2.40	2.60	2.62	0.23	2.43	2.81	2.67	0.95
9	Other food manufactures	20.83	21.67	22.31	35.20	22.80	18.50	17.59	13.12
10	Material and construction	2.81	6.08	8.97	15.50	13.26	4.60	6.47	27.28
11	Chemical manufacturing	4.09	3.65	3.43	1.32	3.73	3.47	3.16	3.53
12	Home appliances	0.03	0.10	0.07	0.06	0.22	1.45	0.48	0.33
13	Vehicles	2.10	3.02	2.70	0.24	1.49	4.72	4.27	0.44
14	Machinery and equipment	0.10	0.11	0.08	0.04	0.14	0.14	0.12	0.11
15	Textile, garment	6.41	5.04	4.88	1.06	4.47	3.29	3.02	1.89
16	Leather	2.83	2.10	2.00	0.31	1.99	1.76	1.47	0.89
17	Other manufacturing products	1.15	1.12	0.95	0.34	1.31	2.41	2.59	2.00
18	Gasoline, lubricants	0.43	0.50	0.53	0.04	0.34	0.96	0.93	0.50
19	Electricity and gas, water	1.04	1.39	1.04	0.41	1.57	2.68	2.08	2.92
20	Trade	7.70	7.56	7.29	1.23	3.82	7.95	10.68	3.57
21	Hotels, restaurants	1.74	3.91	3.93	0.58	3.33	7.68	6.84	3.36
22	Transport services and tourism	2.36	3.31	2.21	1.67	1.84	1.90	2.40	2.15
23	Communication services	0.11	0.30	0.16	0.12	0.27	1.09	1.07	0.81
24	Financial services	1.09	2.01	1.99	0.16	2.27	2.69	2.14	2.64
25	Public and other services	19.24	16.83	16.40	25.15	15.12	14.14	17.13	19.21

Source: Author's calculations from 2000 SAM (CIEM-NIAS, 2003)

H1: rural farmers; H2: rural self-employed, non farm; H3: rural wage-earners; H4: rural unemployment; H5: urban farmers; H6: urban self-employed, H7: urban wage-earners; H8: urban unemployment.

Second to food manufactures sector, public service sector also plays an important role in household consumption structure. As indicated in Table 3, rural households spend about 20 % of total family budget on public services, such as education, health care, and so on. In the urban area, public services also reveal to be one of the most important components in the consumption basket of household. An increase in the prices of public service has a negative impact on all groups of households at different levels. However, urban self-employed household will incur the least impact. In contrast, this will hurt rural people more due to their larger share of public service expenditures. In addition after trade liberalization,

falls in the prices of products such as livestock and fishery, which have large shares in consumption structure of all household groups, unambiguously benefit all people.

It is interesting to note that urban population who buy a large proportion of vehicles; home applicants and its spare part; electricity, gas and water will clearly gain from tariff reduction. The shares of these above products in total consumption are very large for the case of urban households compared with rural counterparts. The decrease in the prices of these products will significantly benefit urban households, not rural ones. This result is quite consistent with the situation that the Vietnamese economy is currently experiencing.

3.5 The Effect of Trade Liberalization on Household Welfare

Using the same approach as employed in many other papers, this paper utilizes Hicksian Equivalent Variations (EV) to measure the welfare change of each household group. It is defined as:

$$EV_r = \sum_{t=1}^{T} \mu(t) \frac{U_{tr} - U_{0r}}{U_{0r}} Y_{0r}$$

where the subscript *r* represents a particular category of household, U_{0r} and Y_{0r} are utilities and income at initial based year, U_{tr} is utility at period *t*. The equivalent variation reflects more thoroughly the change in the satisfaction of households because it takes into account consumer preference as well as income changes (Francois and Kenneth, 1997).

