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# Analysing Economy Wide Effects of Trade Liberalisation on Vietnam using a Dynamic Computable General Equilibrium Model

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## Abstract

Since its reform process in the late 1980s, Vietnam has emerged as a rapidly growing economy with growth rates surpassing its more developed ASEAN neighbours. These high growths in both GDP and exports have also affected the micro level by decreasing poverty rates significantly. However, although average wages have increased during this time, wage inequality has also increased as well. In addition, Vietnam has expanded its external relations by signing a BTA with US, joining ASEAN and more recently being admitted into the WTO. This paper aims to consider the economy wide impacts of trade liberalisation on Vietnam. We approach this by way of multi-region, multi-good, dynamic growth computable general equilibrium (CGE) model. We find that trade liberalisation has caused a large fall in wage inequality thus increasing the welfare of unskilled workers in Vietnam. There is also evidence of a shift away from agriculture towards low-tech and intermediate manufacturing sectors. Additionally, there are significant gains in terms of large physical and human capital accumulation.

*JEL Classification:* D58, F16

*Keywords:* Trade, General Equilibrium, Wage Inequality, Rice, Vietnam

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\*This paper is based on a chapter of an ongoing PhD dissertation hence, it is preliminary and incomplete. All comments and suggestions will be highly appreciated.

## 1. Introduction

Since the implementation of its reform package known as *Doi Moi* in 1986, Vietnam has achieved significant high growth, macroeconomic stability, substantial structural changes and poverty reduction. In particular, a major area of reform involved Vietnam's trade policies which included expanding Vietnam's external relations, promoting exports expansion, subsequently decreasing tariffs and non-tariffs barriers as well as moving towards a flexible exchange rate. Hence, it is of no surprise that a considerable number of studies have surfaced to analyse the implications of Vietnam's trade reforms on its aggregate income, trade patterns and the relative well being of the poor.

A large number of these studies employ economy wide, multi-sector computable general equilibrium (CGE) models due to their advantage in analysing long-run resource general equilibrium allocation issues. However, the majority of these models are static in nature which in turn, do not provide growth and accumulation effects. Moreover, there have been no studies involving the dynamics of human capital accumulation for the case of Vietnam.

Fukase and Winters (1999) believe that economic integration will provide dynamic benefits to Vietnam in terms of 1) better access to foreign knowledge and hence, increase in productivity growth, 2) increase in returns of both physical and human capital which in turn increases domestic and foreign investments and 3) an "open door" policy which aided in accelerating domestic economic reforms. Hence, this paper hopes to contribute to the literature by integrating growth effects of

Vietnam's trade liberalisation which in turn provide dynamic accumulations results. These results also incorporate human capital accumulation. To do so, we employ a multi-sector, multi-region dynamic computable general equilibrium (CGE) model.

We find that Vietnam's economy will benefit greatly from the impact of trade liberalisation. There are significant increases in aggregate GDP as well as consumption growth. Vietnam's sectoral growth is largest in Intermediate Manufacturing and the Low-tech industry which then signifies the economy's sectoral movement away from agricultural towards these industries. In terms of exports, Vietnam's rice sector experiences the largest growth which in turn, suggests its influence as a major rice exporter for the region. In addition, although there was an increase in wage inequality in the short run, the wage gap narrows over time so that inequality will fall in the long run. The most significant result is the accumulation in physical capital; there were significantly large increases in all three types of capital goods (Machinery, Structures and Residential Buildings) as well as large significant human capital accumulation.

The remainder of this paper is as follows; Section 2 presents a brief literature relevant to this paper, Section 3 describes a brief overview of Vietnam's economy and trade policy with particular emphasis of Vietnam's trade with ASEAN. In Section 4 we look at the model structure and data calibration. Section 5 describes the simulations and results and Section 6 concludes the paper.

## 2. Modeling Vietnam's Trade Liberalisation

The adoption of “open door” market oriented policies has prompted a large number of studies on the impact of trade liberalisation on the Vietnamese economy. In keeping with the relevance of this paper, the studies described in this section will be limited to CGE models developed for and employed to Vietnam.<sup>3</sup>

According to Abbott et al. (2006), these CGE models either follow the GTAP model (Hertel and Tsigas, 1997) or the World Bank's Linkage model (van de Mensbrughe, 2005). They find that these models capture economy-wide effects via the following characteristics, i) multiple sectors and factor markets as well as a household and government component, ii) capital and labour is allocated via taxes and tariff incentives and iii) assume a perfectly competitive market. What usually differs among these models is the sectoral aggregation. Base data from these models usually are taken from Vietnam's 1996 Input-Output (IO) table, 1997 social accounting matrix (SAM) using GTAP or a more current SAM used in Tarp (2001, 2002) and Jensen et al. (2004). Household data is taken from the 1992/93 and/or 1997/98 Vietnamese Living Standards Survey (VLSS) or the more recent 2002 Vietnamese Households Living Standards Survey (VHLSS). Another main characteristic of these models is whether they are simulated to estimate short-run or long-run results. A large majority of these studies are static models and hence, do not provide accumulation and transitional effects in both the short run and long run as dynamic models do. For

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<sup>3</sup> Rama and Sa (2005) and Abbott et al. (2006) have reviewed studies concerning the impacts of Vietnam's trade agreements and accession to the WTO. They find that the majority of these studies use computable general equilibrium (CGE) modeling in their investigation of economy-wide impacts of trade reform.

the case of trade liberalisation, the simulations mostly carried out on these models are the impacts of AFTA, APEC, WTO, and the US-BTA on Vietnam's economy.

Fukase and Martin (1999) have utilised the GTAP model to analyse Vietnam's trade liberalisation under AFTA, APEC and unilateral liberalisation scenarios. Their results showed that economic benefits to Vietnam from AFTA are likely to be small. They argue that this is due to three reasons, i) the share of export from Vietnam to AFTA are small, ii) gains from trade creation are offset by costs of trade diversion and iii) there may be significant terms of trade losses. However, when they extended their simulations to unilateral and APEC liberalisation, they found economic benefits to Vietnam to be higher, hence, advised that although AFTA impacts are small, they are an important stepping stone for further liberalisation. In a similar study, Phuong (2003) found that although there were positive impacts from trade liberalisation, the overall results were relatively small i.e. Vietnam GDP only increased by 1.6 percent when it joined AFTA, and by 4 percent when there was global liberalisation.

More recently, Huong and Vanetti (2006) evaluated the impact of Vietnam's liberalisation with the GTAP model. Their results showed that both imports as well as exports increased in all sectors with the largest increase in textiles and apparel. There were also significant welfare gains especially from unilateral liberalisation. Unskilled labour increased by as much as 38 percent with the majority of labour use in the areas of textiles, apparel, wood products and telecommunications. However, Huong and Vanetti (2006) stated that this result seemed unrealistic and advised some sort of trade-off between labour use and wages as a more realistic closure.

