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Foreign Direct Investment in the Readymade Garment Sector of Bangladesh: Macro and Distributional Implications

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Bangladesh, a labour-abundant country, benefits from foreign direct investment (FDI), as it is considered to be a supplement to domestic investment for this capital-scarce economy. This paper measures the impacts of an FDI increase in the RMG sector on the macroeconomy in Bangladesh and on the welfare of households, which are heterogeneous, especially in income sources, using a general equilibrium framework. Simulation results show 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 programmes targeted at the adversely affected household groups.

Keywords: Bangladesh, Readymade Garment, Foreign Direct Investment, Computable General Equilibrium Analysis, Distributional Impact

JEL Classification: C68, F21, F23, O1

I. INTRODUCTION

Foreign direct investment (FDI) is a major component of cross-border factor mobility in the current globalised world and is anticipated to accelerate economic growth by relaxing capital constraints (Mallick and Moore 2008) and alleviating poverty (Gohou and Soumaré 2012, Ucal 2014), which are particularly serious in

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developing countries. This anticipation has been reflected in recent policies in Bangladesh to establish a business-friendly market environment for foreign investors. Being a labour-abundant country, Bangladesh is expected to benefit from FDI as it is considered a supplement to domestic investment. The country has been adopting policies to liberalise its investment regime through various incentive measures to attract foreign investors to its major industries.

The readymade garment (RMG) sector is the most important manufacturing sector in Bangladesh. It accounted for 84 per cent of total exports and 11 per cent of gross domestic product (GDP) in 2018 (Export Promotion Bureau Database, Bangladesh Bureau of Statistics 2018). Around four million workers are employed in this sector; among them, 50 per cent are from rural areas (Bangladesh Bureau of Statistics 2018). More than 20 million people in Bangladesh are dependent on this sector for their livelihood (International Finance Corporation 2016). The RMG sector has contributed to a reduction in poverty and inequality in the country by creating many employment opportunities, especially for unskilled workers (Razzaque and Eusuf 2008, International Labour Organization 2013). Considering its large contribution, further expansion of the RMG sector by attracting FDI and accelerating its ongoing development has received enormous attention in Bangladesh. The large RMG sector in Bangladesh, however, cannot fully utilise the abundant labour force. The surplus-labour emigrates abroad and sends home a large amount of remittances.

While local firms currently dominate the RMG sector, it was initially established by joint venture agreements with multinational enterprises (MNEs) in the 1980s (Alam and Natsuda 2016). The number of MNEs in the industry has decreased because of restrictive government policies and poor infrastructures in recent decades; domestic firms now produce around 95 per cent of RMG output in Bangladesh (Kee 2015). This is reflected by the low rankings in the World Bank's ease of doing business index. The poor business environment increases pecuniary and non- pecuniary operation costs and makes MNEs switch their investment destinations to other countries. The total FDI inflow was historically very low at 3.6 per cent of the country's gross capital formation in 2016 (UNCTAD 2017). The average FDI–GDP ratio for 2011–2015 shows that Bangladesh is ranked 149 among 179 countries (Raihan and Ashraf 2016). Among this low level of FDI inflow, the largest share, around 20 per cent of the total inflow in 2016, is attracted by the textile and RMG sector in Bangladesh (Bangladesh Bank 2016). 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 the FDI mainly allocated by the current major FDI source countries.

The studies on FDI in Bangladesh mainly analysed its impacts on economic growth and found it positive (Ahmad 1990, Dutta, Haider, and Das 2017), and often ambiguous (Kabir 2007, Shimul, Abdullah, and Siddiqua 2009, Islam and Meerza 2013). Most of these studies used aggregate FDI data and reduced-form models; sector-level FDI data and structural models are rarely used. Arguing that using aggregate FDI data might blur the effects of FDI and lead to ambiguous results, 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. Kee (2015) analysed 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)? In the context of Bangladesh with an abundant labour force, 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 abovementioned dilemmas in Bangladesh.

In this paper, we develop a computable general equilibrium (CGE) model for Bangladesh that describes a competition between local firms and MNEs in the RMG sector and the distributional impacts of FDI among households and then simulate an FDI increase.[1] Our simulation exercise for Bangladesh shows that a positive FDI shock would increase both its output and exports, leading to 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.

[1]Considering the main objective of this paper, we only focus on the RMG sector assuming that FDI in this major labour-intensive manufacturing sector vis-à-vis other sectors has significant effects on the macroeconomy (Wang 2009), as well as household welfare and its distribution among households. We did not examine the impacts of FDI on other sectors because of the data availability constraints associated with the sales and sourcing patterns of MNEs and local firms covering a wider range of industries.

The remainder of the paper is structured as follows. Section II describes the methodological approach, data, and simulation scenarios. Section III presents the simulation results while Section IV concludes the paper.