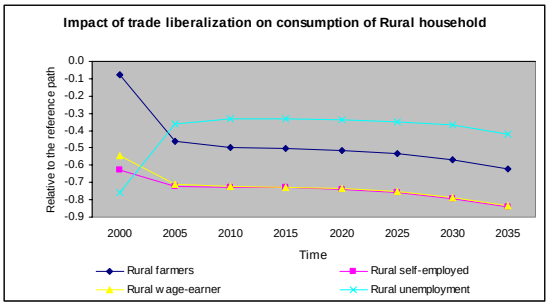
Table 4: **The Effect of Tariff Reduction on Household Welfare**

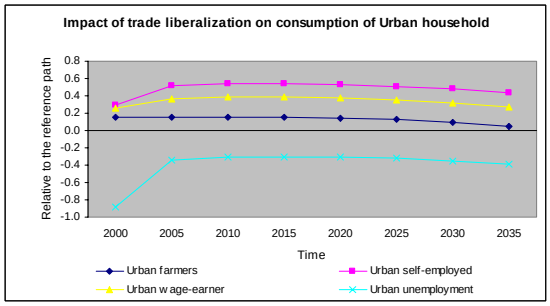
Household categories	Rural		Urban	
	EV	%	EV	%
Self-employed farmers	-8,742	-0.44	275	0.15
Self-employed non-farmers	-4,407	-0.72	5,727	0.49
Wage-earners	-2,520	-0.70	2,893	0.35
Non-employment	-144	-0.41	-216	-0.40
Total	**-15,813**		**8,679**	

The simulation result in Table 4 indicates that, trade liberalization lead to the fall in total welfare at the national level. The improvement in welfare of urban household group (8,679 billion VND) is not enough to compensate for the negative effect of the reduction in the welfare of rural people (-15,813 billion VND).

Although trade liberalization helps improve the welfare of many urban households, it may widen the income gap between rural and urban areas as well as among rural and urban people.

Figure 9: **Impact of trade liberalization on household consumption**





As analysing in previous sections, rural household have to face a large reduction in their income while the adjustment of relative price system does not favour them much. As a result, rural household's consumptions tend to decline and remain well below the baseline scenario in the long run (Figure 9A). Among rural people, rural self-employed and rural wage-earner households have to incur the biggest losses. Rural farmers, who constitute the majority population in rural areas, are also loss. However, this loss is relatively smaller comparing with that of the rural self-employed and rural wage-earner.

In urban areas, urban self-employed household gains the most from trade liberalization while the urban unemployed household loss. As a result, the gap between incomes of urban people may also be widened.

The above-mentioned evidence supports the conclusions of Chan (2002) and Jensen (2003) that trade liberalization seems to increase the inequality between rural and urban areas as well as among urban people, especially in the case of Vietnam.

4. Conclusion

In this study, the welfare impact of trade liberalization is examined. How the welfare of eight household groups is affected is analyzed, assuming the reduction on tariff revenue is offset by the introduction of a uniform increment in indirect tax rates, endogenously determined so as to maintain revenue neutrality. Because the recent tariff structure of Vietnam strictly prohibits the import of consumption goods but favors the import of intermediate inputs, trade liberalization may probably not help reduce production costs significantly while encouraging people to use imported products rather than the domestically produced ones. In addition, the increase in indirect taxes makes domestic products become less competitive. As a result, imports of agriculture and services sector increase while their export decrease. In addition, output of the major sectors also decreases remarkably. At the national level, the total household welfare is negatively affected. In order to understand how

trade liberalization affects each household group, the study analyzes the main sources of income and the destinations of expenditures of each group. Benefits gained from change in the relative prices system of consumption goods are not so large that they can outweigh the losses in incomes, leading to a decline in welfare of all rural households in the long run. In contrast, both income and price effect seem to favor most of urban households. The simulation result proves that, under the effects of trade liberalization, three out of four urban households gain while all rural household groups lose. Therefore, income gap between urban and rural households may become wider.

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Appendixes

LIST OF EQUATIONS

A. INTERTEMPORAL EQUILIBRIUM BLOCK

A.1 Consumption and interest rate

(for each of *r* household categories, subscript *r* is skipped)

$$\frac{Y_{t+1} - SAV_{t+1} - i^* DEBT_{t+1}}{Y_t - SAV_t - i^* DEBT_t} = \left(\frac{1+r_{t+1}}{1+\rho}\right)$$

$$r_t = (1+i^*)\frac{\varepsilon_t}{ER_t} - 1$$

$$\varepsilon_t = \sqrt{ER_t \varepsilon_{t-1}}$$

A.2 Investment (for each of *n* sectors, subscript *j* is skipped)

$$I_t = \frac{K_t}{2}\left(\frac{q_t}{PI_t} - 1\right)$$

$$r_t q_{t-1} = wk_t + PI_t\left(\frac{I_t}{K_t}\right)^2 + (q_t - q_{t-1}) - \delta q_t$$

$$K_{t+1} - K_t = I_t - \delta K_t$$

$$J_t = I_t PI_t\left(1 + \frac{I_t}{K_t}\right)$$

A.3 Foreign debt

$$DEBT_t = DEBT_{t-1} + \left[\sum_j J_{jt} - \sum_r SAV_{rt} - s^g T_t (1 - tr^p)\right] + TF_t$$

$$TF_t = ER_t\left(\sum_j PW_{jt}^m M_{jt} - \sum_j PW_{jt}^e E_{jt}\right)$$

B. GENERAL EQUILIBRIUM BLOCK

(Within period equations, time subscript *t* is skipped)