Besides the GTAP model, there have been other CGE models employed to analyse Vietnam's trade liberalisation. For example, Chan and Dung (2001) developed a CGE model which used base data from the Vietnam 1996 Input-Output (IO) table. They simulated a reduction of all Vietnam's tariffs to 5 percent as well as replacing sales tax with VAT taxes. Their results showed that sectors such as coal, oil, gas, transport, communications and low-tech manufacturing have expanded but agriculture, finance, banking and insurance sectors experienced a fall in output. They also showed that with tariff reduction, export and import volumes increased by 7.8 percent and 5 percent respectively. Like production outputs, the exports of low-tech manufacturing sectors increased while agriculture, banking and finance sectors fell.

Additionally, there have also been a number of CGE models which incorporate Vietnamese household data. This is of no surprise as Vietnam's significant poverty reduction rates have prompted an analysis of trade liberalisation on the welfare of the Vietnamese people. A study by Gallup (2002) also showed that although poverty has fallen significantly in Vietnam, wage inequality has increased.

Huong (2003) presented a similar model to that of Chan and Dung (2001), in which a CGE model was developed based on Vietnam's 1996 IO table but incorporating household data via the 1992/93 VLSS dataset. The simulation was also a 5 percent decrease in Vietnam's tariffs and the loss in revenue was made up through either increase in indirect taxation or external borrowing. Huong (2003) found that with increase in indirect taxation, the Vietnamese economy grew at a slower rate while households gained less from trade liberalisation. Rural households gained more than urban households and the income inequality between rural and urban households improved. However, for the case of external borrowing, the results showed that the

economy reached a higher level of welfare compared to the first option but inequality will tend to widen between rural and urban households due to debt obligations in which, rural households will be forced to pay more in the end.

Jensen and Finn Tarp (2003) presented two static CGE model in which both encompasses the 2000 Vietnamese SAM and the 1998 VLSS household data. One model has 16 aggregate households while the other, the 6002 disaggregated households. They simulated three experiments; i) the elimination of export taxes, ii) elimination of import tariffs and iii) both i) and ii). They found that by eliminating trade taxes increased the number of people living in poverty especially for the case of rural farm households in the northern region of Vietnam. This would then further worsen the regional discrepancies in poverty headcounts.

Nguyen and Ezaki (2005) have also developed a CGE model using GTAP data and the VHLSS 2002 household dataset. They simulated four different trade liberalisation scenarios which include the removal of tariffs between i) Vietnam and the ASEAN-4, ii) scenario i) including China, iii) scenario ii) including East Asian NIEs and Japan, iv) scenario iv) and North America and v) multilateral trade liberalisation. Surprisingly, their results showed that real GDP has fallen in all scenarios. There was however, an increase in private consumption and trade, increase in average wages as well as capital rental in all scenarios except for i). There was an increase in household income and labour income.

For the case of dynamic models, Roland-Holst et al. (2002) simulated a dynamic CGE model from the period 2000 till 2020 to analyse the impact of



Vietnam's accession to the WTO. They stressed on the importance of domestic reforms as well as capital market liberalisation alongside WTO accession. Their results showed that if Vietnam undergoes a passive-style WTO accession without any domestic reforms, this will bring about only marginal benefits to its aggregate economy. Their reasoning for this is that without domestic reforms, Vietnam will only intensifies its comparative advantage in low-wage production which then undermines Vietnam's overall gains from trade. In addition, they also found that capital market liberalisation will increase growth dividends by the most percentage if performed alongside domestic reforms and WTO accession.

Toan (2005) modeled a dynamic CGE model for the Vietnamese economy for the period 2000 till 2035. He simulated Vietnam's tariff reductions to 5 percent which is consisted to WTO requirements. His main findings include expansion of the manufacturing sector at the expense of the agriculture and services sectors in the long run. Consequently, this increased the imports of agriculture and services into Vietnam and increased the exports of the manufacturing sector. Additionally, he also modeled the income distribution of Vietnamese households and found that in the long run, trade liberalisation caused the income gap between urban and rural households to widen.

### **3. Overview of Vietnam's Economic Development**

Vietnam's market oriented reforms known as *Doi Moi* were launched after the Sixth Party Congress in December 1986 with the broad aims of reducing macroeconomic instability as well as accelerating growth. These economic reforms

were concentrated on three major areas, 1) agrarian reform, 2) transition to a market economy alongside price reform and 3) reforms in trade and external relations. Key policies include employing cooperatives for production organisation as well as the distribution of inputs and outputs of the agricultural sector, changing the institutional structure over land and other assets as well as liberalisation of certain key commodities such as rice. Commodity prices were liberalised while simultaneously abolishing the dual pricing system<sup>4</sup>, expansion of private enterprises, credit ceiling were imposed on state-owned enterprises and real interest rates were brought to positive levels hence, curbing Vietnam's extremely high inflation rates.

Since the *Doi Moi* implementations, there have been significant transformations to Vietnam's economy with remarkable achievements in GDP growth, inflation control, expansion of exports, FDI attraction and poverty reduction. Table 3.1 describes Vietnam's major macroeconomic and microeconomic indicators from the period 1987 to 2005. Additionally, Figure 3.1 shows the GDP (PPP) per capita in logs of Vietnam versus more developed Asian countries as well as the United States for reference for the period 1995-2005. We can see that although Vietnam's GDP levels are the lowest in this group, it had a steady upwards trend and has actually narrowed the gap between these countries over time.

Foreign trade policy reforms have been key feature in Vietnam's reform package. So much that liberalisation of markets and export expansion has been argued to be the "engine of growth" for Vietnam since the launch of *Doi Moi* (Van Arkadie and Mallon, 2003). There were two main objectives: i) to transform

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<sup>4</sup> The dual pricing system involved forcing agricultural producers to sell to the state at artificially low prices which in turn, resulted in having producers forced to finance their losses through government subsidies. This problem was particularly severe for the case of rice in which the official price was one-ninth of the free market price in 1988 (Riedel and Comer, 1997).