II. 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, Gasawa, and Hashimoto (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, agricultural–non-agricultural, landowner–landless, rich–poor). It allows us to depict precisely 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[2]

In our CGE model, a composite factor is produced by employing all factors of production using a Cobb–Douglas-type production function. Domestic output is produced using the composite factor and intermediate inputs using a Leontief-type production function. A constant elasticity of transformation (CET) function is assumed to describe the transformation of domestic output into exports and

[2] The details of the Bangladesh CGE model are provided in Appendix B.

domestic goods. Domestic goods are combined with imports to produce Armington composite goods with constant elasticity of substitution (CES) production function. The Armington composite goods produced by local firms are used as both final goods and intermediate inputs; those produced by the RMG MNEs are used only as intermediate inputs for the MNEs, reflecting the Bangladeshi data reporting that the RMG MNEs supply little for final demand. The Armington composite goods are used as intermediate inputs by domestic industries, consumed by the households and government, and used for investment. Household utility depends on household consumption.

In our model, household incomes are generated from factor incomes, government transfers, and foreign remittances. We distinguish five factors (local and foreign capital, skilled and unskilled labour, and land[3]) and 15 industrial sectors. 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.[4]

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 Model Estimation

The model is calibrated to the Bangladesh social accounting matrix (SAM) for 2012, constructed by the Bangladesh Planning Commission, with Armington elasticities of substitution and transformation provided by the GTAP version 9 database (Hertel 1997). This SAM has 86 sectors and is aggregated into 15 sectors, RMG plus 14 other sectors, for our FDI simulation.

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[3] Although we distinguish land as one of the factors of production, the SAM reports that land is used only by the agriculture and cotton sectors. The calibrated share parameter for land input in the Cobb–Douglas-type production function is zero in non-agricultural sectors; our model assumes that they use no land for production.

[4] 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.

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 modelling exercise focusing on FDI incidence. To split the RMG sector, sales and sourcing patterns of MNEs obtained from Kee (2015) are used as weights for the estimation of the MNEs' inputs and outputs in the RMG sector. We assume that the share of sales and exports of MNEs is 5.5 and 5.6 per cent 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 per cent, according to the survey by Kee (2015). The MNEs' input coefficients, which determine their backward linkages, are assumed to be similar to those of local firms. In our CGE model, we distinguish eight household categories reported in the original Bangladesh SAM 2012.

2.1.3 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. It leads to more competition between the MNEs and local firms in output and labour markets. Local firms would lose their sales in the output market. Local firms are also harmed in the labour market as the increased labour demand by the MNEs increases wage rates. As the increases in the MNEs' output and exports are likely to exceed the contraction in the output and exports of local firms, aggregate RMG output and exports would increase. It would relax the balance of payment constraints 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 Simulation Scenarios

We set three simulation scenarios to analyse 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 per cent. Simulation 2 uses the assumption in simulation 1, plus a skill development programme that equips unskilled labour of rural non-agricultural rich households with skills equivalent to those skilled labour possesses. Simulation 3 uses the assumption in simulation 1 plus a foreign-worker training programme that makes the unskilled labour of the same household emigrate abroad for higher wages. Details of these scenarios are provided below.

2.2.1 FDI Increase

In scenario 1, we assume an FDI stock increase in the RMG sector of 25 per cent, which is comparable to a 0.035 per cent 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. Out of 190 countries in 2017, the country's rank was very low at 176 (World Bank 2017).[5] 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. It 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). The time required to get a permanent electricity connection is 429 days in Bangladesh, compared with only 46 days in India and Vietnam, 59 days in Indonesia, and 31 days in Malaysia (World Bank *World Development Indicators*). This reflects Bangladesh's very poor energy infrastructure, which is one of the main impediments to attracting FDI. Another constraint to FDI inflow in Bangladesh is access to land to start a new business, particularly when investing in the manufacturing sector. The time required to register a property in Bangladesh is 244 days, whereas it takes only 47, 51, and 25 in India, Sri Lanka, and Indonesia, respectively. The difficulties with the land transfer and the land administration systems in Bangladesh have resulted in a rank of 185 (World Bank Doing Business Database).

In our experiment, we assume that the Bangladesh government implements reforms in these areas, so the country can improve its rank to 126, which is comparable to the ranks of countries such as Vietnam, Sri Lanka, and India.[6] Given this target, we estimate the magnitude of the FDI increase achieved in the improved

[5] 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).