B.1 Production

$$L_{lj} = \left(\frac{PV_j}{W_l}\right)\beta_{lj} V_j \qquad (j=1,2,\ldots,n;\ l=1,2\ldots,l)$$

$$V_j = \overline{A}_j \prod_t L_{lj}^{\beta_{lj}} K_j^{\beta_{Kj}} \qquad (j=1,2,\ldots,n)$$

$$X_j = \frac{V_j}{v_j} \qquad (j=1,2,\ldots,n)$$

$$X_{ij} = a_{ij} X_j \qquad (i=1,2,\ldots,n;\ j=1,2,\ldots,n)$$

$$\pi_j = P^*_j X_j (1 - t_j^i) - \sum_i P_i X_{ij} - \sum_l W_l L_{lj} \qquad (j=1,2,\ldots,n)$$

$$wk_j = \frac{\pi_j}{K_j} \qquad (j=1,2,\ldots,n)$$

B.2 Government Revenue and Household Income

$$T = \sum_l W_l \bar{L}_l t_{Ll}^d + (\sum_j \pi_j) t_K^d + \sum_j X_j P_j^* t_j^i + \sum_j M_j PM_j t_j^m + \sum_j E_j PE_j t_j^e + ER.\bar{F}_g$$

$$Y_r = \sum_l \bar{L}_l W_l (1 - t_{Ll}^d) d_{rl}^L + (\sum_j \pi_j)(1 - t_K^d) d_r^K + Ttr^p d_r^T + ER.\bar{F}_{pr}$$

B.3 Demand

$$C_{jr} = \frac{\alpha_{jr}\left(Y_r - i^* DEBT_r - SAV_r\right)}{P_j} \qquad (j=1,2,\ldots,n;\ r=1,2,\ldots,h)$$

$$Inv_j = \frac{h_j \sum_j J_j}{PI} \qquad (j=1,2,\ldots,n)$$

$$G_j = \frac{k_j T (1 - tr^p)(1 - s^g)}{PG} \qquad (j=1,2,\ldots,n)$$

$$Q_j = \sum_i X_{ji} + \sum_r C_{rj} + G_j + Inv_j \qquad (j=1,2,\ldots,n)$$

$$D_j = \bar{B}_j^{\sigma_j - 1} \omega_j^{\sigma_j} \left(\frac{PD_j}{P_j}\right)^{-\sigma_j} Q_j \qquad (j=1,2,\ldots,n)$$

$$M_j = \bar{B}_j^{\sigma_j - 1} (1 - \omega_j)^{\sigma_j} \left(\frac{PM_j}{P_j}\right)^{-\sigma_j} Q_j \qquad (j=1,2,\ldots,n)$$

$$E_j = \bar{N}_j^{-1-\phi_j} (1 - \gamma_j)^{-\phi_j} \left(\frac{PE_j}{P_j^*}\right)^{\phi_j} X_j \qquad (j=1,2,\ldots,n)$$

B.4 Domestic supply

$$S_j = \bar{N}_j^{-1-\phi_j} \gamma_j^{-\phi_j} \left(\frac{PD_j}{P_j^*}\right)^{\phi_j} X_j \qquad (j=1,2,\ldots,n)$$

B.5 Market equilibrium block

$$\sum_l L_{lj} - \bar{L}_l = 0 \qquad (t=1,2,\ldots,l)$$

$$D_j - S_j = 0 \qquad (j=1,2,\ldots,n\text{-}1)$$

$$\left(\sum_j P\overline{W}_j^{\,m} M_j + \frac{i^*}{ER}\sum_r DEBT_r\right) -$$

$$\left\{\sum_j P\overline{W}_j^{\,e} E_j + \frac{1}{ER}\left[\sum_j J_j - \sum_r SAV_r - s^g T(1-tr^p)\right] + \sum_r \overline{F}_{pr} + \overline{F}_g\right\} = 0$$