Vietnam's centrally planned economy into a open market economy and ii) to promote export oriented industries by abolishing the anti-export bias set during the protectionist era while simultaneously protecting the manufacturing sector (Auffret, 2003). These objectives were carried by way of liberalising prices and linking them to world prices, increasing the number of FTCs, the abolishment of quantitative restraints (QRs) and the reduction of other non-tariff barriers, the reduction of tariffs, adoption of a flexible market exchange rate system, and the liberalisation of expanding FDI in Vietnam.<sup>5</sup>

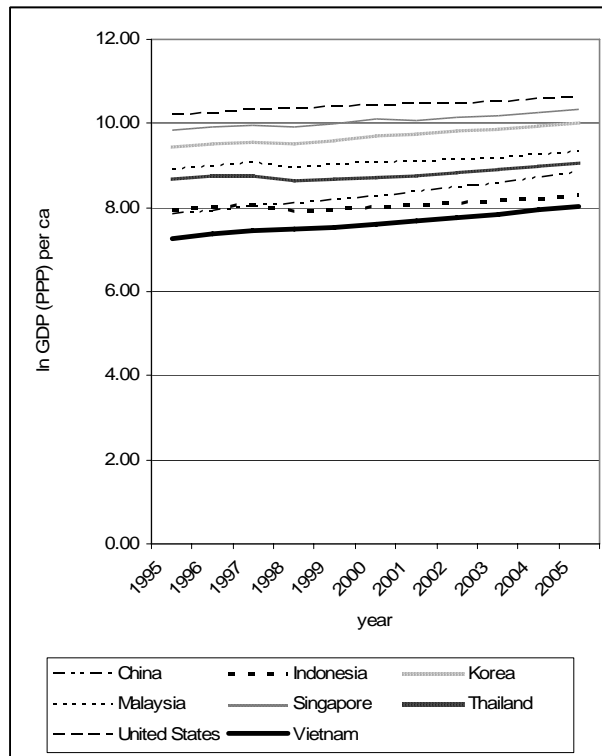
**Table 3.1: Selected Key Indicators of Economic Development, 1987-2005**

Indicator	1987	1992	1997	2002	2005
<i>Population</i>					
Total Population, millions	62.45	68.45	74.31	79.73	83.12
<i>Structural Output Composition, % of GDP at current prices</i>					
Agriculture	40.6	33.9	25.8	23.0	20.9
Industry	28.4	27.3	32.1	38.5	41.0
Services	31.1	38.8	42.2	38.5	38.1
<i>Income Growth</i>					
GDP Growth, %	3.6	8.7	8.2	7.1	8.4
GDP (PPP) per capita	752.767	1,106.85	1,715.89	2,365.29	3,077.55
<i>Trade</i>					
Exports, % of GDP	2.3	25.1	34.2	47.6	0.4
Imports, % of GDP	-6.0	-25.7	-38.9	-50.7	4.0
<i>Trade Growth, % of GDP</i>					
Exports	8.3	23.7	26.6	11.2	...
Imports	13.9	8.7	4.0	21.8	...
Trade Balance	-17.2	115.8	38.1	-155.7	...

Source: ADB Key Indicators 2006, UNCTAD Database and IMF World Economic Outlook Database

<sup>5</sup> The literature on Vietnam's trade policies is vast; for more information on this subject, see CIE (1998), Athukorala (2002) and Auffret (2005).

**Figure 3.1: Vietnam's GDP (PPP) per Capita versus Selected Economies**

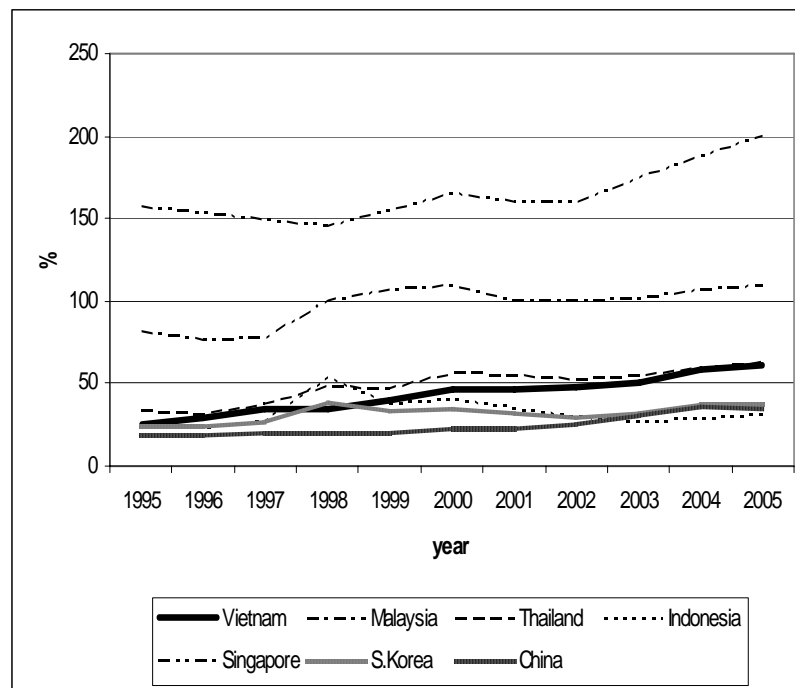


*Source: World Economic Outlook Database, April 2007, IMF*

Since these trade reforms have taken place, there has been rapid growth of Vietnam's exports. Figure 3.3 shows us the ratio of export to GDP for Vietnam versus five other Asian economies. We can see that the ratio of exports to GDP for Vietnam has grown rapidly at a steady upwards trend, exceeding the ratio of exports of all these countries except for Malaysia and Singapore. By 2003, Vietnam's export ratio has matched that of Thailand's, making it the third most "open" economy in the region alongside Thailand. According to Van Arkadie and Mallon (2003), the growth in Vietnam's exports were underpinned by a few factors; the growth of petroleum especially to European countries, expansion of agriculture, seafood and aquaculture exports during the 1980s and 1990s, diversification of agricultural exports, expansion of textiles and footwear in the 1990s, growth in handicraft exports and the emergence of electronic exports.

Another important part of the trade reform package is the expansion of external relations in order to meet the aims *Doi Moi*. Accordingly, Vietnam has already participated in a number of trade agreements. Vietnam signed a trade agreement with the EU in 1992. It joined the Association of Southeast Asian Nations (ASEAN) in 1995 as well as became a member of APEC in 1998. In 2001, Vietnam signed a bilateral trade agreement with the United States. More recently Vietnam has been admitted as a member of the WTO as of January 11, 2007. Figure 3.4 presents a timeline of significant changes regarding Vietnam's trade policies and development of external relations since the implementation of *Doi Moi* in 1986 till WTO accession in 2007.