[6] The government sets the target of positioning Bangladesh among the top 100 countries in the World Bank's ease of doing business rank (Independent 2018). This target is much higher than in our analysis.

business environment.[7] 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 a 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 per cent. Based on their estimate, our policy goal will increase the FDI stock by around 25 per cent.[8] It is the rationale for our assumption of a 25 per cent 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.[9]

2.2.2 Human Resource Development Programmes

As discussed below, the results of simulation 1 show that rural non-agricultural rich households would be adversely affected by the FDI increase. To mitigate this adverse impact, we consider two hypothetical skill development programmes targeting rural non-agricultural rich households. In the first programme, 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 per cent, that is, 10,206 Bangladeshi taka (BDT) per month per worker, based on the Bangladesh labour force survey and the SAM.[10] This skill

[7] Improvements in the business environment incur some pecuniary and nonpecuniary costs. As direct estimates of these costs are unavailable, we instead provide the total costs of the Bangladesh Export Processing Zones Authority (2018), which was around 3.1 billion BDT in the fiscal year 2018. That budget accounts for only 0.07 per cent of the government budget. Thus, we do not describe it in the model explicitly.

[8] FDI in the RMG sector in Bangladesh is mostly attracted into the export processing zones (EPZs) and it is often argued that MNEs in the EPZs are inherently "footloose," *i.e.,* they instantaneously relocate their plants in response to the changes in the host country's environment (Görg and Strobl 2003). We follow earlier studies that use the ease of doing business index for cross-country analysis, although the index is not the only or perfect indicator to explain the host country's environment. We are open to various methodologies that are consistent with our assumptions and hope to employ some alternative measures of FDI attractiveness, which may predict different impacts on the volume of FDI inflows.

[9] 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.

[10] To compute the changes in endowment income resulting from the proposed programme, the share of skilled and unskilled labour in Bangladesh is calculated based on the World Bank (2013). These are 28.5 per cent and 71.5 per cent, respectively. Using the data of the

transformation increases the skilled labour wages of rural non-agricultural rich households by around 821 million BDT, which is 0.4 per cent of their skilled labour endowment. At the same time, when 4,000 unskilled workers become skilled, these households sacrifice unskilled labour wages of around 332 million BDT, comparable to 0.1 per cent of their unskilled labour endowment. Simulation 2 incorporates these endowment changes, along with the 25 per cent increase in the FDI stock in the RMG sector assumed in simulation 1.

In the second human resource development programme, the same number of unskilled workers of rural non-agricultural rich households is assumed to be given the training to emigrate and work abroad for a migration premium; the premium is estimated to be 187 per cent or 12,956 BDT per month per migrant worker. Based on our assumed migration premium, by getting jobs in international labour markets, the remittance earnings of these households would increase by 954 million BDT (or 0.09 per cent of their total remittance receipt) at the sacrifice of the same amount of unskilled labour wages as in simulation 2.[11] Simulation 3 incorporates these endowment changes and remittance receipts, which are exogenous in BDT, in addition to the FDI stock increase assumed in simulation 1.

We ignore the costs of these programmes. While this assumption may seem too simple, it could be found permissible considering the following simulation context. First, the assumed number of trainees is only 0.6 per cent of total enrolments of formal training programmes in Bangladesh (Asian Development Bank 2016). Second, many of those training programmes are provided as part of various skill development projects financed by development partners, such as the World Bank and the Asian Development Bank (ADB). Therefore, we do not expect that our simplifying assumption could affect our macroeconomic simulation results substantially.

working labour force from the Ministry of Finance (2014) and total skilled and unskilled labour wages from the Bangladesh SAM 2012, the average skill premium is calculated as 10,206 BDT per month per worker.

[11] 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 programmes, we conducted a sensitivity analysis.