B.6 Price

$$PM_j = ER.P\overline{W}_j^{\,m}(1+t_j^{\,m}) \qquad (j=1,2,\ldots,n)$$

$$PE_j = ER.P\overline{W}_j^{\,e}(1-t_j^{\,e}) \qquad (j=1,2,\ldots,n)$$

$$P_j = \overline{B}_j^{\,-1}\left\{\omega_j^{\,\sigma_j} PD_j^{\,1-\sigma_j} + (1-\omega_j)^{\sigma_j} PM_j^{\,1-\sigma_j}\right\}^{\frac{1}{1-\sigma_j}} \qquad (j=1,2,\ldots,n)$$

$$P_j^* = \overline{N}_j^{\,-1}\left[\gamma_j^{\,-\phi_j} PD_j^{\,\phi_j+1} + (1-\gamma_j)^{-\phi_j} PE_j^{\,\phi_j+1}\right]^{\frac{1}{\phi_j+1}} \qquad (j=1,2,\ldots,n)$$

$$\sum_j P_j \frac{Q_j}{\sum_j Q_j} = 1$$

$$PV_j = \frac{P^*_j(1-t_j^{\,i}) - \sum_i P_i a_{ij}}{v_j} \qquad (j=1,2,\ldots,n)$$

$$PI = \sum_j h_j P_j$$

$$PG = \sum_j k_j P_j$$

C. STEADY-STATE EQUILIBRIUM BLOCK

$$I_{jT} = \delta_j K_{jT}$$

$$\left[\sum_j J_{jT} - \sum_r SAV_{rT} - s^g T_T(1-tr^p)\right] + TF_T = 0$$

$$r_T = \rho$$

Table A1: **List of Parameters Used in the CGE Model**

δ_j	Depreciation rate
ρ	Rate of time preference
σ_j	Elasticity of substitution
ω_j	CES share parameter for domestic good consumed
$\overline{B}_j$	CES efficiency parameter
ϕ_j	Elasticity of transformation
γ_j	CET share parameter for domestic good supplied
$\overline{N}_j$	CET efficiency parameter
β_{tj}	Labor elasticity of production

β_{Kj}	Capital elasticity of production
$\overline{A}_j$	Production function efficiency parameter
a_{ij}	Input coefficient
v_j	Value added coefficient
α_{jr}	Household's budget share for consumption
η_{jr}	Minimum level of consumption
s^g	Government saving rate
h_j	Share of investment expenditure
k_j	Share of government consumption expenditure
t_L^d	Direct tax rates on labor
t_K^d	Direct tax rates on capital
t_j^i	Indirect tax rates
t_j^m	Import tax rates
t_j^e	Export tax rates
Tr^p	Government transfer rate to household
d_{rt}^L	Distribution rate of labor
d_{rt}^K	Distribution rate of capital
d_{rt}^T	Distribution rate of government transfer

Table A2: **List of Endogenous Variable Used in the CGE Model**

r_t	Domestic interest rate at time *t*
ε_t	Expected exchange rate for time *t+1*
SAV	Household saving
DEBT	Foreign debt
TF	Trade deficit
I_j	New investment
J_j	Investment expenditure
wk_j	Rate of return on capital
q_j	Shadow price on capital
X_j	Output of sector *j*
X_{ij}	Intermediate input
L_j	Labor input
K_j	Capital stock
V_j	Value added

π_j	Profit of sector *j*
Y_r	Household income
T	Government revenue
C_j	Household consumption
G_j	Government consumption
Inv_j	Demand of good for investment
Q_j	Total domestic demand
D_j	Demand for domestic goods
M_j	Import
E_j	Export
S_j	Supply for domestic usage
W_t	Wage rate
PD_j	Price of domestic goods
PM_j	Price of imported goods
PE_j	Price of exported goods
P_j	Price of composite good
P_j^*	Aggregate price of output
ER	Exchange rate
PV_j	Price of value added
PI	Price index of investment basket
PG	Price index of government consumption basket

Table A3: **List of Exogenous Variable Used in the CGE Model**

i^*	World interest rate
$\overline{L}_l$	Labor supply
$\overline{F}_g$	Government borrowing from abroad
$\overline{F}_p$	Household borrowing from abroad
FDI	Foreign direct investment
$P\overline{W}_j^m$	World price of imported good
$P\overline{W}_j^e$	World price of exported good