**Figure 3.3: Vietnam's Export/GDP Ratio versus Selected Asian Economies Developing Countries**



Source: ADB Key Indicators 2006

**Figure 3.5: Time for Vietnam's Trade Development and External Relations**

1986	Implementation of <i>Doi Moi</i> Economic Reforms
1987	
1988	Import tariffs introduced for the first time
1989	Market-oriented reforms: Unified exchange rate and Elimination of state monopoly of foreign trade
1990	Export Processing Zone (EPZ) established
1991	Preferential tariffs established via Law on Import and Export Duties
1992	European Union trade agreement, Introduction of the Harmonised-System (HS) of tariffs
1993	
1994	Introduction of Quotas
1995	WTO accession party established, Joined ASEAN
1996	
1997	Asian Financial Crisis
1998	Joined APEC
1999	Most Favoured Nation (MFN) agreement with Japan
2000	Signed US-Vietnam Bilateral Trade Agreement (BTA)
2001	CEPT/AFTA implementation begins, Removal of most Quotas
2002	US-Vietnam BTA begins, ASEAN-China FTA signed
2003	ASEAN-Japan Comprehensive economic partnership, Tariff rate quotas (TRQs) introduced
2004	EU-Vietnam bilateral agreement on WTO accession
2005	New/amended Law on Commerce and Trade
2006	Final bilateral agreements for WTO accession reached, CEPT/AFTA requirements should be fulfilled
2007	WTO accession on January 11, 2007

Source: Abbott et al. (2007)

### 3.1 Vietnam in the context of ASEAN

ASEAN was formally established in 1967 with four original member countries; Indonesia, Malaysia, Philippines and Singapore. Brunei joined in 1984. It was only a decade late in which Vietnam joined in 1995, Lao PDR and Myanmar in 1997 and the most recent member, Cambodia in 1999. Consequently, the last four members are also known as the “new member countries” of ASEAN. Table 3.2 shows us some key macroeconomic indicators of these countries and Table 3.3 shows trade indicators of exports, imports and intra-trade between the ASEAN countries. In terms of growth, Vietnam has recorded the highest growth rates in 2006 which was followed by Singapore and Lao PDR. However, Vietnam’s GDP per capita is still fairly low.

This could be due to the population growth which has been having an upward trend in the last few years.

**Table 3.2: Macroeconomic Indicators of ASEAN Member Countries in 2006**

Country	Share of Real GDP (PPP) (%)	Population Share (%)	Annual population growth (%)	GDP per capita (USD PPP) relative to Singapore (%)
Brunei Darussalam	0.3	0.1	3.5	0.9
Cambodia	1.5	2.5	2.5	0.1
Indonesia	32.5	39.1	1.3	0.2
Lao PDR	0.5	1.1	2.5	0.1
Malaysia	10.6	4.7	2.1	0.4
Myanmar	4.1	10.1	2.3	0.1
Philippines	15.7	15.3	2.0	0.2
Singapore	4.9	0.8	3.3	1.0
Thailand	20.2	11.5	0.7	0.3
Viet Nam	9.6	14.8	1.3	0.1
<b>ASEAN</b>	<b>100.0</b>	<b>100.0</b>	<b>1.5</b>	

Source: Asean Statistical Yearbook 2005 and World Economic Outlook Database, April 2007, IMF

**Table 3.3: Trade Indicators of ASEAN Member Countries in 2006**

Country	Merchandise Exports		Merchandise Imports	
	Ratio to GDP (%)	Intra-ASEAN share to total (%)	Ratio to GDP (%)	Intra-ASEAN share to total (%)
Brunei Darussalam	48.7	24.0	8.7	49.1
Cambodia	42.6	4.7	35.2	36.4
Indonesia	28.5	18.5	21.5	30.0
Lao PDR	7.3	84.8	12.1	51.6
Malaysia	107.7	26.1	88.0	25.5
Myanmar	29.4	49.9	17.7	54.9
Philippines	40.2	17.3	44.0	18.7
Singapore	205.3	31.3	180.3	26.1
Thailand	62.9	21.8	61.4	18.3
Viet Nam	65.0	17.6	72.8	27.4
<b>ASEAN</b>	<b>71.9</b>	<b>25.3</b>	<b>63.6</b>	<b>24.5</b>

Source: Asean Statistical Yearbook 2005

### 3.2 Vietnam's Trade with ASEAN

We now turn to Vietnam's trade with the other ASEAN member countries. From Table 3.4 shows us the share of exports and imports between ASEAN and Vietnam. We can see that Singapore is Vietnam's largest trading partner in ASEAN with more than 33.18 percent of exports and 48 percent of imports. This is followed by Malaysia in which makes up 17.4 percent of export share and Thailand which makes up 14.31 percent export share. Thailand also imports around 25 percent import share from Vietnam makes up 13.31 percent.

**Table 3.4: Vietnam's Trade with ASEAN Members and Other Major Trade Partners**

Share of Total Exports to ASEAN (%)	2005	Share of Total Imports From ASEAN (%)	2005
<i>By ASEAN Countries:</i>		<i>By ASEAN Countries:</i>	
Cambodia	9.83	Cambodia	1.66
Indonesia	8.60	Indonesia	7.43
Laos	1.23	Laos	1.01
Malaysia	17.42	Malaysia	13.31
Myanmar	0.22	Myanmar	0.48
Philippines	15.21	Philippines	2.22
Singapore	33.18	Singapore	48.60
Thailand	14.31	Thailand	25.30

Source: ADB Key Indicators 2006 and Statistical Yearbook 2005, General Statistics Office, Vietnam

Table 2.4 illustrates the composition of Vietnam's trade with the ASEAN member countries in 2002. Exports of primary products to ASEAN made up almost 70 percent of total exports in which Mineral fuels, lubricants and related materials make up 44.1 percent. Food, foodstuff and live animals make up almost 20 percent.



Manufactured products make up 30 percent of total exports to ASEAN in which the highest ratio goes to Machinery, transport and equipment at 14.4 percent. On the other hand, Vietnam imports a smaller share of primary products from ASEAN at 40.3 percent and a larger share of manufacture product at almost 60 percent.

**Table 3.4: Composition of Vietnam's Exports and Imports to ASEAN by SITC in 2002**

	Exports to ASEAN		Imports from ASEAN	
	Thousand USD	Share (%)	Thousand USD	Share (%)
<b>TOTAL</b>	<b>2,434,915</b>	<b>100</b>	<b>4769177</b>	<b>100</b>
<i>Primary products</i>	<i>1,681,771</i>	<i>69.11</i>	<i>1920515</i>	<i>40.3</i>
Food, foodstuff and live animals	469,809	19.3	184028	3.9
Beverages and tobacco	9,944	0.4	104822	2.2
Crude materials, inedible, except fuels	127,709	5.2	280327	5.9
Mineral fuels, lubricants and related materials	1073642	44.1	1252581	26.3
Animal and vegetable oils, fats and wax	667	0.03	98758	2.1
<i>Manufactured products</i>	<i>753144</i>	<i>30.9</i>	<i>2848615</i>	<i>59.7</i>
Chemical and related products, n.e.s	84819	3.5	912727	19.1
Manufactured goods classified chiefly by materials	180782	7.4	741993	15.6
Machinery, transport and equipments	350064	14.4	1025390	21.5
Miscellaneous manufactured articles	137480	5.6	168505	3.5
<i>Commodities not clasified elsewhere in SITC</i>	<i>0</i>	<i>0</i>	<i>47</i>	<i>0</i>

Source: General Statistics Office, International Merchandise Trade of Vietnam, 2002.

