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Abstract

Bangladesh, being a labor-abundant country, benefits from foreign direct investment (FDI) as it is considered as a supplement to domestic investment for this capital-scarce economy. We examine how the benefits of increased FDI in the ready-made garments (RMG) sector are transmitted and shared among households with different characteristics, and the appropriate government policies to mitigate adverse distributional problems, if any, created from the increased FDI. To address these issues, we develop a computable general equilibrium model for Bangladesh that describes competition between local firms and multinational enterprises (MNEs) in the RMG sector and the distributional impacts of FDI among households. Our simulation results demonstrate that an increase in FDI promotes both output and exports in the RMG sector. However, because of the competition between MNEs and domestic firms, the output of domestic firms would fall slightly. Scrutinizing the welfare effects among household groups, we find that the benefits of FDI-induced growth would affect all household groups unevenly. We also demonstrate that the benefits could be shared equitably among household groups with skill development programs targeted at the adversely affected household groups.

Key words: Bangladesh, ready-made garments, foreign direct investment, computable general equilibrium analysis, distributional impact.

JEL Classification Code: C68, F21, F23, O15

1. Introduction

Foreign direct investment (FDI) is a major component of cross-border factor mobility in the current globalized world and is anticipated to accelerate economic growth by relaxing a capital constraint that is particularly serious in developing countries. This anticipation has been reflected in recent policies in Bangladesh to establish a business-friendly market environment for foreign investors. Bangladesh, being a labor-abundant country, is expected to benefit from FDI as it is considered to be a supplement to domestic investment. The country has been adopting policies to liberalize its investment regime through various incentive measures to attract foreign investors in its major industries.

The ready-made garments (RMG) industry is the most important manufacturing sector in Bangladesh. It accounted for 82 percent of total exports and 13 percent of gross domestic product (GDP) in 2016. Around four million workers are employed in this sector; among them, 50 percent are from rural areas. More than 20 million people in Bangladesh are dependent on this sector for their livelihood (International Finance Corporation, 2016, p. 1). The RMG sector, by creating many employment opportunities, especially for unskilled workers, has contributed to a reduction in poverty and inequality in the country. The backward linkages of this sector are also strengthening the textile, power, accessories, and spare-parts industries. Considering its large contribution, further expansion of the RMG sector by attracting FDI and the acceleration of its ongoing development has received enormous attention in Bangladesh.

While the RMG sector is currently dominated by local firms, it was initially established by joint venture agreements with multinational enterprises (MNEs) in the 1980s. Under those agreements, technological know-how and the marketing networks of the MNEs were combined with abundant cheap domestic labor to help Bangladesh obtain market access in western countries (Alam and Natsuda, 2016, p. 320). The number of MNEs in the industry has decreased in recent decades, and domestic firms now produce around 95 percent of RMG output in Bangladesh (Kee, 2014, p. 39). This decline in the number of MNEs can be attributed to restrictive government policies that created an unfavorable business environment. The World Bank's ease of doing business index ranks Bangladesh very low.

In the absence of any effective laws to regulate FDI, several complex rules have been enforced by various authorities with overlapping administrative procedures. Sector-specific investment regulations have restricted FDI in high-growth industries such as garments,

pharmaceuticals, and telecommunications (UNCTAD, 2013, p. 2). MNEs have to satisfy at least seven procedures in registering businesses and experience frequent inspection (on average 17 a year) by regulatory agencies after starting a business, and thus organizations incur sizable monetary and time costs. The National Board of Revenue frequently reopens decade-old complex tax cases, targeting MNEs that filed applications for profit repatriation. The repatriation process can be ongoing until the settlement of the tax dispute (US Trade Representative, 2017, p. 45). An electricity connection and access to land are also very costly and time consuming for MNEs. The country now has sufficient electricity generation capacity, but a poor transmission and distribution system often interrupts the power supply to manufacturing plants. Land ownership barriers include "lack of coherence, outdated laws, a poor land registry and frequent court disputes related to land titles" (UNCTAD, 2014, p. 7)[1]

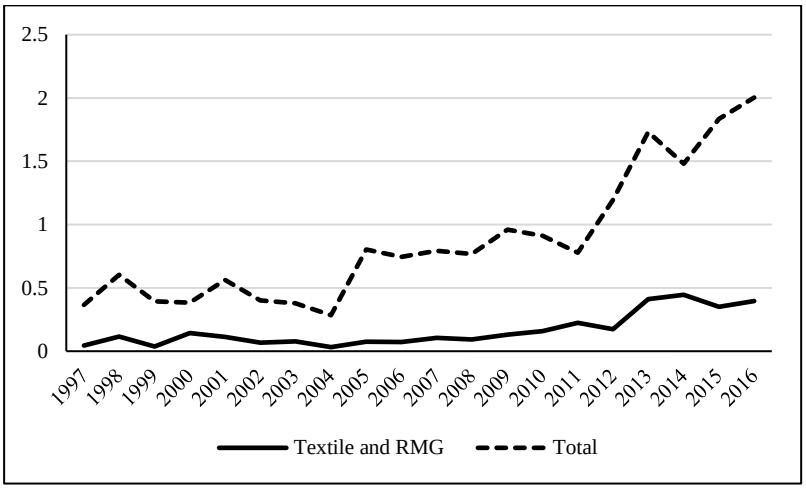
The government has taken several measures to improve this business-unfriendly environment and attract FDI. The establishment of export processing zones (EPZs) in 1983 was a milestone. A substantial amount of FDI in Bangladesh has taken place in EPZs because of various tax incentives and facilities offered to investors, therefore, it has partially achieved its objective of creating more job opportunities by promoting exports (Kathuria *et al.*, 2016, p. 256). From 2006 onward, FDI became permitted outside the EPZs, which had been restricted previously. Another milestone was the establishment of the Bangladesh Economic Zone Authority in 2010.[2] It is scheduled to create 100 economic zones within 15 years to facilitate investment and create new job opportunities.

Despite these liberalizing measures to attract FDI during the last two decades, the total FDI inflow has been historically very low at 3.6 percent of the country's gross capital formation in 2016 (UNCTAD, 2017, Annex Table 5) (Figure 1). The average FDI-GDP ratio in 2011–2015 shows that Bangladesh is ranked 149 among 179 countries. The FDI-GDP ratio of Bangladesh is 1.4 percent, whereas most Southeast Asian countries have a ratio well above two percent (Raihan and Ashraf, 2016, p. 2).

[1] Both MNEs and citizens of the US filed cases complaining about the fraudulent sale of land in Bangladesh (US Trade Representative 2017, p. 46).

[2] Besides several tax exemptions, the main nonfiscal incentives include permission for 100 percent foreign ownership; no ceiling on foreign investment; issuance of work permits to foreigners up to five percent of total employees of an industrial unit; 50-year land lease period with a possibility of extension; 20 percent sale to domestic tariff areas; provision of transfer of shares of foreign shareholders to local shareholders and investors; etc.

Figure 1: Net FDI Inflow in Bangladesh (1997–2016) [Unit: Billion USD]

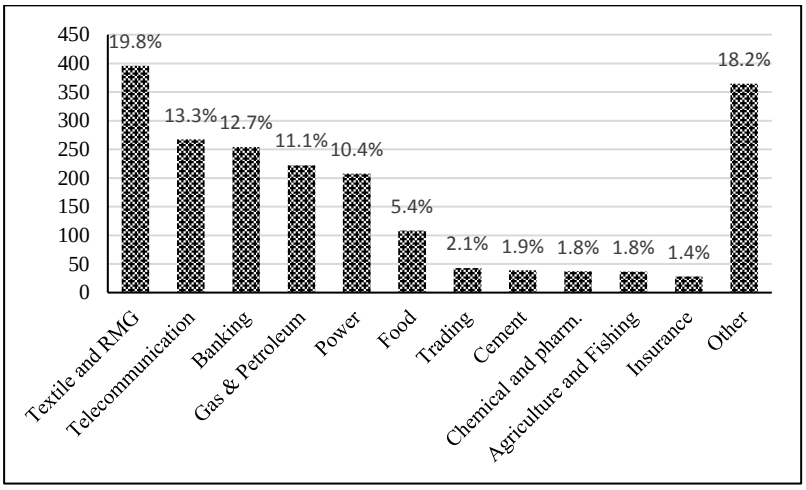


Source: Based on Bangladesh Bank (2016)

Among this low level of FDI inflow, the largest share, around 20 percent of the total inflow in 2016, is attracted by the textile and RMG sector in Bangladesh (Figure 2). In recent years, service sectors, such as telecommunication and banking, attracted considerable FDI because of their privatization policy. While the high growth achieved in the RMG sector is mainly from indigenous investment, there is substantial scope for further expansion of the RMG sector by increasing exports through FDI mainly from the current major FDI donors, such as South Korea and Hong Kong as well as the UK.[3] As the FDI in the RMG sector requires unskilled workers, poor households are expected to be the main beneficiaries of FDI. However, the reemergence of RMG MNEs may have some negative impacts on domestic RMG firms because they compete with each other for cheap labor and export markets. While there is a consensus among policy makers, academia, and civil society regarding policies to attract FDI, the impact of FDI on the domestic economy—especially, trade-offs between competition among domestic firms and MNEs in the RMG sector and on the distributional outcome among firms and households—is not self-evident in the Bangladesh context.

[3] The significance of Hong Kong might need careful examination considering the possibility that it serves as a way station for FDI (from mainland China), as argued by Blanchard and Acalin (2016) for Hungary's FDI to the US.