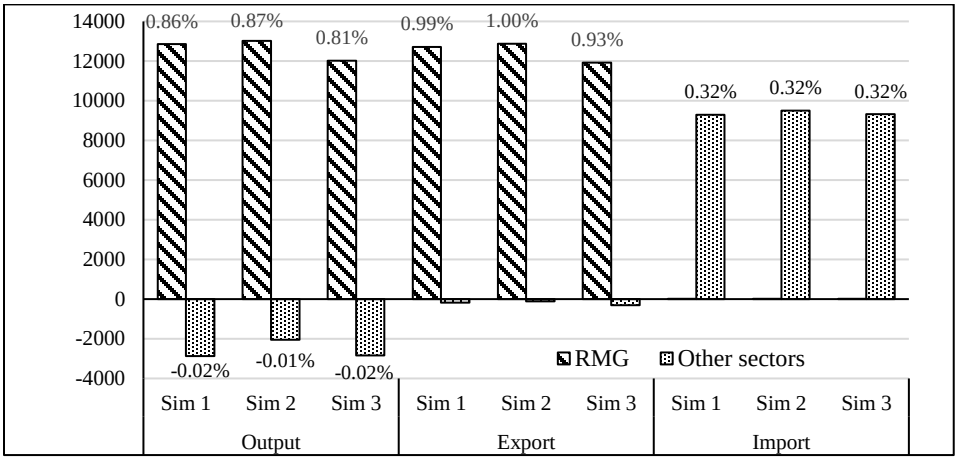
III. SIMULATION RESULTS

3.1 Sectoral Impact of FDI Increase

The 25 per cent FDI stock increase (simulation 1) would expand the total production of the RMG sector by 0.9 per cent from the base quantity (Figure 1).[12] Because the RMG sector is highly export-oriented, its output increase is almost entirely exported. Expansion of the RMG sector can occur by mobilising resources, especially labour, from other sectors, and thus leads to a contraction of output in the other sectors by 0.02 per cent. The decrease in domestic production of these other sectors is compensated for by the increased imports of 0.3 per cent made possible by the increase in RMG exports and the induced appreciation of the BDT.

Figure 1: **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.

The output and export expansion in the RMG sector would not occur uniformly between the MNEs and domestic firms. In all three scenarios, while MNE output and exports would increase significantly by 25 per cent, by as much as the magnitude of the FDI increase, domestic firms would experience a slight contraction. It happens because the increase in FDI makes MNEs more aggressive, both in the factor and output markets, and captures some of the market shares of the domestic firms. However, the gains by MNEs dominate the losses by domestic

[12]All the value variables, such as output, exports, and GDP, are measured using the constant prices of the base run equilibrium. Land is chosen as a numeraire, and all the prices are expressed relative to the numeraire price.

firms, so that overall RMG output would expand, as shown in Figure 1. This differential outcome of FDI promotion between MNEs and domestic firms is observed in many other developing countries (Aitken and Harrison 1999, Jeon and Ahn 2004, Konara and Wei 2016).

Our simulation results also show that the increase in the FDI stock in the RMG sector also affects the output of the other 14 sectors in different ways. While output in many sectors would decline, the textile and power sectors would experience an output gain through backward linkages with the RMG sector. In addition to the backward linkages, differences in factor intensity also explain the variation of the output changes among sectors. As the FDI stock increase would make labour less readily available, labour-intensive sectors, especially service sectors, would contract significantly.

3.2 Macro Impact of FDI Increase

In simulation 1, the increase of the foreign capital stock by 25 per cent would increase the country's real GDP by 0.05 per cent (Figure 2). 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.[13] This is because the increase of the RMG MNEs negatively affects the other sectors, especially the domestic RMG firms, which employ a large amount of domestic capital.

[13] The magnitude of the rental price fall of foreign capital in the RMG MNEs might be too small in light of the assumed large shock in the foreign capital stocks. This is achieved by mobilising labour input from other sectors so as to fully utilise the increased foreign capital.

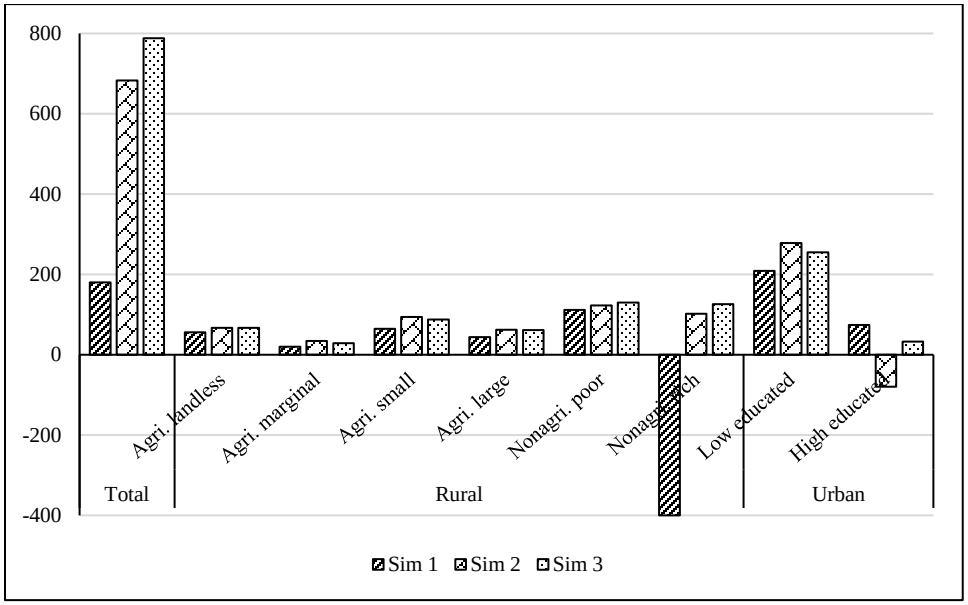
Figure 2: **Impact on Real GDP and Factor Prices**
[Unit: Percentage Change from the Base]

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 (Figure 3). This welfare impact can be broken down into eight individual household groups. The breakdown shows that all the household groups would experience a positive welfare gain, except the rural non-agricultural rich households, which suffer a welfare loss of 400 million BDT. According to the data reported in the SAM, this household group is highly dependent on domestic capital income (55 per cent of total income), whose return is predicted to fall around 0.04 per cent in simulation 1 (Figure 2).