### 3.3 Vietnam's Rice Exports to ASEAN

Rice is a key export commodity for Vietnam. Major agrarian reforms as well as rice market liberalizations have significantly changed the status of Vietnam's rice sector. So much that, Vietnam moved from being a major rice importer before the reforms to the world's third largest rice exporter.<sup>6</sup> Table 3.5 shows Vietnam's major rice export destinations. More than 60 percent of Vietnamese rice is exported to Asia, 20 percent to Africa, almost 10 percent to the Americas and so on. Out of total exports

<sup>6</sup> Rice statistics available on the International Rice Research Institute (IRRI), <http://www.irri.org>

to Asia, ASEAN exports make up a fair amount which is 43 percent. Major rice exporters are Malaysia and the Philippines.

Apart from being the country's third largest export commodity, rice plays a central role in the lives of the Vietnamese people. It is the country's main staple food and most widely produced agricultural commodity. Vietnam's largest export commodity is textile products followed by marine products. This is followed by rice, coffee, wood and wooden products, rubber, frozen shrimp and coal (ADB Key Indicators, 2006). Paddy is grown on 53 percent of agricultural land and makes up 64 percent of sown area of crops.

Minot and Goletti (2000) provide a very detailed report on the rice market liberalisation and poverty in Vietnam. They utilised data from the 1992/93 Vietnamese Living Standards Survey (VLSS) which showed that 69.9 percent of households in Vietnam grow rice, 99.9 percent consume rice and rice expenditure makes up around 30 percent of a household's total consumption expenditure. Rice makes up for about 66 percent of the total calorie intake of the Vietnamese people. Additionally, they also calculated rice consumption across households and found that rural households consume more rice per person per year than that of an urban household. More than 80 percent of rural households grow and sell rice.

Hence, the rice market is very important not only to the Vietnamese economy as a whole, but specifically to rural Vietnam. By liberalising the rice market in our model,

we are able to analyse the impact on the distribution of income. Specifically, any changes to wages will be an important factor in determining welfare.

**Table 3.5: Vietnam's Principle Rice Export Destinations, 2004**

<b>Destination Country / Region</b>	<b>Metric Tons</b>	<b>Percentage</b>
Total Asia	491505	61.3%
Total Africa	161250	20.1%
Europe	64266	8.0%
Americas	79700	9.9%
Australia	1588	0.2%
Others	3200	0.4%
<b>Total Rice Exports</b>	<b>801509</b>	<b>100.0%</b>
Of Total Asian Exports:		
<i>ASEAN</i>	211363	43.0%
Indonesia	9700	2.0%
Philippines	70630	14.4%
Malaysia	97947	19.9%
Singapore	33086	6.7%
<i>Other Asian</i>		
Iraq	205750	41.9%
Iran	31000	6.3%
Japan	25700	5.2%
Others	17692	3.6%
<b>Total Asia Rice Exports</b>	<b>491505</b>	<b>100.0%</b>

Source: Vietnam Grain and Feed May Rice Update, 2004

## **4. Model Framework**

### **4.1 Model Specifications**

The model presented in this paper is a multi-sector, multi-region dynamic computable general equilibrium (DCGE) open economy growth model of perfect foresight based on the work of Harris and Robertson (2007). This section aims to

briefly describe the model specifications. More detail on the model's key equations can be found in Appendix A.

There are a total of 11 sectors; 6 of which are traded sectors (Agriculture & Minerals, Rice, Low-tech, Intermediate Manufacturing, Durables and Traded Services) and 4 of which are non-trade sectors (Construction, Non-Traded Services, Public and Housing). There is also an additional non-traded sector, Education, which is treated separately. The model has 7 factors; 4 of which are considered to be reproducible inputs (Machinery, Structures, Residential Buildings and Skilled Labour) and 3 are exogenously evolving inputs (Unskilled Labour, Land and Natural Resources). There are also 3 regions; ASEAN (Indonesia, Malaysia, Philippines, Singapore, Thailand and the Rest of Southeast Asia), Vietnam and the other countries are considered to be the Rest of the World (ROW). The model's structure is summarised in Table 4.1 below.

**Table 4.1: Model Sectors, Factors and Regions**

<b>Commodities</b>	<b>Factors</b>	<b>Regions</b>
<i>Traded Sectors:</i>	Machinery, <i>M</i>	ASEAN
(1) Agriculture & Minerals	Structures, <i>B</i>	Vietnam
(2) Rice	Residential Buildings, <i>D</i>	Rest of the World
(3) Low-tech	Skilled Labour, <i>Ls</i>	
(4) Intermediate Manufac.	Unskilled Labour, <i>Lu</i>	
(5) Durables	Land, <i>N</i>	
(6) Traded Services	Natural Resources, <i>R</i>	
<i>Non-Traded Sectors:</i>		
(7) Construction		
(8) Non-traded Services		
(9) Public		
(10) Housing		
(11) Education		

There are three agents in the each economy; firms, households and government. Consumers maximize utility subject to initial conditions and expectations. Government spending is assumed to be a fixed proportion of aggregate spending to GDP and

government revenue is attained through taxes, tariffs and factor incomes. There is also a lump sum subsidy which is distributed any surplus back to consumers so that the government budget remains balanced. Final demands consist of consumption spending by the government as well as households which are then modelled using a nested constant elasticity of substitution (CES) demand function of the seven factors of production. Final demands also include the investments in all three of the capital goods. Firms maximise their profits by way of maximising their revenue functions. The output of traded goods are an aggregate of destination specific goods i.e. goods for the home and the other two foreign markets. On the other hand, the output of non-traded goods is just the production of a single good for the sector. The revenue function comprises of constant elasticity of transformation (CET) functions of the prices in each sector.

ASEAN and Vietnam are assumed to be small open economies and take world prices as given whereas the ROW will supply and import traded goods. All commodities are considered to be homogenous and produced competitively by firms using intermediate inputs as well as the seven factors of production mentioned above. The factor demands are derived from profit maximisation conditions. Capital is intersectorally immobile and the stock of capital is fixed in each region. Labour mobility is determined by government education policy decisions.

## **4.2 Data and Model Calibration**

Data for the model was obtained from various reliable sources. The main data source is the GTAP version 6 database which contains 57 sectors, 87 regions and 5

factors. The GTAP data is aggregated into 6 traded sectors, 4 non-traded sectors and 3 regions in accordance to the model structure in Table 4.1. Additionally, the GTAP data is also used to obtain data for the factors of production. Data on capital from GTAP is disaggregated into 3 capital goods; Machinery, Structures and Residential Buildings using a capital-intensity index. This, along with the data on Skilled Labour, Unskilled Labour, Land, and Natural Resources make up the 7 factors of production as presented in Table 4.1. We use the GTAP data to build the Social Accounting Matrices (SAMS) for each economy.