Figure 2: Net FDI Inflow in Bangladesh by Major Sector in 2016 [Unit: Million USD]



Source: Based on Bangladesh Bank (2016)

The recent literature on the effects of FDI in Bangladesh empirically analyzes its impacts on economic growth. Ahmad (1990) estimated a two-gap model for Bangladesh and revealed that foreign capital stimulated its economic growth. Quader (2009) identified determinants of FDI and found a positive impact of FDI on growth. This finding is consistent with many other studies (Alam and Mian, 2006; Noor, 2016; Dutta *et al.*, 2017) while some studies (Kabir, 2007; Shimul *et al.*, 2009; Ahmed and Tania, 2010; Islam and Meerza, 2013) examining the causal relationship between FDI and GDP growth found the relationship to be ambiguous.

Most of these studies use aggregate FDI data and reduced-form models; sector-level FDI data and structural models are rarely used. As Wang (2009) argued, an examination with aggregate FDI data, which the previous studies used, might blur the effects of FDI and lead to ambiguous results. Thus, Wang (2009) used sector-level FDI data for 12 Asian countries, including Bangladesh, and found that the growth effects depend on the sectors hosting the FDI. The growth effects are found to be strong for manufacturing FDI, compared with nonmanufacturing FDI. More detailed sector-specific FDI studies are scant. Khatun and Ahmad (2015) found that FDI in the energy sector was associated with higher energy consumption and higher GDP growth in Bangladesh. Kee (2014) analyzed the impacts of FDI in the RMG sector using firm-level data for Bangladesh and confirmed a positive impact on firms' total factor productivity but did not provide any macroeconomic or distributional implications.

The above backdrop raises some pertinent questions for Bangladesh. Does an increased FDI inflow in the RMG sector, which could result from regulatory reforms for MNEs, enhance social welfare overall? How are the benefits of FDI inflow transmitted and shared among households with different characteristics (rural–urban, rich–poor, landowner–landless, highly educated–poorly educated)? What are the appropriate government policies to mitigate the adverse distributional problems, if any, created from the increased FDI in the RMG sector? To answer these questions, we need a comprehensive macroeconomic framework that can be used to examine the above-mentioned dilemmas in Bangladesh. We develop a computable general equilibrium (CGE) model for Bangladesh that describes competition between local firms and MNEs in the RMG sector and the distributional impacts among households and then simulate an FDI increase. Using counterfactual experiments, we find an overall welfare gain through a rise of wages but detect that a certain household group is negatively affected by the FDI increase. We subsequently explore policy interventions targeted at this social group to achieve a more equitable distribution of gains.

The remainder of the paper is organized as follows. Section 2 describes the methodological approach, data, and simulation scenarios. The simulation results are presented in Section 3, while Section 4 provides concluding comments.

2. Methodology and Data

2.1. The Model

To overcome the existing controversies, we simulate an FDI increase in the RMG sector to predict the possible macro impacts on output and household welfare by using a static CGE model, developed based on the standard CGE model by Hosoe et al. (2010), which computationally implements the theoretical framework of Arrow−Debreu's general equilibrium model. This model allows us to examine the economy-wide impacts with details of sectoral inputs and outputs, and income and expenditure of social groups of interest. It enables us to identify how the FDI in the RMG sector affects these macro and micro variables and who ultimately receives the benefits. We extend this standard model in two ways. Following Latorre and Hosoe (2016), we include two subsectors of the RMG sector. One subsector hosts MNEs, whose capital is provided by the foreign owner. The other subsector hosts only local RMG firms, whose capital owners are domestic households. This extension linking the FDI incidence in the RMG sector to the macroeconomic outcome in the structural model is an important

extension over previous studies that either use reduced form econometric techniques or focus on aggregate macro variables. We distinguish eight different types of households (rural–urban, rich–poor, landowner–landless). This allows us precisely to depict the mechanism through which FDI affects the RMG sector, and how its impact is propagated in the macroeconomy and shared among different social groups. As the RMG sector is large in Bangladesh, resource constraints, especially factor markets, and the distribution of gains/losses among households, are explicitly considered in our general equilibrium model.

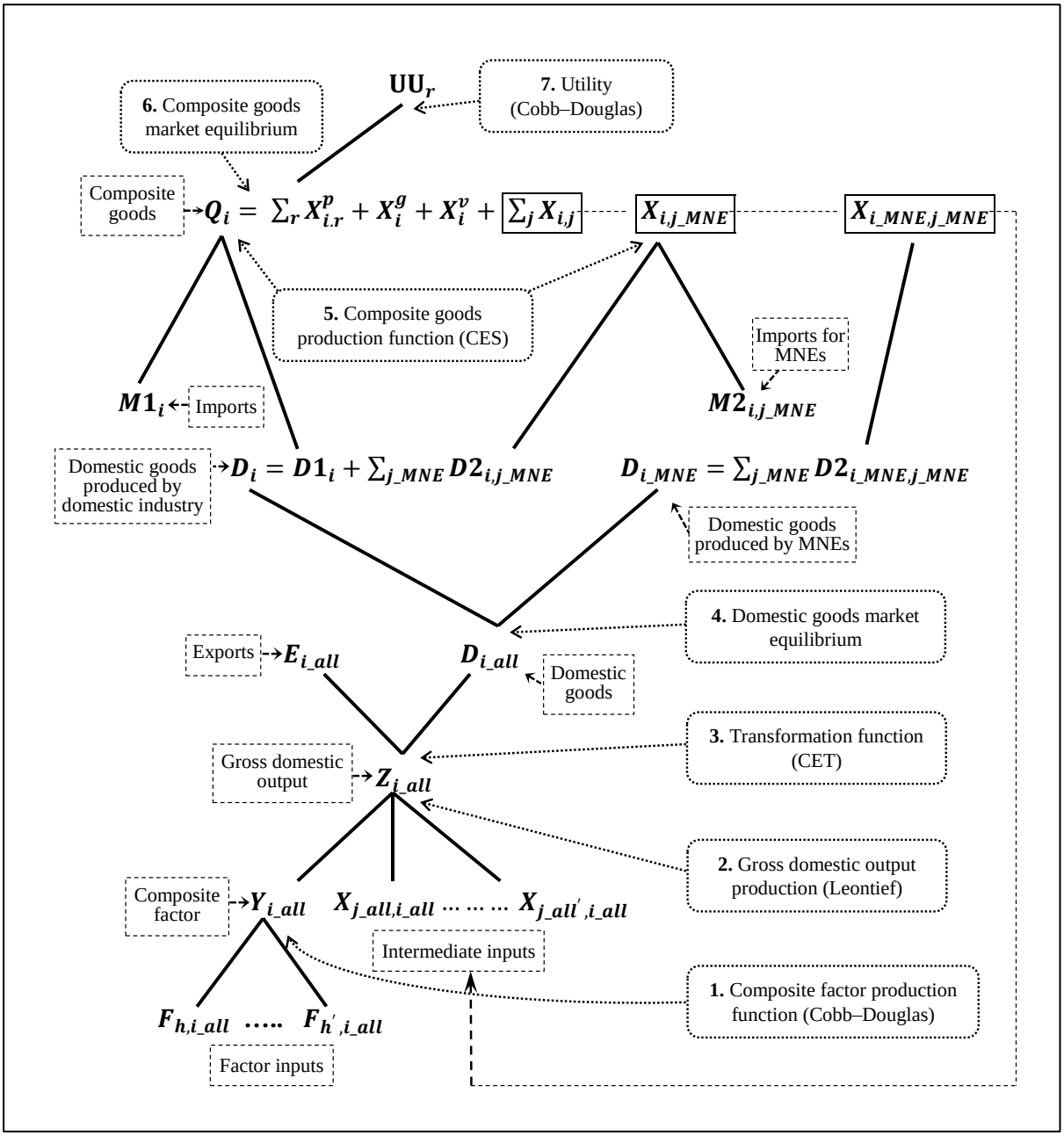
2.1.1. The Structure of the Bangladesh CGE Model

The basic structure of the model is presented in Figure 3. The bottom part (label 1) of the figure shows that in the *i_all*-th sector a composite factor (Y_{i_all}) is produced by employing all factors of production (F_{h,i_all}) using a Cobb–Douglas-type production function.[4] Domestic output (Z_{i_all}) is produced using the composite factor and *j_all*-th intermediate inputs (X_{j_all,i_all}). A Leontief-type production function is assumed for the production function (label 2). A constant elasticity of transformation (CET) function is assumed to describe the transformation of domestic output into exports (E_{i_all}) and domestic goods (D_{i_all}), shown by label 3. Domestic goods are supplied to the *i*-th domestic firms (left part) and *i_MNE*-th MNEs (right part) (label 4).[5] The domestic goods produced by domestic industries (D_i) are used for two purposes. A large portion of these goods ($D1_i$) is combined with imports by local firms of intermediate and final goods ($M1_i$) to produce Armington composite goods (Q_i) using a constant elasticity of substitution (CES) production function. For the RMG sector only, the other portion of domestic goods ($D2_{i,j\_MNE}$) is combined with imports ($M2_{i,j\_MNE}$) for the production of composite intermediate inputs for the *j_MNE*-th MNEs, using a CES function (label 5). As, according to the Bangladesh data (discussed later), the RMG MNEs are 100 percent export oriented and do not supply for domestic consumption, the domestic goods produced by MNEs (D_{i_MNE}) are only used for self-intermediate uses (X_{i_MNE,j_MNE}). The Armington composite goods are used as intermediate inputs by domestic industries ($X_{i,j}$), consumed by the *r*-th household ($X_{i,r}^{p}$), consumed by the government (X_i^g), and used for

[4] The *i_all*-th (or *j_all*-th) sector includes local firms and MNEs. The *i*-th (or *j*-th) sector includes only the former; the *i_MNE* (or *j_MNE*) sector includes the latter.
[5] The MNEs and FDI are considered only for the RMG sector.

investment (X_i^v) as shown by label 6. Household utility (UU_r) depends on the consumption of ($X_{i,r}^p$) (label 7).