Figure 3: **Changes in Household Welfare [Unit: EV in Million BDT]**



3.4 Human Capital Development Programmes

From the viewpoint of distributional equity of the 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.[14] In simulations 2 and 3, we assume two skill development programmes targeted at rural non-agricultural rich households to alleviate the abovementioned adverse impacts on them. The results show that these human capital development programmes enable these households to earn wage premiums in the skilled and foreign labour markets. In simulation 2, rural non-agricultural rich households would become net welfare gainers (Figure 3). 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 labour supplied by rural non-agricultural rich households. As shown in Figure 2, the gain in the skilled labour wage, on which these households are heavily dependent, would almost disappear.

[14]The new allocation demonstrated in simulation 1, which harms rural non-agricultural 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 too favourable 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.

When training is provided for foreign labour markets (simulation 3), such a negative effect on the skilled wage rate is not experienced by urban highly educated households (Figure 2). The human capital development programme for foreign labour markets ensures an equitable distribution of gains in society (Figure 3). While urban highly educated households experience a positive gain, the other seven household groups would enjoy a gain comparable to that in simulation 2.[15] Needless to say, instead of the training programmes, a cash transfer programme from the gainers to the losers can be an alternative and efficient solution, if available.

In terms of sectoral output (Figure 1), 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 1). This is partly because the emigration promoted by the skill development programme reduces the domestic endowment of unskilled workers and partly because the programme increases remittances, which leads to an appreciation of the BDT and thus reduces RMG exports.

3.5 Sensitivity Analysis

3.5.1 Sensitivity Analysis with respect to Skill Premium in Simulation 2

In the first skill development programme (simulation 2), we assumed a skill premium of 148 per cent. 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. The welfare estimates of the rural non-agricultural rich households have doubled in value for the higher skill premium case and were very small for the lower skill premium case; the urban highly-educated households suffer larger losses for the higher skill premium case and smaller losses for the lower skill premium case (Table I). While the reason for the welfare change for the rural non-agricultural rich household is self-evident, the latter requires an explanation. The high-skill premium assumption implies that fewer units of skilled labour, which are estimated in the calibration process, exist in the status quo, given the wage

[15] 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 realised for these households. However, our assumption about the migration premium would not substantially affect the welfare estimates of these households in simulation 3. For details, see the sensitivity analysis.

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 labour market, leading to the larger welfare deterioration in the urban highly- educated households. The sectoral output shows little deviation from the baseline case (Appendix Table A1). Our findings are qualitatively robust despite the variations in the welfare-impact estimates for the two types of households.

TABLE I
IMPACTS ON HOUSEHOLD WELFARE WITH HIGHER AND LOWER SKILL AND EMIGRATION PREMIUM [UNIT: EV IN MILLION BDT]

	Skill premium			Emigration premium		
	Base	30 percentage points higher	30 percentage points lower	Base	30 percentage points higher	30 percentage points lower
Rural						
Agricultural landless	67.2	67.3	67.0	67.2	67.3	67.1
Agricultural marginal	34.2	35.3	33.2	28.8	29.2	28.5
Agricultural small	94.4	96.6	92.3	87.6	88.7	86.5
Agricultural large	62.3	64.0	60.8	61.1	62.3	59.9
Nonagricultural poor	123.1	122.7	123.6	130.3	130.7	130
Nonagricultural rich	102.5	204.0	5.9	125.8	212.1	36.8
Urban						
Poorly educated	278.3	281.4	275.4	254.9	255.1	254.8
Highly educated	–79.3	–94.3	–65.1	32.6	31.8	33.5

3.5.2 Sensitivity Analysis with respect to Labour Migration Premium in Simulation 3

In the second skill development programme (simulation 3), we estimated the migration premium to be 187 per cent. 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 welfare of the rural non-agricultural rich households increases/decreases substantially with the higher/lower emigration premium rates, but the magnitude of these shifts is smaller than that found with the alternative skill premiums (Table I). Little change is found in the impacts on the other seven household types. The results also show no visible differences in the sectoral output changes between the baseline case and higher/lower migration premium cases (Appendix Table A2).

3.5.3 Sensitivity Analysis with respect to Armington Elasticities 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 the elasticity of substitution/transformation values that are 30 per cent higher and 30 per cent lower than the base values. The sensitivity analysis results show that sectoral output does not differ substantially (Appendix Table A3). The welfare estimates are only affected marginally by the parameter values (Appendix Table A4).