We express income in terms of Purchasing Power Parity (PPP), hence, data for GDP per capita and GDP per worker for each region is obtained from the Penn World Tables (PWT) version 6.1. National income data is obtained from the Asian Development Bank (ADB) Key Indicators database for Vietnam. For the other ASEAN countries, GDP expenditure numbers are obtained from the United Nations Main Aggregates and Incomes Database. The reason why Vietnam's data was not obtained from the United Nations Database is because there were no data available for Vietnam's total imports i.e. only data on net exports was available. Consequently, data for Vietnam is taken from the ADB Database and converted to the consistent current US dollars by the end of period exchange rate. This is done so Vietnam GDP data is consistent with the ASEAN GDP numbers which are already in US dollars.

For the purpose of calculating human capital accumulation, we obtained data for the Education sector for both regions. Student enrolment numbers for ASEAN and Vietnam were attained from the UNESCO Global Education Digest 2005. These were used along with labour force data on both regions obtained from the ADB Key

Indicators Database to calculate the human capital ratios such as Skilled Labour/Working Population and Total Students/Working Population. Additionally, the implied wage ratio of skilled to unskilled workers is abstracted from a GTAP technical paper by Liu, Leeuwen, Trinh Vo, Tyers and Hertel (1998). Data on vital statistics such as the birth rate, death rate and population growth were attained from the ASEAN Statistical Yearbook 2005 for the ASEAN region and the Government Statistical Office (GSO), Vietnam for the Vietnam region.

The calibration process is designed to develop a benchmark representing an equilibrium condition for a selected representative year as well as an initial steady state growth condition for all three regions. The model is calibrated to a year 2000 benchmark. This dataset is then adjusted for mutual consistency which is done using the row and column sum (RAS) adjustment method. GTAP data is scaled using the Penn World Tables (PWT 6.1) data so that income is expressed in Purchasing Power Parity (PPP) dollars. Industry value added as well as trade flow data is scaled so that the benchmark model is in a steady state with balanced trade. We also obtained the share and scale parameters for the expenditure, investment, revenue and cost function in the model.

Appendix B contains the calibrated benchmark values. We can see from Table B.2 that both ASEAN and Vietnam are labour-intensive regions. Table B.3 shows us the tariff structure of traded commodities for all three regions. For Vietnam, the highly protected sectors against ASEAN are Agriculture and Minerals (55.66%) Traded Services (22.65%) and Durables (18.06%) and against the ROW are Agriculture and

Minerals (22.75%), Low-tech (22.53%), Traded Services (22.65%) and Durables (20.65%). Commodity outputs for the region are shown in Table B.4 whereby Vietnam displayed the highest output in Low-tech (19.48%), Agriculture and Minerals (13.14%) and Intermediate Manufacturing (11.62%). Furthermore, Table B.5 shows us the base value for the human capital variables. Vietnam's ratio of skilled to unskilled labour is calibrated to approximately half of that of ASEAN.

## **5 Results of Simulations**

### **5.1 Simulation Design**

This part of the paper aims to discuss the results from two simulation scenarios; i) bilateral liberalisation between ASEAN and Vietnam and ii) unilateral liberalisation in Vietnam.

Before conducting the trade liberalisation experiments, we will first clarify their specifications. For scenario i) the experiment involves the complete removal of import tariffs of all traded goods between Vietnam and the ASEAN countries. Scenario ii) involves only Vietnam removing all its imports tariffs on ASEAN. Tariffs are removed from the first year. There are no gradual reductions in tariffs and there is no announcement of the trade liberalisation shock; hence, we will not expect any anticipation effects for the price reduction. The model is calibrated for 100 years which we will assume to be the in the "long-run".



## 5.2 Results and Analysis

In this section we will present both static and dynamic results from each scenario. A table of static outcomes as well as the dynamic graphs are located in Appendix C. Bilateral liberalisation results are denoted as (BL) while unilateral liberalisation results are denoted as (UL). The results will focus on the impacts on the Vietnamese economy. Specifically, we are interested in discussing the distributional effects following a trade liberalisation experiment on a relatively poor country such as Vietnam. Except for exports, the impact of Vietnam's trade liberalisation on ASEAN is relatively small.

### 5.2.1 *Economic Growth: Real GDP and Real Aggregate Consumption*

Past research have shown that trade liberalisation is positively corrected to GDP growth.<sup>7</sup> From Table C.1, we can see that the static results are very significant for Vietnam; real GDP increase by 13.7 percent for unilateral liberalisation and 17.4 percent for bilateral liberalisation. Additionally, aggregate real consumption increase by 4.6 percent for unilateral and by 7 percent for bilateral liberalisation.

The dynamic results for real GDP (Figure C.1.) are quite similar for both scenarios except for the instantaneous effect. For the case of bilateral tariff removal, real GDP increase to just over 1 percent in the first year and there was no increase for unilateral liberalisation. This is not surprising with the absence of anticipation effects.

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<sup>7</sup> See Harrison (1996) and Krueger (1997).

However, real GDP increase subsequently to around 10 percent after 20 years and around 16 percent after 50 years for both scenarios.

### 5.2.2 *Sectoral Growth*

Figure C.2 in Appendix C shows the gross sectoral growth in Vietnam. For the case of bilateral liberalisation, all sectors apart from Agriculture and Minerals experience positive shocks. The sector which experiences the biggest growth is in Durables which increase by 25 percent in the first year, reach around 58 percent after 20 years and increase up to 68 percent in the long run. Intermediate Manufacturing and Traded Services also experience high rates of growth with an increase of Intermediate Manufacturing from 5 percent in the first year to 30 percent in the twentieth year. Traded Services starts off around 5 percent as well in the first year and will reach around 40 percent after 20 years. Rice did not experience that much growth; the instantaneous effect was relatively high at 10 percent but this falls to around 6 percent in the second year and remains so till the long run.

For the case of unilateral liberalisation, all sectors have positive growth except for Agriculture and Minerals and the Rice sectors. Traded services experiences the highest growth followed closely by the Low-tech sector which grows to 40 percent in the first five years. Intermediate Manufacturing, Traded Services and Durables all reach 25 percent growth by the tenth year. The dynamic path of Agriculture and Minerals output is exactly the same of that in bilateral liberalisation. Rice falls to -5 percent in the first year and remains in negative values into the long run.

The expansion in the Durables, Low-tech and Intermediate Manufacturing sectors comes as no surprise as mentioned in Section 3, Vietnam is becoming a major producer of Low-tech goods such as textiles and footwear and Intermediate Manufacturing such as chemical manufactures. However, what is interesting is the speed of growth of these sectors in such a short time. On the other hand, it is very surprising to see the retraction of the Agriculture and Minerals sector by such a big amount in both scenarios. This then implies that once either bilateral or unilateral tariffs are removed, Vietnam will move away from all agriculture production. For the case of unilateral liberalisation, this includes the production of Rice as well. We should then expect to see imports of Agriculture and Minerals (and Rice under unilateral liberalisation) into Vietnam once these shocks are put into place.