Figure 3: Structure of the Bangladesh CGE Model



In our model, household incomes are generated from factor incomes, government transfers, and foreign remittances. We distinguish 15 industrial sectors and five factors (local and foreign capital, skilled and unskilled labor, and land). We assume that factors are fully employed while factor prices (rate of return on capital, wage rates, and rental rate for land) are flexibly adjusted to achieve factor market equilibrium. All the factors are assumed to be mobile

across sectors. We assume that MNEs use foreign capital but no local capital; the local firms use only local capital for simplicity.[6]

The government generates its revenue from direct income taxes, production taxes, and import tariffs, whose tax rates are exogenous. The government proportionately allocates its revenue among consumption, household transfers, subsidies, and savings. The foreign sector receives payments from net imports and the remuneration of foreign capital. The foreign exchange rate is flexibly adjusted to ensure the current account deficit is unchanged in USD terms. As a small country assumption, we set world prices of exports and imports to be exogenous in USD terms.

2.1.2. Expected Impacts of FDI

An increase in FDI in the RMG sector, which is presumed to be induced by a better business environment, would expand the production capacity of the RMG sector. This leads to more competition between the MNEs and local firms in output and labor markets. Local firms would lose their sales in the output market. Local firms are also harmed in the labor market as the increased labor demand by the MNEs increases wage rates. As the increase in the MNEs' output and exports is likely to exceed the contraction in the output and exports of local firms, aggregate RMG output and exports would increase. This would relax the balance of payment constraint and allow more imports of goods and services, leading to an expansion of the attainable consumption set for domestic households in general.

The aggregate gains from the FDI increase are captured by households through factor income and thus may be unevenly shared among households. As the composition of factor income varies among households, there may be a household worse-off from the adverse change in factor prices on their major income source, under the injection of foreign capital.

2.2. Model Estimation and Splitting the RMG Sector

The model is calibrated to the Bangladesh social accounting matrix (SAM) for 2012 with Armington elasticities of substitution and transformation provided by the GTAP version 9 database (Hertel, 1997). The Bangladesh SAM for 2012 was constructed by the Planning

[6] As the foreign capital is used only by the MNEs in the RMG sector, this factor is sector-specific and cannot move to other sectors.

Commission of Bangladesh on the basis of input–output tables for 2012, SAM coefficients for 2006–07, Household Income and Expenditure Survey (HIES), and Economic Survey of Bangladesh (Policy Research Institute, 2012, p. 3). This SAM has 86 sectors and is aggregated into 15 sectors for our FDI simulation.[7]

The RMG sector in the SAM is further divided into two subsectors: one for domestic firms and the other for MNEs established with FDI. This split is a key feature of our CGE modeling exercise focusing on the FDI incidence. To split the RMG sector, sales and sourcing patterns of MNEs obtained from Kee (2014) are used as weights for estimation of the MNEs' inputs and outputs in the RMG sector. We assume that the share of sales and exports of MNEs are 5.5 and 5.6 percent of total sales and exports of the RMG sector, respectively. The share of imported inputs in total intermediate inputs for the MNEs in the RMG sector is estimated to be 87 percent according to the survey by Kee (2014). The MNEs' input coefficients, which determine their backward linkages, are assumed to be similar to those of local firms. As all the MNEs in the RMG sector are 100 percent export oriented and have no forward linkages, our SAM describes only self-intermediate uses and exports by MNEs.

In our CGE model, we distinguish eight household categories reported in the original Bangladesh SAM 2012 (Table 1). Rural households are divided into six categories based on income class, land ownership, and occupation, whereas urban households are divided into two categories by household head education. The income of these households is generated from factor income, government transfers, and foreign remittances. Figure 4 shows the share of income generating factors in total household income, which accurately represent these household characteristics. Among these eight household groups, urban highly educated households generate most of their income from skilled labor wages, while urban poorly educated households do so from unskilled labor wage. Rural nonagricultural rich households depend heavily on capital income. Rural agricultural large households generate considerable amounts of income from land. Other households generate most of their income from unskilled labor wages.[8]

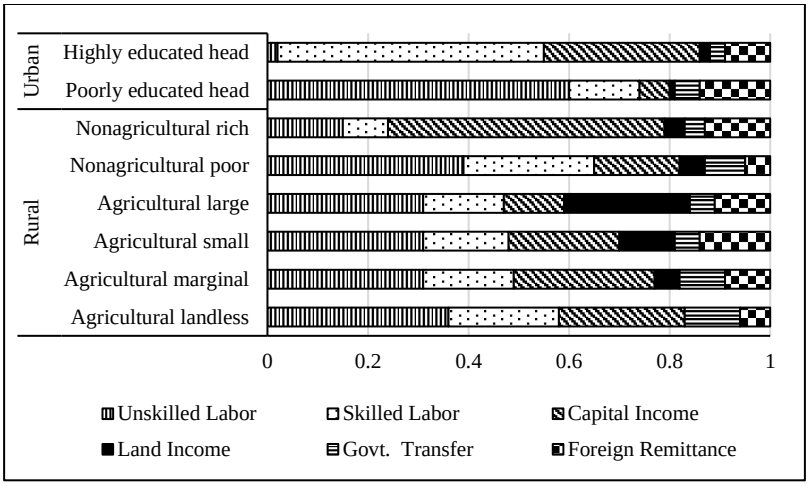
[7] The Appendix shows the details of the original and aggregated SAMs.
[8] Our SAM also shows different consumption patterns among households, but the differences are not large.

Table 1: Definition of Household Types

Household type	Description
Rural	
Agricultural landless	Agricultural households who have no land
Agricultural marginal	Agricultural households who own up to 0.49 acres of land
Agricultural small	Agricultural households who own 0.5–2.49 acres of land
Agricultural large	Agricultural households who own more than 2.49 acres of land
Nonagricultural poor	Not engaged in agricultural activities and own less than 0.5 acres of land
Nonagricultural rich	Not engaged in agricultural activities and own more than 0.5 acres of land
Urban	
Poorly educated	Head's education is 1–8 class
Highly educated	Head's education is more than 8 class

Source: HIES (2010) and Policy Research Institute (2012)

Figure 4: Share of Income Generating Factors in Total Household Income



Source: Bangladesh SAM 2012

We finalize the SAM by correcting an apparent statistical error in the original SAM data. The original SAM records an unreasonably large level of RMG exports, compared with actual export data reported in Export Receipt Statistics (Bangladesh Bank, 2016). To balance the SAM, we use the latter RMG export data and adjust the RMG inventory change data, which report a large negative value because of the above-mentioned export data error.

2.3. Simulation Scenarios

We set three simulation scenarios to analyze the macro and distributional impacts of FDI in the RMG sector of Bangladesh. In simulation 1, we assume an increase of the FDI stock in the RMG sector by 25 percent. Simulation 2 uses the assumption in simulation 1 plus a skill development program that equips unskilled labor of rural nonagricultural rich households with skills equivalent to those that skilled labor possesses. Simulation 3 uses the assumption in simulation 1 plus a foreign-worker training program that makes the unskilled labor of the same household emigrate abroad for higher wages. Details of these scenarios are provided below.

2.3.1. FDI Increase

In scenario 1, we assume an FDI stock increase in the RMG sector of 25 percent, which is comparable to a 0.035 percent increase in base run GDP, induced by regulatory reforms that attract FDI. Future regulatory reforms taken by the government cannot be predicted. Hence, we take an alternative approach by using a government-set policy goal that makes the country as attractive as other Asian countries in terms of being an FDI destination.

Attractiveness as an FDI destination is often measured by the World Bank's ease of doing business index. The country's current rank is very low at 176 out of 190 countries in 2017 (Table 2).[9] The overall rank is calculated using a range of country-specific factors. For instance, Bangladesh's rank in access to electricity, which is vital for modern industries, is 187 out of 190 countries. This is very poor compared with India (rank 26), Vietnam (rank 96), Malaysia (rank 8), and Indonesia (rank 49). The factors used in the electricity rank are "procedures, time and cost to get connected to the electricity grid, the reliability of the electricity supply and the transparency of tariffs" (World Bank 2017, p. 14). The time required to get a permanent electricity connection is 429 days in Bangladesh, compared with only 46 days in India and Vietnam, 31 days in Malaysia, and 59 days in Indonesia (World Bank World Development Indicators). This reflects the very poor energy infrastructure in Bangladesh, which is one of the main impediments to attracting FDI. Another constraint to FDI inflow in Bangladesh is access to land to start up a new business, particularly when investing in the manufacturing sector. The

[9] This index is constructed by considering government regulations on 10 factors affecting business life and investment decisions in a country. These factors are starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency (World Bank 2017, p. 1).

time required to register a property in Bangladesh is 244 days, whereas it takes only 47, 51, and 25 days in India, Sri Lanka, and Indonesia, respectively. The difficulties with the land transfer and land administration systems in Bangladesh have resulted in a rank of 185.