IV. CONCLUSIONS

This paper attempts to measure the impacts of an FDI increase in the RMG sector on the macroeconomy in Bangladesh and on the welfare of households, which are heterogeneous, especially in income sources, using a general equilibrium framework. Our simulations demonstrates that the FDI stock increase in the RMG sector would increase both its output and exports. It would then lead to an overall welfare gain of 180 million BDT and a GDP increase of 0.05 per cent. 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 due to a deterioration of its (domestic) capital income.

To ensure an equitable distribution of the benefits among household groups, we considered two skill development programmes that improve the human capital of the adversely affected household group. One programme, converting unskilled labour to skilled labour in the 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 programme, providing training for emigrant workers, would not make any household worse off but may achieve a smaller domestic production gain because the programme allows the labour force to go abroad in exchange for remittances.

Our study has some limitations. First, we used a static model with full employment, whereas Bangladesh suffers structural deficiencies in its labour markets. When we model unemployment explicitly, the FDI increase would not be constrained by the labour endowment and, therefore, might intensify its positive welfare effect. However, welfare estimates for individual household groups would not be self-evident because the increase in labour 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 skill development programmes were costless, other than the opportunity costs of the transformed unskilled labour, given our simulation context that only a small fraction of the labour force enrols.

The costs need to be considered explicitly when this type of policy intervention becomes large scale. Third, we examined the impacts of FDI in the RMG sector because of data availability constraints in other sectors. Survey data on sales and sourcing patterns of MNEs and local firms that cover a wider range of industries would allow us to examine the impacts of sector-specific FDI more intensely. Finally, 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 for examining the short-run and long-run effects of factor mobility.

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Appendix A: Tables of Sensitivity Analysis

Table A1: **Impacts on Sectoral Output Change with Higher and Lower Skill Premium [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 A2: **Impacts on Sectoral Output Change with Higher and Lower Emigration Premium [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 A3: **Impacts on Sectoral Output Change with Higher and Lower Elasticities of Substitution/Transformation [Unit: Percentage Change from the Base]**

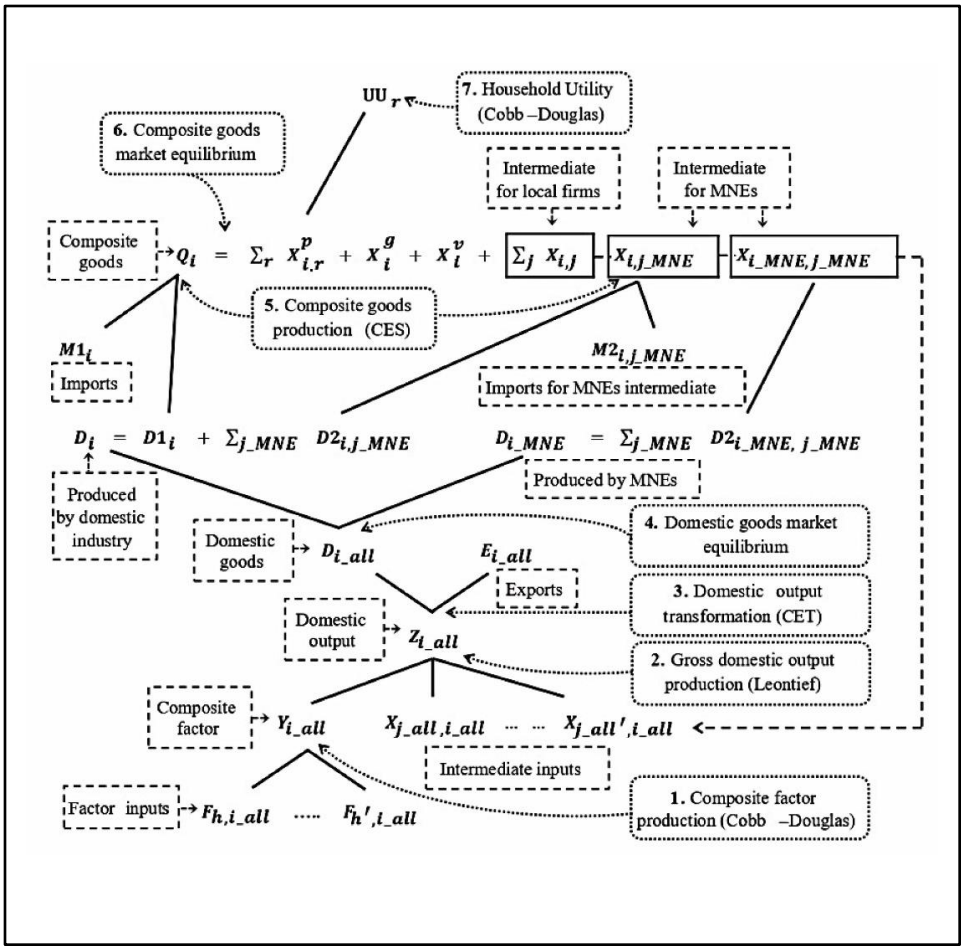
	Baseline case			30 per cent higher elasticity case			30 per cent lower elasticity case		
	Sim 1	Sim 2	Sim 3	Sim 1	Sim 2	Sim 3	Sim 1	Sim 2	Sim 3
Agriculture	–0.01	–0.01	0.00	–0.01	–0.01	0.00	–0.01	0.00	0.00
Cotton Cultivation	–0.12	–0.12	–0.20	–0.13	–0.13	–0.21	–0.11	–0.11	–0.19
Mining and Quarrying	0.01	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 Mfg.	–0.04	–0.03	–0.04	–0.04	–0.03	–0.04	–0.04	–0.03	–0.03
Construct-ion	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 Commni-cations	–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 A4: **Impacts on Household Welfare with Higher and Lower Elasticities of Substitution/Transformation [Unit: EV in Million BDT]**