### 5.2.3 *International Trade*

#### i) Exports from Vietnam

ASEAN's export tariffs on Vietnam were highest in the Rice sector (Table B.3 in Appendix B) hence we would not be surprised that expansion of exports were highest in the Rice sector following a trade liberalisation shock. From Figure C.3 in Appendix C, we can see that for the case of bilateral liberalisation, the exports of Rice from Vietnam to ASEAN will grow instantaneously by over 160 percent; this then will fall slightly to around 150 percent which will sustain into the long run. The increase of Rice exports to the Rest of the World (ROW) is relatively high as well; it increase to around

25 percent in the first year but this too will fall to around 15 percent in which will sustain into the long run.

Under unilateral liberalisation (Figure C.4), rice growth was around 10 percent in the first year and then falls to around 5 percent in the tenth year which too, will sustain into the long run. However, under unilateral liberation, the rice sector did not experience the highest growth. This is due to the high tariff set on Rice imports into ASEAN.

Like the case of outputs, the exports of Agriculture and Minerals to ASEAN and the ROW also fall for both scenarios. For exports to ASEAN and under bilateral liberalisation, exports fall by almost 10 percent instantaneously and continued to remain in negative values. For the ROW, the effects were much larger whereby exports of Agriculture and Minerals fell by 20 percent in the first year and this continued to fall to -28 percent in the long run. For the case of unilateral liberalisation, exports of to Agriculture and Minerals to ASEAN fall by 15 percent in the first year and continue to fall to about -23 percent in the long run. This result is the same for Vietnam exports to the ROW.

This then tells us, with the liberalisation of the price of rice, this is has cause some fairly large trade diversion in the between the Rice sector and all other Agriculture and Minerals sector. Although we know from the tariff schedule that protection on Rice is

clearly higher than that of Agriculture and Minerals, it still emphasise the importance of the export of Rice relative to all other agricultural exports.<sup>8</sup>

Under bilateral liberalisation, the export sector which increase significantly for Vietnam is the Durables sector (Figure C.3). In the first year of the shock, Durables exports from Vietnam to ASEAN increase by almost 100 percent. This then continue to expand to 120 percent in the twentieth year and on to over 150 percent in the long run. The same goes for export to the ROW; in the first year exports increase by 35 percent, in the twentieth year, it increases to over 50 percent and up to 65 percent in the long run. The dynamic path results are similar to both the Intermediate Manufacturing and Traded Services sector which also increase by significant amounts.

Under unilateral liberalisation (Figure C.4), Traded Services have the largest increase; up to 30 percent in the first 20 years to ASEAN and up to almost 40 percent in 20 years to ROW. Exports of Intermediate Manufacturing are significantly under unilateral liberalisation compared to bilateral liberalisation. Under bilateral, exports of Intermediate Manufacturing to ASEAN increase by around 50 percent after 20 years and reach 75 percent in the long run. However, under unilateral, export only increase to just under 30 percent after 20 years and reaches 35 percent in the long run

The pattern of export growth for the Low-tech sector is different. Under bilateral liberalisation, exports to both ASEAN and ROW increase by approximately 34 percent and 25 percent respectively in the first year and this grew quickly in the first 5

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<sup>8</sup> From Table 3.5, we can see that ASEAN countries are a major export destination for Vietnam's rice export (43% of total Asian exports).

years; for ASEAN it grew up to 43 percent but continue to plateau around 42 percent into the long run. For the ROW, in the first five years, Low-tech exports grew up to 35 percent and this too continues to plateau around 33 percent in the long run. Hence, this tells us that the growth of Low-tech exports will be high only in the first five years but we don't expect any further increases into the long run. This result is similar to that in the case of unilateral liberalisation. This is rather strange as Low-tech exports consist of textiles, footwear and electronic equipment; the sector in which we expect Vietnam to expand in the future and not as much as in the Durables sector.

ii) Exports from ASEAN

Under, bilateral liberalisation, export of Agriculture and Minerals from ASEAN to Vietnam increased by tremendous amounts (Figure C.5). In the first year, exports grew by almost 350 percent and this continues to grow up to 400 percent in the long run. Under unilateral liberalisation, export increase to about 330 percent and up to 370 percent in the long run. This comes as no surprise as the Agriculture and Minerals sector is largely protected in Vietnam (Table B.3, Appendix B). The other two sectors which grew relatively large are the Low-tech sector and the Durables sector.

What is interesting here is the comparison between bilateral and unilateral liberalisation. We can see that the dynamic pathway and results are relatively similar between the two scenarios; hence, we can say that if Vietnam implements unilateral liberalisation against ASEAN, it can receive almost the same export results as it will under bilateral liberalisation.

#### 5.2.4 *Real Return to Factors and Changes in Endowments*

Further, we look at the changes to real returns of the factors to Vietnam as described in Figure C.6 in Appendix C.

Under complete liberalisation, the real rental returns for machinery and structures will increase in the short run to fall back again after about 10 years. The same goes for skilled wages which goes up by over 10 percent immediately and then up to almost 14 percent in 10 years to come down again. Residential real returns will start off at an increase of about 7 percent and fall all the way to -3 percent in the first 5 years in which it will increase again to over 1 percent. Under gradual liberalisation, the real return for machinery and structures actually fall by about -4 percent and -2 percent respectively but this manage to recover quickly with positive growth and to fall back again after about 10 years as well. For the case of unilateral liberalisation, real returns for machinery and structures go up by about 6 percent and 5 percent respectively and fall back again after 10 years. However, the fall to Residential real returns is the largest among the three scenarios in the short run; to more than -3 percent in the first five years.

Hence, we can say that there is a lot of capital accumulation occurring in the short run and this is reflective of the gross capital stocks for machinery and structures (Figure C.7, Appendix C). This also explains the increase in exports of capital intensive goods such as Durables and Intermediate Manufacturing from Vietnam to ASEAN and ROW. Additionally, there is also evidence of human capital accumulation whereby

increase in skilled wages has cause workers to move from unskilled jobs to skilled jobs as indicated in the labour supply graph. Hence, we can say that what has happened to Vietnam following trade liberalisation with ASEAN depicts the typical “East Asian Miracle” story.

In addition, we also look at the case of real wages. In this model, real wages is measured as wage efficiency units divided by the CPI. In all three cases, the trade shock has cause a huge skill premium the first period which continue to widen in the next ten years. Under complete liberalisation, skilled wages increase up to 11 percent while unskilled wage goes up by about 4 percent. By the tenth year, skilled wages will increase up to about 12 percent while unskilled wages fall to 1.5 percent giving us a 10 percent skill premium. For the case of gradual liberalisation, the short term effect are not as large; skilled wages increase up to 6 percent and unskilled wages up to 2 percent. However, by the tenth year, the skill premium is almost as large as the case of complete liberalisation. Under unilateral liberalisation, skilled wage goes up to around 8 percent in the first year while unskilled wages goes up by about 2 percent. By the tenth year, there is a 9 percent skill premium. Thus, we can say that the largest skill premium occurs when there is complete trade liberalisation.