Table 2: World Bank's Ease of Doing Business Ranking in 2017

	Bangladesh	Vietnam	Malaysia	Indonesia	Sri Lanka	India
Overall rank	176	82	23	91	110	130
Area-specific rank:						
Starting a business	*122*	*121*	*112*	*151*	*74*	*155*
Dealing with construction permits	*138*	*24*	*13*	*116*	*88*	*185*
Getting electricity	*187*	*96*	*8*	*49*	*86*	*26*
Registering property	*185*	*59*	*40*	*118*	*155*	*138*
Getting credit	*157*	*32*	*20*	*62*	*118*	*44*
Protecting minority investors	*70*	*87*	*3*	*70*	*42*	*13*
Paying taxes	*151*	*167*	*61*	*104*	*158*	*172*
Trading across borders	*173*	*93*	*60*	*108*	*90*	*143*
Enforcing contracts	*189*	*69*	*42*	*166*	*163*	*172*
Resolving insolvency	*151*	*125*	*46*	*76*	*75*	*136*

Source: World Bank Doing Business Database

In our experiment, we assume that the Bangladesh government implements reforms in these areas so that the country can improve its rank to 126, which is comparable to the ranks of countries such as Vietnam, Sri Lanka, and India. Given this target, we estimate the magnitude of FDI increase achieved in the improved business environment. Several studies (Wei, 2000; Aizenman and Spiegel, 2006; Jayasuriya, 2011; Zhang, 2012; Duval and Utoktham, 2014; Corcoran and Gillanders, 2015) estimated the marginal effect of host country's deregulations and found a significant positive impact on FDI. For instance, Corcoran and Gillanders (2015) used average FDI stock data for the period 2004–2009 and found that the business environment, represented by the World Bank's ease of doing business rank, affected the FDI inflow stock and that an increase in the rank by one position was associated with an increase in the FDI inflow stock by 0.56 percent. Based on their estimate, our policy goal will increase the FDI stock by around 25 percent. This is the rationale for our assumption of a 25 percent increase in

the FDI stock in the RMG sector in simulation 1. In our model, the remuneration of foreign capital is transferred to the foreign owners, not captured by domestic households.[10]

2.3.2. Human Resource Development Programs

As discussed below, the results of simulation 1 show that rural nonagricultural rich households would be adversely affected by the FDI increase. To mitigate this adverse impact, we consider two hypothetical skill development programs for households. In the first program, 4,000 unskilled workers are assumed to be given technical and vocational training to become skilled workers and earn the skill premium. The skill premium is estimated to be 148 percent, which is 10,206 Bangladeshi taka (BDT) per month per worker, based on the Bangladesh labor force survey and the SAM.[11] This premium estimate implies an increase in skilled labor wages of 821 million BDT (or 0.4 percent of the skilled labor endowment) at the sacrifice of unskilled labor wages of 332 million BDT (or 0.1 percent of the unskilled labor endowment) for rural nonagricultural rich households in total. Simulation 2 incorporates these endowment changes along with the 25 percent increase in the FDI stock in the RMG sector assumed in simulation 1.

In the second human resource development program, the same number of unskilled workers are assumed to be given training to emigrate and work abroad for a migration premium that is estimated to be 187 percent or 12,956 BDT per month per migrant worker. Based on our assumed migration premium, by getting jobs in international labor markets, the remittance earnings of these workers would increase by 954 million BDT (or 0.09 percent of total remittances) at the sacrifice of the same amount of unskilled labor wages.[12] Simulation 3

[10] It should be noted that we assume the policy outcome (indicated by the ranking) but not any specific policies that could achieve this goal. The feasibility, effectiveness, and implementation costs of the policies should be examined separately.

[11] To compute the changes in endowment income resulting from the proposed program, the share of skilled and unskilled labor in Bangladesh is calculated based on the World Bank (2013). These are 28.5 percent and 71.5 percent, respectively. Using the data of the working labor force from the Ministry of Finance (2014) and total skilled and unskilled labor wages from the Bangladesh SAM 2012, the average skill premium is calculated as 10,206 BDT per month per worker.

[12] Siddiqui (2016) reported that remittances per male migrant are around 200,000 BDT a year in Bangladesh, mainly from Saudi Arabia, UAE, the USA, Malaysia, Kuwait, and Oman. Based on Siddiqui (2016) and our interview with Bangladeshi government officials, we estimate the remittances to be 238,478 BDT per year per migrant in Bangladesh. To verify the robustness of our simulation results with these two human resource development programs, we conducted a sensitivity analysis. The results are reported in the Appendix.

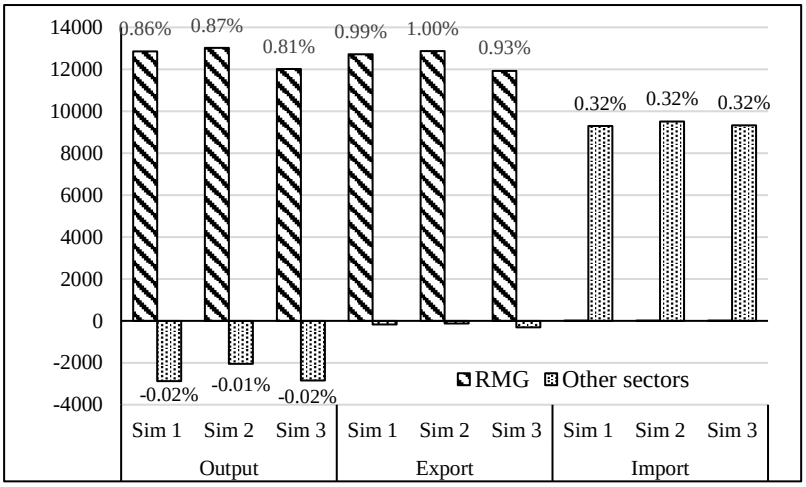
incorporates these endowment change and remittance receipts, which is exogenous in BDT, in addition to the FDI stock increase assumed in simulation 1.

3. Simulation Results

3.1. Sectoral Impact of FDI Increase

The 25 percent FDI stock increase (simulation 1) would expand total production of the RMG sector by 0.9 percent from the base quantity (Figure 5). Because the RMG sector is highly export oriented, its output increase almost entirely is exported. The expansion of the RMG sector can occur by mobilizing resources, especially labor, from other sectors, and thus leads to a contraction of output in the other sectors by 0.02 percent. The decrease in domestic production of these other sectors is compensated for by increased imports of 0.3 percent, which are made possible by the increase in RMG exports and the induced appreciation of the BDT.

Figure 5: Impacts on Output and Trade [Unit: Million BDT and Percentage Change from the Base]

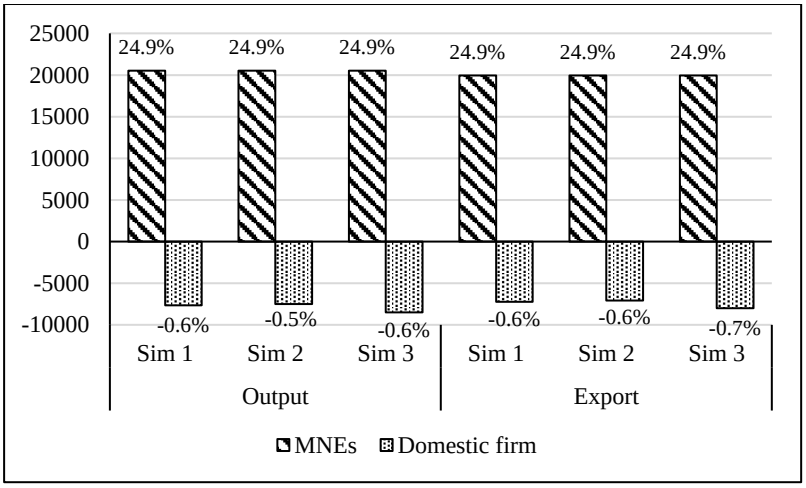


Note: Sectors other than the RMG sector are aggregated into "Other sectors" in this figure but reported in detail in Figure 7.

The output and export expansion in the RMG sector would not occur uniformly between MNEs and domestic firms (Figure 6). While MNE output and exports would increase significantly, by as much as the magnitude of the FDI increase, domestic firms would experience a slight contraction. This happens because the increase in FDI makes MNEs more aggressive both in the factor and output markets, and captures some of the market share of the

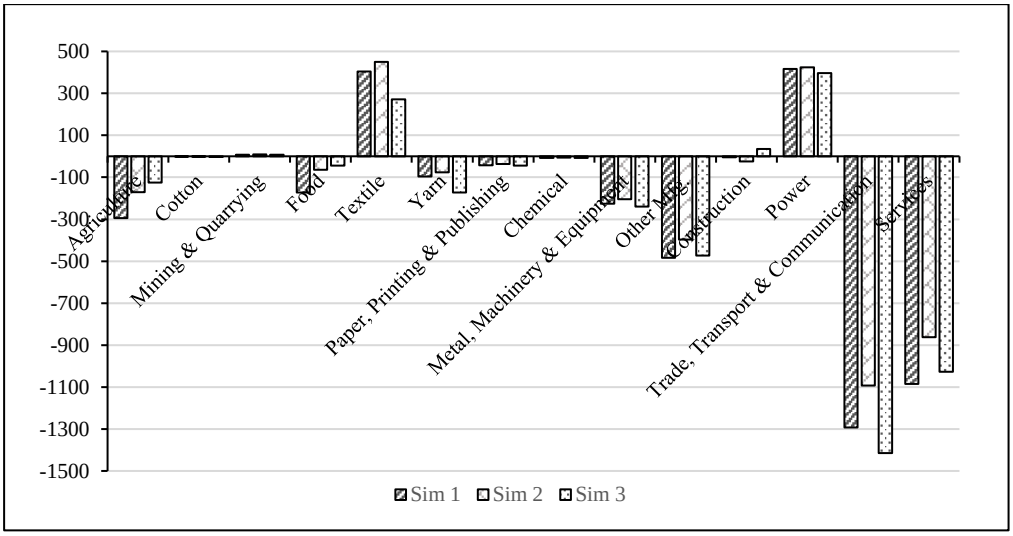
domestic firms. However, the gains by MNEs dominate the losses by domestic firms, so that overall RMG output would expand as shown in Figure 5.