	Baseline case			30 per cent higher elasticity case			30 per cent 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

Appendix B: Model Details

Structure of the Bangladesh CGE Model



Functional Form of Bangladesh CGE Model

Sets, Variable, 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^f_{h,j_all}	factor price
$P^y_{j\_all}$	composite factor price
$P^z_{j\_all}$	supply price of the gross domestic output
P^q_i	Armington's composite good price
$P^{q2}_{i\_all,j\_MNE}$	Armington's composite good price of MNEs' intermediate
$P^e_{i\_all}$	export price in local currency
P^{m1}_i	import price for local firms' intermediate and final uses in local currency
$P^{m2}_{i\_all,j\_MNE}$	import price for MNEs' intermediate in local currency
$P^d_{i\_all}$	domestic good price
ε	foreign exchange rate (domestic currency/foreign currency)
S^p_r	private savings by household and corporations
S^g	government savings
T^d_r	direct tax revenue
$T^z_{j\_all}$	production tax revenue
T^{m1}_j	import tariff revenue from local firms

$T^{m2}_{i\_all,j\_MNE}$	import tariff revenue from MNEs
$T^{s}_{j\_all}$	production subsidy
T^{x}_{j}	export subsidy
G^{t}_{r}	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
R^{m}	remittances
S^{f}	current account deficits in foreign currency term (foreign savings)
R^{f}	payment of foreign capital service
$P^{we}_{i\_all}$	price of exported goods in foreign currency
$P^{wm}_{i\_all}$	price of imported goods in foreign currency
τ^{d}_{r}	direct tax rate on household income
$\tau^{z}_{j\_all}$	production tax rate
τ^{m1}_{i}	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_r^p	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

Model

[Domestic Production Block]

Composite factor production function

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

Factor demand function

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

Intermediate input demand function

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

Composite factor demand function

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

Unit cost function for gross domestic output for the local firm sector

$$P^z_j = ay_j P^y_j + \sum_i ax_{i,j} P^q_i \qquad \forall\ j$$

Unit cost function for gross domestic output for the MNE sector

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

[Government]

Direct tax revenue function

$$T^{d}_{r} = \tau^{d}_{r}\left(\sum_{h1}\left(\sum_{j} P^{f}_{h1,j} F_{h1,j}\right)\rho_{r,h1} + \sum_{h2}\left(\sum_{j\_all} P^{f}_{h2,j\_all} F_{h2,j\_all}\right)\rho_{r,h2}\right) \qquad \forall\, r$$

Production tax revenue function

$$T^{z}_{j\_all} = \tau^{z}_{j\_all} P^{z}_{j\_all} Z_{j\_all} \qquad \forall\, j\_all$$

Import tariff revenue function

$$T^{m}_{i} = \tau^{m1}_{i} P^{m1}_{i} M1_{i} + \sum_{j\_MNE} \tau^{m2}_{i,j\_MNE} P^{m2}_{i,j\_MNE} M2_{i,j\_MNE} \qquad \forall\, i$$

Government subsidy expense function

$$T^{s}_{j\_all} = \tau^{s}_{j\_all} P^{z}_{j\_all} Z_{j\_all} \qquad \forall\ j\_all$$

Export subsidy expense function

$$T^{x}_{j\_all} = \tau^{x}_{j\_all} P^{e}_{j\_all} E_{j\_all} \qquad \forall\, j\_all$$