Figure 6: Changes in Output and Exports by MNEs vs. Domestic Firms in the RMG Sector [Unit: Million BDT and Percentage Change from the Base]



The increase in the FDI stock in the RMG sector also affects the output of the other 14 sectors in different ways (Figure 7). While output in many sectors would decline, the textile and power sectors would experience an output gain through backward linkages with the RMG sector. Besides the backward linkages, differences in factor intensity also explain the variation of the output changes among sectors. As the FDI stock increase would make labor less readily available, labor-intensive sectors, especially service sectors, would contract significantly.

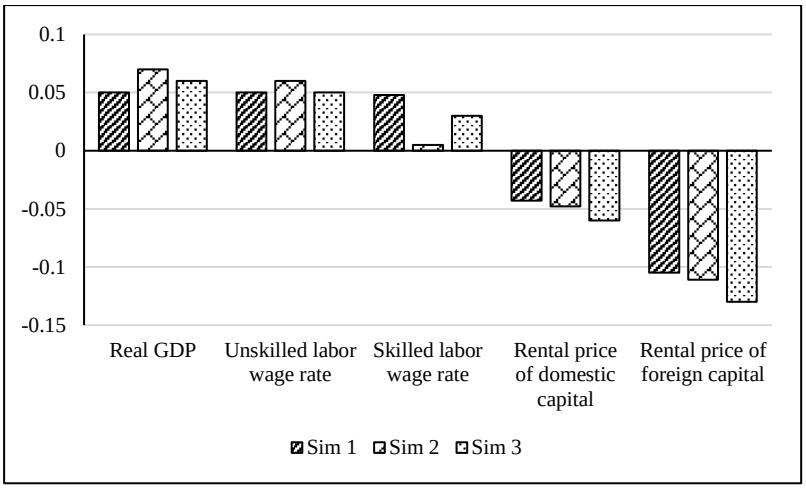
Figure 7: Change of Output in the Other Sectors [Unit: Million BDT]



3.2. Macro Impact of FDI Increase

In simulation 1, the increase of the foreign capital stock by 25 percent would increase the country's real GDP by 0.05 percent (Figure 8). Behind the GDP gains, skilled and unskilled wage rates would rise, reflecting demand increases in the RMG MNEs. While the rental price of foreign capital falls sharply because of the assumed FDI increase, the rental price of domestic capital also falls, though marginally. This is because the increase in production by the RMG MNEs associated with the FDI increase caused declines in the other sectors, especially the domestic RMG firms, which employ a large amount of domestic capital.

Figure 8: Impact on Real GDP and Factor Prices [Unit: Percentage Change from the Base]

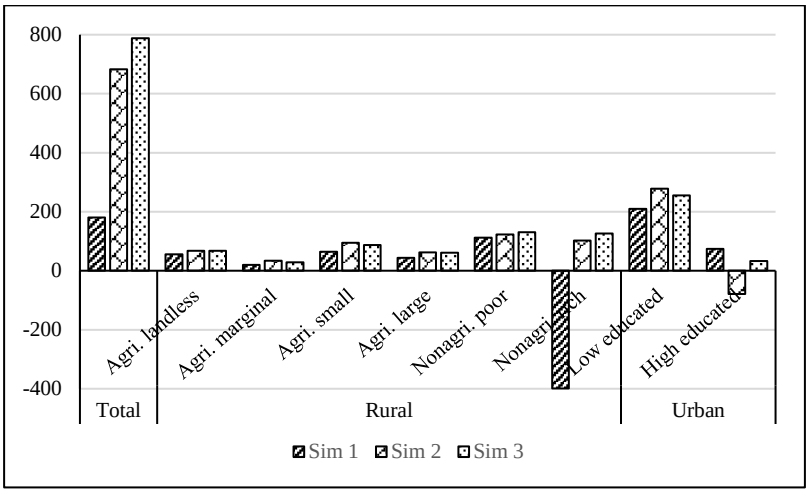


Note: As land is chosen as a numeraire, its price is not shown

3.3. Impact on Household Welfare and Distribution

The FDI stock increase in the RMG sector (simulation 1) would improve aggregate household welfare by 180 million BDT, measured by Hicksian equivalent variations (EVs) (Figure 9). This welfare impact can be broken down into that for eight individual household groups. The breakdown shows that all the household groups would experience a positive welfare gain, except the rural nonagricultural rich households, which suffer a welfare loss of 400 million BDT. This household is highly dependent on domestic capital income (55 percent of total income) (Figure 4), whose return is predicted to fall by around 0.04 percent in simulation 1 (Figure 8).

Figure 9: Changes in Household Welfare [Unit: EV in Million BDT]



Note: The household types are explained in detail in Table 1.

3.4. Human Capital Development Programs

From the viewpoint of distributional equity of gains from the FDI increase, the outcome of simulation 1 may be unacceptable for the government and/or households left behind. We thus further investigate distribution policies as remedies for this equity issue.[13] In simulations 2 and 3, we assume two skill development programs targeted at rural nonagricultural rich households to alleviate the above-mentioned adverse impact on them. The results show that these human capital development programs enable these households to earn wage premiums in the skilled and foreign labor markets. In simulation 2, rural nonagricultural rich households would become net welfare gainers (Figure 9). Aggregate household welfare would also improve further, and urban highly educated households would experience a slight welfare loss, by facing more severe competition from the newly transformed skilled labor supplied by rural nonagricultural rich households. As shown in Figure 8, the gain in the skilled labor wage rate would almost disappear.

When training is provided for foreign labor markets (simulation 3), such a negative side-effect on the skilled wage rate is not experienced by urban highly educated households (Figure 8). The human capital development program for foreign labor markets ensures an equitable

[13] The new allocation demonstrated in simulation 1, which harms rural nonagricultural rich households, would be rejected by Pareto's criteria if the original allocation is accepted as a fair allocation by the society. To the contrary, if the society finds the original allocation is too favorable for these households because they are now relatively rich in rural areas, the new allocation would be accepted without amendments such as in simulations 2 and 3.

distribution of gains in society (Figure 9). While urban highly educated households experience a positive gain, the other seven household groups would enjoy a gain comparable with that in simulation 2.[14] Needless to say, instead of the training programs, a cash transfer program from the gainers to the losers can be an alternative and efficient solution, if available.

In terms of sectoral output (Figures 7 and 8), the skill upgrading assumed in simulation 2 would improve output in all the sectors compared with their sectoral output in simulation 1. In contrast, the outcome of simulation 3 appears controversial. Compared with the outcome of simulation 2, the sectoral output would decrease in many sectors. Furthermore, RMG exports would be lower than that in simulation 2 (Figure 5). This is partly because the emigration promoted by the skill development program reduces the domestic endowment of unskilled workers and partly because the program increases remittances, which leads to an appreciation of the BDT, which thus reduces RMG exports.

4. Conclusion

This paper attempted to measure quantitatively the impacts of an FDI increase in the RMG sector on the macroeconomy in Bangladesh and welfare of households, which are heterogeneous especially in income sources, using a general equilibrium framework. Our simulations demonstrated that the FDI stock increase in the RMG sector would increase both its output and exports. This would then lead to an overall welfare gain of 180 million BDT and a GDP increase of 0.05 percent. However, because of the competition between MNEs and domestic firms, the output of domestic firms would fall slightly. By examining the welfare effects of the household groups, we found that the benefits of FDI-induced growth would not be transmitted to all household groups equally. One out of the eight household groups would experience a welfare loss, mainly because of a deterioration of its (domestic) capital income.

To ensure an equitable distribution of the benefits among household groups, we considered two skill-development programs that improve the human capital of the adversely affected household group. One program, converting unskilled labor to skilled labor in the

[14] The welfare estimates for the urban highly educated households depend on our assumptions about skill premiums. When we assume a higher/lower skill premium in simulation 2, a larger/smaller welfare deterioration would be realized for these households. However, our assumption about the migration premium would not substantially affect the welfare estimates of these households in simulation 3. See Appendix B for details of the sensitivity analysis.

domestic market, would benefit the households adversely affected by the FDI increase but, at the same time, would harm other households that largely depend on skilled wage income. The other program, to train emigrant workers, would not create any losing households but may achieve a smaller domestic production gain, because the program allows the labor force to go abroad in exchange for remittances.

Our study has certain limitations. First, we used a static model with full employment, whereas Bangladesh suffers structural deficiencies in its labor markets. When we model unemployment explicitly, the FDI increase would not be constrained by the labor endowment and therefore, might intensify its positive welfare effect. In this sense, our aggregate welfare-impact estimates are lower bound estimates. However, welfare estimates for individual household groups would not be self-evident because the increase in labor income depends on the reduction of unemployment in each household, not the changes in wage rates. Nevertheless, our full employment assumption provided us with a benchmark for any extension with unemployment. Second, we assumed that the human resource development was costless, other than the opportunity costs of the transformed unskilled labor. However, any training and education incur pecuniary and nonpecuniary costs in reality. Third, the static nature of our model could not capture the effects of physical and human capital accumulation and productivity changes in the long run. Training and education may need a substantial amount of time; emigrants may return home as the domestic economy develops after several years. Our analysis can be further extended to a dynamic analysis to examine the short-run and long-run effects of factor mobility.

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Appendix A: Aggregation of Social Accounting Matrix

Table A.1: Bangladesh 2012 SAM Accounts

Sectors (no. of original sectors and institutions)	Description of Elements
Industrial Sectors (86)	
Agriculture (20)	Paddy Cultivation, Wheat Cultivation, Other Grain Cultivation, Jute Cultivation, Sugarcane Cultivation, Potato Cultivation, Vegetable Cultivation, Pulses Cultivation, Oilseed Cultivation, Fruit Cultivation, Cotton Cultivation, Tobacco Cultivation, Tea Cultivation, Spice Cultivation, Other Crop Cultivation, Livestock Rearing, Poultry Rearing, Shrimp Farming, Fishing, Forestry
Mining & Quarrying (1)	Mining and Quarrying
Manufacturing (39)	Rice Milling, Grain Milling, Fish Process, Oil Industry, Sweetener Industry, Tea Product, Salt Refining, Food Process, Tanning and Finishing, Leather Industry, Baling, Jute Fabrication, Yarn Industry, Cloth Milling, Handloom Cloth, Dyeing and Bleaching, Woven, Knitting, Toiletries, Cigarette Industry, Bidi Industry, Wood and Cork Product, Furniture Industry, Paper Industry, Printing and Publishing, Pharmaceuticals, Fertiliser Industry, Basic Chemical, Petroleum Refinery, Earth ware Industry, Plastic Products, Glass Industry, Clay Industry, Cement, Basic Metal, Metal, Machinery and Equipments, Transport Equipments, Miscellaneous Industry
Construction (04)	Building, Kutcha House, Agriculture Construction and Other Construction
Electricity, Gas and Water Supply (3)	Electricity, Water Generation, Gas Extraction and Distribution
Trade, and Transport (7)	Wholesale Trade, Retail Trade, Air Transport, Water Transport, Land Transport, Railway Transport, Other Transport,
Services (12)	Housing and Real Estate Service, Health Service, Education Service, Public Administration and Defense, Bank and other Financial Services, Insurance, Professional Service, Entertainment, Hotel and Restaurant, Communication, Other Services, ICT
Factors of Production (4)	
Labor (2)	Labour Unskilled, and Labour Skilled
Capital (2)	Capital and Land
Current Institutions (11)	
Households (8)	Rural: landless, Agricultural marginal, Agricultural small, Agricultural large, Non-farm poor and Non-farm non poor Urban: Low educated heads, and High educated heads
Others (3)	Government, Corporation and Rest of the World
Capital Institution (1)	Investment

Source: Policy Research Institute, 2012, pp. 2-3

Table A2: Mapping between Disaggregated SAM and Aggregated SAM

	Sector	Abbreviation	Comprising Original SAM Sectors
1	Agriculture	AGR	Paddy Cultivation, Wheat Cultivation, Other Grain Cultivation, Jute Cultivation, Sugarcane Cultivation, Potato Cultivation, Vegetable Cultivation, Pulses Cultivation, Oilseed Cultivation, Fruit Cultivation, Tobacco Cultivation, Tea Cultivation, Spice Cultivation, Other Crop Cultivation, Livestock Rearing, Poultry Rearing, Shrimp Farming, Fishing, Forestry
2	Cotton Cultivation	COT	Cotton Cultivation
3	Mining and Quarrying	MIN	Mining and Quarrying
4	Food Products	FOD	Rice Milling, Grain Milling, Fish Process, Oil Industry, Sweetener Industry, Tea Product, Salt Refining, Food Process
5	Textile	TEX	Cloth Milling
6	Ready-Made Garments	RMG	Woven, Knitting
7	Ready-Made Garments hosting MNEs	RMG2	
8	Yarn Industry	YRN	Yarn Industry
9	Paper, Printing and Publishing	PPP	Paper Industry, Printing and Publishing
10	Basic Chemical	CHM	Basic Chemical
11	Metal, Machinery and Equipment	MME	Basic Metal, Metal, Machinery and Equipments
12	Other Manufacturing	OMC	Tanning and Finishing, Leather Industry, Baling, Jute Fabrication, Handloom Cloth, Dyeing and Bleaching, Toiletries, Cigarette Industry, Bidi Industry, Wood and Cork Product, Furniture Industry, Pharmaceuticals, Fertilizer Industry, Petroleum Refinery, Earth ware Industry, Plastic Products, Glass Industry, Clay Industry, Cement, Transport Equipments, Miscellaneous Industry
13	Construction	CON	Building, Kutcha House, Agriculture Construction and Other Construction
14	Power	POW	Electricity, Water Generation, Gas Extraction and Distribution
15	Trade, Transport and Communications	TTC	Wholesale Trade, Retail Trade, Air Transport, Water Transport, Land Transport, Railway Transport, Other Transport,
16	Services	SVC	Housing and Real Estate Service, Health Service, Education Service, Public Administration and Defense, Bank and other Financial Services, Insurance, Professional Service, Entertainment, Hotel and Restaurant, Communication, Other Services, ICT

Appendix B: Sensitivity Analysis

B.1 Sensitivity Analysis with Respect to Skill Premium in Simulation 2

In the first skill development program (simulation 2), we assumed a skill premium of 148 percent. To check the robustness of our results with respect to this assumption, we performed the same simulation (simulation 2) alternatively using premiums that were 30 percentage points higher and 30 percentage points lower. While the sectoral output shows little deviation from the baseline case (Table B1), the welfare estimates of the rural nonagricultural rich households have doubled in value for the higher skill premium case and were very small for the lower skill premium case (Table B2). The urban highly educated households suffer larger losses for the higher skill premium case and smaller losses for the lower skill premium case. The reason for the welfare estimate change for the rural nonagricultural rich household is self-evident. The reason for the latter requires an explanation. The high-skill premium assumption implies that fewer units of skilled labor, which are estimated in the calibration process, exist in the status quo, given the wage incomes reported in the SAM. Even when the number of new skilled workers is the same (*i.e.*, 4,000 workers), their impact becomes larger in the skilled labor market, leading to the larger welfare deterioration in the urban highly educated households. Despite these variations in welfare-impact estimates for the two types of households, our findings are qualitatively robust.

Table B1: Impacts on Sectoral Output Change [Unit: Percentage Change from the Base]

	Baseline Case	30 Percentage Points Higher Skill Premium Case	30 Percentage Points Lower Skill Premium Case
Agriculture	–0.01	0.00	–0.01
Cotton Cultivation	–0.12	–0.12	–0.12
Mining and Quarrying	0.01	0.01	0.01
Food Products	0.00	0.00	0.00
Textile	0.29	0.30	0.29
Ready-Made Garments	–0.53	–0.53	–0.54
Ready-Made Garments hosting MNEs	24.90	24.90	24.89
Yarn Industry	–0.07	–0.06	–0.07
Paper, Printing, and Publishing	–0.05	–0.05	–0.05
Basic Chemical	–0.06	–0.06	–0.06
Metal, Machinery, and Equipment	–0.03	–0.03	–0.03
Other Manufacturing	–0.03	–0.03	–0.03
Construction	0.00	0.00	0.00
Power	0.28	0.28	0.28
Trade, Transport, and Communications	–0.04	–0.04	–0.04
Services	–0.02	–0.02	–0.02

Table B2: Impacts on Household Welfare [Unit: EV in Million BDT]

	Baseline Case	30 Percentage Points Higher Skill Premium Case	30 Percentage Points Lower Skill Premium Case
Rural			
Agricultural landless	67.2	67.3	67.0
Agricultural marginal	34.2	35.3	33.2
Agricultural small	94.4	96.6	92.3
Agricultural large	62.3	64.0	60.8
Nonagricultural poor	123.1	122.7	123.6
Nonagricultural rich	102.5	204.0	5.9
Urban			
Poorly educated	278.3	281.4	275.4
Highly educated	–79.3	–94.3	–65.1

B.2 Sensitivity Analysis with Respect to Labor Migration Premium in Simulation 3

In the second skill development program (simulation 3), we estimated the migration premium to be 187 percent. We also checked the robustness of our results with respect to this assumption by alternatively using migration premiums that were 30 percentage points higher and 30 percentage points lower. The results show no visible difference in the sectoral output changes between the baseline case and higher/lower migration premium cases (Table B3). The welfare of the rural nonagricultural rich households increases/decreases substantially with the higher/lower emigration premium rates (Table B4), but the magnitude of these shifts is smaller than that found in Table B2 with the alternative skill premiums. Little change is found in the impacts on the other seven households.

Table B3: Impacts on Sectoral Output Change [Unit: Percentage Change from the Base]

	Baseline Case	30 Percentage Points Higher Emigration Premium Case	30 Percentage Points Lower Emigration Premium Case
Agriculture	0.00	0.00	0.00
Cotton Cultivation	–0.20	–0.21	–0.19
Mining and Quarrying	0.01	0.01	0.01
Food Products	0.00	0.00	0.00
Textile	0.18	0.17	0.19
Ready-Made Garments	–0.60	–0.61	–0.60
Ready-Made Garments hosting MNEs	24.88	24.88	24.88
Yarn Industry	–0.15	–0.15	–0.14
Paper, Printing, and Publishing	–0.06	–0.06	–0.06
Basic Chemical	–0.08	–0.08	–0.08
Metal, Machinery, and Equipment	–0.03	–0.03	–0.03
Other Manufacturing	–0.04	–0.04	–0.04
Construction	0.00	0.00	0.00
Power	0.26	0.26	0.26
Trade, Transport, and Communications	–0.05	–0.05	–0.05
Services	–0.03	–0.03	–0.03

Table B4: Impacts on Household Welfare [Unit: EV in Million BDT]

	Baseline Case	30 Percentage Points Higher Emigration Premium Case	30 Percentage Points Lower Emigration Premium Case
Rural			
Agricultural landless	67.2	67.3	67.1
Agricultural marginal	28.8	29.2	28.5
Agricultural small	87.6	88.7	86.5
Agricultural large	61.1	62.3	59.9
Nonagricultural poor	130.3	130.7	130
Nonagricultural rich	125.8	212.1	36.8
Urban			
Poorly educated	254.9	255.1	254.8
Highly educated	32.6	31.8	33.5

B.3 Sensitivity Analysis with Respect to Armington Elasticity of Substitution/ Transformation

The results of a CGE analysis often differ according to the assumption of some key parameter values, especially the Armington elasticities of substitution/transformation (σ/ψ). To test the robustness of our simulation results, we performed a sensitivity analysis by considering elasticity of substitution/transformation values that are 30 percent higher and 30 percent lower values than the base values. The results of the sensitivity analysis show that sectoral output does not differ substantially (Table B5). The welfare estimates are only affected marginally by the parameter values (Table B6).