Government transfer expense function

$$G^{t}_{r} = \tau^{g}_{r}\left(\sum_{s} T^{d}_{s} + \sum_{j\_all} T^{z}_{j\_all} + \sum_{j} T^{m}_{j} + \sum_{j\_all} T^{s}_{j\_all} + \sum_{j\_all} T^{x}_{j\_all}\right) \qquad \forall\, r$$

Government demand function

$$X^{g}_{i} = \frac{\mu_{i}}{P^{q}_{i}}\left(\sum_{r} T^{d}_{r} + \sum_{j\_all} T^{z}_{j\_all} + \sum_{j} T^{m}_{j} + \sum_{j\_all} T^{s}_{j\_all} + \sum_{j\_all} T^{x}_{j\_all} - \sum_{r} G^{t}_{r} - S^{g}\right) \qquad \forall\, i$$

[Investment and Savings]

Investment demand function

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

Household savings function

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

Government savings function

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

[Household]

Household demand function

$$X_{i,r1}^p = \frac{\alpha_{i,r1}}{P_i^q}\left(\sum_{h1}\left(\sum_j P_{h1,j}^f F_{h1,j}\right)\rho_{r1,h1} + \sum_{h2}\left(\sum_{j\_all} P_{h2,j\_all}^f F_{h2,j\_all}\right)\rho_{r1,h2} + G_{r1}^t + \varepsilon R_{r1}^m - S_{r1}^p - T_{r1}^d\right) \qquad \forall\, i, r1$$

[Export and Import price and balance of payment constraint]

Export price conversion function

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

Import price conversion function

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

Import price conversion function for MNEs intermediate inputs

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

Balance of payment constraint

$$\sum_{i\_all} P^{we}_{i\_all} E_{i\_all} + \sum_r R^m_r + S^f - \sum_{h1,j\_MNE} \frac{P^f_{h1,j\_MNE}}{\varepsilon} FFF_{j\_MNE,h1} = \sum_i P^{wm1}_i M1_i + \sum_{i\_all,j\_MNE} P^{wm2}_{i\_all,j\_MNE} M2_{i\_all,j\_MNE}$$

[Substitution between Import and Domestic Good]

Armington composite good production function

$$Q_i = \gamma 1_i \left(\delta m1_i M1_i^{\eta_i} + \delta d1_i D1_i^{\eta_i}\right)^{\frac{1}{\eta_i}} \qquad \forall\, i$$

Import demand function for local firms' intermediate and final uses

$$M1_i = \left(\frac{\gamma 1_i^{\eta_i} \delta m1_i P_i^q}{(1+\tau_i^{m1}) P_i^{m1}}\right)^{\frac{1}{1-\eta_i}} Q_i \qquad \forall\, i$$

Domestic good demand function for local firms' intermediate and final uses

$$D1_i = \left(\frac{\gamma 1_i^{\eta_i} \delta d1_i P_i^q}{P_i^d}\right)^{\frac{1}{1-\eta_i}} Q_i \qquad \forall\, i$$

Composite good production function for MNEs' intermediate

$$X_{i\_all,j\_MNE} = \gamma 2_{i\_all,j\_MNE} \left(\delta m2_{i\_all,j\_MNE} M2_{i\_all,j\_MNE}^{\eta_{i\_all}} + \delta d2_{i\_all,j\_MNE} D2_{i\_all,j\_MNE}^{\eta_i}\right)^{\frac{1}{\eta_{i\_all}}} \qquad \forall\, i\_all, j\_MNE$$

Import demand function for MNEs' intermediate

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

Domestic good demand function for MNEs' intermediate

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

[Transformation between Export and Domestic Goods]

Gross domestic output transformation function

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

Export supply function

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

Domestic good supply function

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

[Market Clearing Conditions]

Market clearing condition for the Armington composite good

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

Market clearing condition of domestic good for local firms' intermediate and final uses

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

Market clearing condition of domestic good for MNEs' intermediate

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

Market clearing condition of local capital

$$\sum_j F_{h1,j} = \sum_r FF_{r,h1} \qquad \forall\ h1$$

Market clearing condition for foreign capital

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

Market clearing condition for labor

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

[Price Equalization Conditions]

Wage equalization condition across sectors

$$P^f_{h2,i\_all} = P^f_{h2,j\_all} \qquad \forall\ h2, j\_all$$

Price equalization condition of domestic capital across sectors

$$P^f_{h1,i} = P^f_{h1,j} \qquad \forall\ h1, i, j$$

Price equalization condition of foreign capital across MNE sectors

$$P^f_{h1,i\_MNE} = P^f_{h1,j\_MNE} \qquad \forall\ h1, i\_MNE, j\_MNE$$

[Utility and Fictitious Objective Function (Social Welfare)]

Household utility function

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

Social welfare function

$$SW = \sum_{r1} UU_{r1}$$