Table B5: Impacts on Sectoral Output Change [Unit: Percentage Change from the Base]

	Baseline Case			30 Percent Higher Elasticity Case			30 Percent Lower Elasticity Case		
	Sim 1	Sim 2	Sim 3	Sim 1	Sim 2	Sim 3	Sim 1	Sim 2	Sim 3
Agriculture	–0.01	–0.01	0.00	–0.01	–0.01	0.00	–0.01	0.00	0.00
Cotton Cultivation	–0.12	–0.12	–0.20	–0.13	–0.13	–0.21	–0.11	–0.11	–0.19
Mining and Quarrying	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Food Products	–0.01	0.00	0.00	–0.01	0.00	0.00	–0.01	0.00	0.00
Textile	0.26	0.29	0.18	0.23	0.26	0.14	0.31	0.33	0.22
Ready-Made Garments	–0.55	–0.53	–0.60	–0.54	–0.53	–0.60	–0.55	–0.54	–0.61
Ready-Made Garments hosting MNEs	24.89	24.90	24.88	24.90	24.90	24.89	24.87	24.88	24.86
Yarn Industry	–0.08	–0.07	–0.15	–0.09	–0.07	–0.15	–0.08	–0.06	–0.15
Paper, Printing, and Publishing	–0.05	–0.05	–0.06	–0.05	–0.05	–0.06	–0.05	–0.05	–0.06
Basic Chemical	–0.07	–0.06	–0.08	–0.07	–0.06	–0.08	–0.06	–0.05	–0.07
Metal, Machinery, and Equipment	–0.03	–0.03	–0.03	–0.03	–0.03	–0.03	–0.03	–0.03	–0.03
Other Manufacturing	–0.04	–0.03	–0.04	–0.04	–0.03	–0.04	–0.04	–0.03	–0.03
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power	0.27	0.28	0.26	0.27	0.28	0.26	0.27	0.27	0.26
Trade, Transport, and Communications	–0.04	–0.04	–0.05	–0.05	–0.04	–0.05	–0.04	–0.04	–0.05
Services	–0.03	–0.02	–0.03	–0.03	–0.02	–0.03	–0.03	–0.02	–0.03

Table B6: Impacts on Household Welfare [Unit: EV in Million BDT]

	Baseline Case			30 Percent Higher Elasticity Case			30 Percent Lower Elasticity Case		
	Sim 1	Sim 2	Sim 3	Sim 1	Sim 2	Sim 3	Sim 1	Sim 2	Sim 3
Rural									
Agricultural landless	55.7	67.2	67.2	53.5	65.2	64.9	59.3	70.6	71.2
Agricultural marginal	19.7	34.2	28.8	18.3	32.8	27.2	22.2	36.7	31.6
Agricultural small	64.8	94.4	87.6	63.1	92.4	85.5	67.9	97.7	91.2
Agricultural large	44.0	62.3	61.1	42.5	60.4	59.1	46.8	65.5	64.5
Nonagricultural poor	112.0	123.1	130.3	109.0	120.2	127.0	117.0	128.1	136.0
Nonagricultural rich	–399.5	102.5	125.8	–402.9	99.4	122.1	–393.1	108.6	132.8
Urban									
Poorly educated	209.2	278.3	254.9	208.4	277.6	254.0	210.4	279.4	256.2
Highly educated	74.0	–79.3	32.6	71.7	–81.1	30.4	77.8	–76.1	36.6

[This Appendix C is for referees' reference, not for publication]

Appendix C: Details of Bangladesh CGE Model

C.1 Sets, Variables, and Parameters

Sets

i_all, j_all	all sectors
i, j	sectors not hosting MNEs
i_MNE, j_MNE	sectors hosting MNEs
h, k	factors of production
$h1, k1$	capital
$h2, k2$	labor and land
r, s	institutions (household and corporation)
$r1, s1$	household

Endogenous variables

Y_{j_all}	composite factor (value added)
F_{h,j_all}	factor input used by all sectors
X_{i_all,j_all}	intermediate input
Z_{j_all}	gross domestic output
X_i^p	household consumption

X_i^g	government consumption
X_i^v	investment demand
E_{i_all}	exports
$M1_i$	imports for local firms' intermediate and final uses
$M2_{i\_all,j\_MNE}$	imports for MNEs' intermediate
Q_i	Armington's composite good
D_{i_all}	domestic good produced by all firms
$D1_i$	domestic good used for Armington's composite good
$D2_{i\_all,j\_MNE}$	domestic good used for composite intermediate inputs for MNEs
P_{h,j_all}^f	factor price
$P_{j\_all}^y$	composite factor price
$P_{j\_all}^z$	supply price of the gross domestic output
P_i^q	Armington's composite good price
P_{i_all,j_MNE}^{q2}	Armington's composite good price of MNEs' intermediate
$P_{i\_all}^e$	export price in local currency
P_i^{m1}	import price for local firms' intermediate and final uses in local currency
P_{i_all,j_MNE}^{m2}	import price for MNEs' intermediate in local currency
$P_{i\_all}^d$	domestic good price
ε	foreign exchange rate (domestic currency/foreign currency)
S_r^p	private savings by household and corporations

S^g	government savings
T_r^d	direct tax revenue
$T_{j\_all}^z$	production tax revenue
T_j^{m1}	import tariff revenue from local firms
T_{i_all,j_MNE}^{m2}	import tariff revenue from MNEs
$T_{j\_all}^s$	production subsidy
T_j^x	export subsidy
G_r^t	government transfer
UU_{r1}	utility of household (fictitious)
SW	Social Welfare

Exogenous variables

$FF_{r,h}$	factor endowment of household
$FFF_{i\_MNE,h}$	primary factor owned by foreigner
S^f	current account deficits in foreign currency term (foreign savings)
R^f	payment of foreign capital service
$P_{i\_all}^{we}$	price of exported goods in foreign currency
$P_{i\_all}^{wm}$	price of imported goods in foreign currency
τ_r^d	direct tax rate on household income
$\tau_{j\_all}^z$	production tax rate
τ_i^{m1}	import tariff rate on local firm's input

$\tau^{m2}_{i\_all,j\_MNE}$	import tariff rate on MNEs intermediate
$\tau^{s}_{i\_all}$	production subsidy rate
$\tau^{x}_{i\_all}$	export subsidy rate
τ^{g}_{r}	government transfer rate to household

Parameters

ax_{i_all,j_all}	input requirement coefficient of intermediate inputs
ay_{j_all}	input requirement coefficient of composite good
$\alpha_{i,r1}$	share coefficient of household for the consumption in the utility function
β_{h,j_all}	share coefficient for the factor used by firm in the composite factor production function.
b_{j_all}	scaling coefficient in the composite factor production function
μ_i	share of goods in government expenditure
λ_i	expenditure share of the goods in total investment
ss^{p}_{r}	average propensity for savings by the household
ss^{g}	average propensity for savings by the government
$\gamma 1_i$	scaling coefficient in the Armington composite good production function
$\gamma 2_{i\_all,j\_MNE}$	scaling coefficient in Armington composite intermediate input production function used by MNEs
$\delta m1_i$, $\delta d1_i$	input share coefficient in Armington composite good production function

$\delta m2_{i\_all,j\_MNE}$, $\delta d2_{i\_all,j\_MNE}$ input share coefficient in Armington composite intermediate input production function

η_{i_all} parameter defined by the elasticity of substitution $\left(\eta_{i\_all} = \frac{\sigma_{i\_all}-1}{\sigma_{i\_all}}, \sigma_{i\_all} \leq 1\right)$

σ_{i_all} elasticity of substitution in the Armington composite good production function $\left(\sigma_{i\_all} = -\frac{d(M_{i\_all}/D_{i\_all})}{M_{i\_all}/D_{i\_all}} / \frac{d(P^m_{i\_all}/P^d_{i\_all})}{P^m_{i\_all}/P^d_{i\_all}}\right)$

θ_{i_all} scaling coefficient in the transformation function

$\xi d_{i\_all}, \xi e_{i\_all}$ share coefficients in the transformation function

ϕ_{i_all} parameter defined by the elasticity of transformation $\left(\phi_{i\_all} = \frac{\psi_{i\_all}+1}{\psi_{i\_all}}, \psi_i \geq 1\right)$

ψ_{i_all} elasticity of transformation in the transformation function $\left(\psi_{i\_all} = -\frac{d(E_{i\_all}/D_{i\_all})}{E_{i\_all}/D_{i\_all}} / \frac{d(P^e_{i\_all}/P^d_{i\_all})}{P^e_{i\_all}/P^d_{i\_all}}\right)$

$\rho_{r,h}$ share of factors by household

C.2 Model

[Domestic Production Block]

$$Y_{j\_all} = b_{j\_all} \prod_h F_{h,j\_all}^{\beta_{h,j\_all}} \qquad \forall\, j\_all, h$$

$$F_{h,j\_all} = \frac{\beta_{h,j\_all} P^y_{j\_all}}{P^f_{h,j\_all}} Y_{j\_all} \qquad \forall\, h, j\_all$$

$$X_{i\_all,j\_all} = ax_{i\_all,j\_all} Z_{j\_all} \qquad \forall\, i\_all, j\_all$$

$$Y_{j\_all} = ay_{j\_all} Z_{j\_all} \qquad \forall\, j\_all$$

$$P_j^z = ay_j P_j^y + \sum_i ax_{i,j}\, P_i^q \qquad \forall\, i, j$$

$$P_{j\_MNE}^z = ay_{j\_MNE} P_{j\_MNE}^y + \sum_{i\_all} ax_{i\_all,j\_MNE}\, P_{i\_all,j\_MNE}^{q2} \qquad \forall\, i\_all, j\_MNE$$

[Government]

$$T_r^d = \tau_r^d \left(\sum_{h1} \left(\sum_j P_{h1,j}^f\, F_{h1,j}\right) \rho_{r,h1} + \sum_{h2} \left(\sum_{j\_all} P_{h2,j\_all}^f\, F_{h2,j\_all}\right) \rho_{r,h2}\right) \quad \forall\, h1, h2, r, j\_all$$

$$T_{j\_all}^z = \tau_{j\_all}^z P_{j\_all}^z Z_{j\_all} \qquad \forall\, j\_all$$

$$T_i^m = \tau_i^{m1} P_i^{m1} M1_i + \sum_{j\_MNE} \tau_{i,j\_MNE}^{m2} P_{i,j\_MNE}^{m2} M2_{i,j\_MNE} \qquad \forall\, i, j\_MNE$$

$$T_{j\_all}^s = \tau_{j\_all}^s P_{j\_all}^z Z_{j\_all} \qquad \forall\, h, j\_all$$

$$T_{j\_all}^x = \tau_{j\_all}^x P_{j\_all}^e E_{j\_all} \qquad \forall\, j\_all$$

$$G_r^t = \tau_r^g \left(\sum_s T_s^d + \sum_{j\_all} T_{j\_all}^z + \sum_j T_j^m + \sum_{j\_all} T_{j\_all}^s + \sum_{j\_all} T_{j\_all}^x\right) \qquad \forall\, r, s, j, j\_all$$

$$X_i^g = \frac{\mu_i}{P_i^q} \left(\sum_r T_r^d + \sum_{j\_all} T_{j\_all}^z + \sum_j T_j^m + \sum_{j\_all} T_{j\_all}^s + \sum_{j\_all} T_{j\_all}^x - \sum_r G_r^t - S^g\right)$$

$$\forall\, i, r, j, j\_all$$

[Investment and Savings]

$$X_i^v = \frac{\lambda_i}{P_i^q} \left(\sum_r S_r^p + S^g + \varepsilon S^f\right) \qquad \forall\, i, r$$

$$S_r^p = ss_r^p \left(\sum_{h1} \left(\sum_j P_{h1,j}^f\, F_{h1,j}\right) \rho_{r,h1} + \sum_{h2} \left(\sum_{j\_all} P_{h2,j\_all}^f\, F_{h2,j\_all}\right) \rho_{r,h2} + G_r^t + \varepsilon R_r^m\right)$$

$$\forall\, r, h1, h2, j, j\_all$$

$$S^g = ss^g \left(\sum_r T_r^d + \sum_{j\_all} T_{j\_all}^z + \sum_j T_j^m + \sum_{j\_all} T_{j\_all}^s + \sum_{j\_all} T_{j\_all}^x\right) \qquad \forall\, r, j, j\_all$$

[Household]

$$X^{p}_{i,r1} = \frac{\alpha_{i,r1}}{P^{q}_{i}}\left(\sum_{h1}\left(\sum_{j} P^{f}_{h1,j} F_{h1,j}\right)\rho_{r1,h1} + \sum_{h2}\left(\sum_{j\_all} P^{f}_{h2,j\_all} F_{h2,j\_all}\right)\rho_{r1,h2} + G^{t}_{r1} + \varepsilon R^{m}_{r1} - S^{p}_{r1} - T^{d}_{r1}\right) \qquad \forall\, i, r1, h1, h2, j\_all$$

[Export and Import price and balance of payment constraint]

$$\left(1 + \tau^{x}_{i\_all}\right)P^{e}_{i\_all} = \varepsilon P^{we}_{i\_all} \qquad \forall\, i\_all$$

$$P^{m1}_{i} = \varepsilon P^{wm1}_{i} \qquad \forall\, i$$

$$P^{m2}_{i\_all,j\_MNE} = \varepsilon P^{wm2}_{i\_all,j\_MNE} \qquad \forall\, i\_all, j\_MNE$$

$$\sum_{i\_all} P^{we}_{i\_all} E_{i\_all} + \sum_{r} R^{m}_{r} + S^{f} - \sum_{h1,j\_MNE} \frac{P^{f}_{h1,j\_MNE}}{\varepsilon} FFF_{j\_MNE,h1} = \sum_{i} P^{wm1}_{i} M1_{i} + \sum_{i\_all,j\_MNE} P^{wm2}_{i\_all,j\_MNE} M2_{i\_all,j\_MNE} \qquad \forall\, i\_all, r, h1, j\_MNE$$

[Substitution between Import and Domestic Good]

$$Q_{i} = \gamma 1_{i}\left(\delta m1_{i} M1^{\eta_i}_{i} + \delta d1_{i} D1^{\eta_i}_{i}\right)^{\frac{1}{\eta_i}} \qquad \forall\, i$$

$$M1_{i} = \left(\frac{\gamma 1^{\eta_i}_{i}\delta m1_{i} P^{q}_{i}}{\left(1+\tau^{m1}_{i}\right)P^{m1}_{i}}\right)^{\frac{1}{1-\eta_i}} Q_{i} \qquad \forall\, i$$

$$D1_{i} = \left(\frac{\gamma 1^{\eta_i}_{i}\delta d1_{i} P^{q}_{i}}{P^{d}_{i}}\right)^{\frac{1}{1-\eta_i}} Q_{i} \qquad \forall\, i$$

$$X_{i\_all,j\_MNE} = \gamma 2_{i\_all,j\_MNE}\left(\delta m2_{i\_all,j\_MNE} M2^{\eta_{i\_all}}_{i\_all,j\_MNE} + \delta d2_{i\_all,j\_MNE} D2^{\eta_i}_{i\_all,j\_MNE}\right)^{\frac{1}{\eta_{i\_all}}} \qquad \forall\, i\_all, j\_MNE$$

$$M2_{i\_all,j\_MNE} = \left(\frac{\gamma 2^{\eta_{i\_all}}_{i\_all,j\_MNE}\delta m2_{i\_all,j\_MNE} P^{q2}_{i\_all,j\_MNE}}{\left(1+\tau^{m2}_{i\_all,j\_MNE}\right)P^{m2}_{i\_all,j\_MNE}}\right)^{\frac{1}{1-\eta_{i\_all}}} X_{i\_all,j\_MNE} \qquad \forall\, i\_all, j\_MNE$$

$$D2_{i\_all,j\_MNE} = \left(\frac{\gamma 2_{i\_all,j\_MNE}^{\eta_{i\_all}} \delta d2_{i\_all,j\_MNE} P_{i\_all,j\_MNE}^{q2}}{P_{i\_all}^{d}}\right)^{\frac{1}{1-\eta_{i\_all}}} X_{i\_all,j\_MNE} \qquad \forall\, i\_all, j\_MNE$$

[Transformation between Export and Domestic Goods]

$$Z_{i\_all} = \theta_{i\_all}\left(\xi e_{i\_all} E_{i\_all}^{\phi_{i\_all}} + \xi d_{i\_all} D_{i\_all}^{\phi_{i\_all}}\right)^{\frac{1}{\phi_{i\_all}}} \qquad \forall\, i\_all$$

$$E_{i\_all} = \left(\frac{\theta_{i\_all}^{\phi_{i\_all}} \xi e_{i_{all}} (1+\tau_{i\_all}^{z}+\tau_{i\_all}^{s}) P_{i\_all}^{z}}{P_{i\_all}^{e}}\right)^{\frac{1}{1-\phi_{i\_all}}} Z_{i\_all} \qquad \forall\, i\_all$$

$$D_{i\_all} = \left(\frac{\theta_{i\_all}^{\phi_{i\_all}} \xi d_{i\_all} (1+\tau_{i\_all}^{z}+\tau_{i\_all}^{s}) P_{i\_all}^{z}}{P_{i\_all}^{d}}\right)^{\frac{1}{1-\phi_{i\_all}}} Z_{i\_all} \qquad \forall\, i\_all$$

[Market Clearing Conditions]

$$Q_i = \sum_{r1} X_{i,r1}^{p} + X_i^{g} + X_i^{v} + \sum_j X_{i,j} \qquad \forall\, i, j, r1$$

$$D_i = D1_i + \sum_{j\_MNE} D2_{i,j\_MNE} \qquad \forall\, i, j\_MNE$$

$$D_{i\_MNE} = \sum_{j\_MNE} D2_{i\_MNE,j\_MNE} \qquad \forall\, i\_MNE, j\_MNE$$

$$\sum_{j\_MNE} F_{h1,j\_MNE} = \sum_{j\_MNE} FFF_{J\_MNE,h1} \qquad \forall\, h1, j\_MNE$$

$$\sum_{j\_all} F_{h2,j\_all} = \sum_r FF_{r,h2} \qquad \forall\, j\_all, h2, r$$

[Price Equalization Conditions]

$$P_{h2,i\_all}^{f} = P_{h2,j\_all}^{f} \qquad \forall\, h2, j\_all$$

$$P_{h1,i}^{f} = P_{h1,j}^{f} \qquad \forall\, h1, i, j$$

$$P^{f}_{h1,i\_MNE} = P^{f}_{h1,j\_MNE} \qquad \forall\, h1, i\_all, j\_MNE$$

[Utility and Fictitious Objective Function (Social Welfare)]

$$UU_{r1} = \prod_i {X^{p}_{i,r1}}^{\alpha_{i,r1}} \qquad \forall\, i, r1$$

$$SW = \sum_{r1} UU_{r1} \qquad \forall\, r1$$