The lowering of the skill premium after the tenth year indicates a falling wage inequality in Vietnam. That is, for all three cases, the skill premium only occurs in the short run. After the tenth year, we can say that the trade shock will actually benefit the poor i.e. those earning unskilled wage, by decreasing the skill premium and increasing unskilled wages. If we look at the static results in Table C.1., real factor returns



increased by over 6 percent for unskilled workers and 4.5 percent for skilled workers under complete liberalisation. Under unilateral liberalisation, unskilled wages increase by 4 percent while skilled wages increase by 3.2 percent.

In terms of changes in endowments for Vietnam, the effects have been huge especially in the growth of capital goods as well as Skilled Labour. From the static results in Table C.1 as well as Figure C.8, we can see that under complete liberalisation, endowments of Machinery will increase by 32.4 percent, Structures by 26.4 percent, Residential Buildings by 12 percent and Skilled Labour by 16.7 percent. Unskilled Labour falls by -1.1 percent. For the case of unilateral liberalisation, endowments of Machinery will increase by 27.1 percent, Structures by 21.5 percent, Residential Buildings by 7.2 percent and Skilled Labour by 13.7 percent. Unskilled Labour also falls but by -0.9 percent.

We notice two things in relation to these capital accumulation results. The first is the relocation of the factors and sectors i.e. we can see a Rybczynski type effect occurring whereby the increase in capital goods such as Machinery for example, leads to the increase in capital-intensive sectors such as Durables and Intermediate Manufacturing. The increase in Skilled Labour also leads to the increase of skilled-intensive sectors such as Traded Services and Low-tech. On the other hand, there is a fall in Unskilled Labour which then, leads to a contraction of unskilled-intensive sectors such as Agriculture and Minerals.

The second thing we notice that the factors which increase in the long run consists of the reproducible capital goods. Hence, this tells us that, for the case of Vietnam, there is a lot of investment in all three capital goods. This is evident from large increase in gross capital stock (Figure C.7) especially for the case of Machinery which has the largest increment for both bilateral and unilateral trade liberalisation. Additionally, there has been a significant increase in the stock of skilled labour as well. We can see that after the shock has been implemented, skilled labour grows at a significantly high rate, while, unskilled labour has hardly any growth. Hence, this tells us that there is there large investment in education which in turn, increases the stock of skilled labour.

#### *5.2.5 Real Wages and the Price of Rice*

The real wages we previously looked at are measured using the CPI. However, in relevance to the Vietnamese economy, we are interested in analysing the changes of the wage for unskilled workers with respect to the changes in the price of rice. As mentioned in Section 3, more than 80 percent of rural households in Vietnam grow and sell rice (Minot and Goletti, 2000). Hence, we are interested to know what are the effects of trade liberalisation on the price of rice and consequently, on the real wages in terms of price of rice.

The dynamic pathways of the price of rice in both scenarios are shown in Figure C.9 in Appendix C. We can see that under bilateral liberalisation, the price of rice will fall significantly to around -8.7 percent in the fifth year but will increase again

to reach around -4.5 percent in the long run. Under unilateral liberalisation, the price of rice falls to around -6.9 percent in the fifth year and climbs back up to -3.6 in the long run. Turning to real wages measured with respect to the price of rice, we can see that in both cases, unskilled wages will start off at an increase but will experience a fall in the first five years. This will then increase to about 12.5 percent under bilateral liberalisation and to around 8 percent under unilateral liberalisation. On the other hand, the wage of skilled workers measured in terms of the price of rice has a large increase in the short run for both cases. Hence, we will also have a large skill premium in the short run but this will decrease significant in the long run. This then tells us that although there is significant wage inequality in the short run, there will be long terms gains for the unskilled worker.

## **6 Conclusion**

In this paper, we aim to analyse the economy wide effects of trade liberalisation on Vietnam in the context of AFTA. We find that by bilateral removal of tariffs, there were highly beneficial effects to Vietnam, for example, the large increase in GDP by 17.4 percent and aggregate consumption by 7 percent in the long run. We also find that with unilateral liberalisation, Vietnam experience comparable impacts as that from bilateral liberalisation.

From both cases, there has been a huge expansion of the Durables, Intermediate Manufacturing, Low-tech and Traded services sector at the expense of the Agriculture and Minerals sector which retracted significantly. This result further emphasises

Vietnam's shift from a pre-dominantly agricultural economy to that of a manufacturing one. This shift is also mirrored in Vietnam's exports as well; there was a large increase in all sectors except for Agriculture and Minerals. Instead, there was an increase of imports of agricultural and mineral goods from ASEAN countries to satisfy domestic demand. Additionally, by isolating Rice as a sector, we are able to see its importance in the Vietnamese economy.

Results for factors of production were also highly significant for Vietnam. For one, the movement towards manufacturing industries and exports is reflected in the increase of gross capital stocks in machinery, structures as well as skilled labour. Hence, there was both physical as well as human capital accumulation. This is highly evident in the static results whereby all capital goods as well as skilled labour increase by substantial amounts. Also, we found that despite a large skill premium in the short run, trade liberalisation has cause wages inequality to fall in the long run.

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# Appendix A

## A.1 Production

There is a production function of intermediate goods and factors of production which produces gross output flow,  $g_i$ , in every industry  $i$ . The intermediate goods are combined with fixed coefficients,  $Y_{ij}$  and  $a_{ij}$ , in which  $a_{ij}$  is a technological parameter.

$$g_i = \min[m_i, v_i] \quad (1)$$

$$m_i = \min_{i=1\dots n} \left[ \frac{Y_{ij}}{a_{ij}} \right] \quad (2)$$

The value added function is an aggregate of vectors of the factors of production,

$$v_i = v(v_{M_i}, v_{B_i}, v_{D_i}, v_{Ls_i}, v_{Lu_i}, v_{N_i}, v_{R_i}) \quad (3)$$

The cost function is dual to the value added aggregator,

$$c_i = c(w_{M_i}, w_{B_i}, w_{D_i}, w_{Ls_i}, w_{Lu_i}, w_{N_i}, w_{R_i})$$

Next, we assume that the cost function takes on a nested CES form. We can then redefine the cost function with an upper and lower nest,

$$C_i = C(R_i, w_{Lu_i}, w_{N_i}, w_{R_i})^{\frac{1}{\rho}}$$

$$R_i = R(w_{M_i}, w_{B_i}, w_{D_i}, w_{Ls_i})^{\frac{1}{\nu}}$$

## A.2 Commodity Supplies

The model consists of both traded and non-traded goods. For traded goods, gross output,  $g_i$  comprises of the aggregate of three destination specific goods; one for the home market, and two for the foreign markets for each industry  $i$ . An example for gross output for the North (N) region is given below.

$$g_i^N = g^{iN}(x_i^{NN}, x_i^{NS}, x_i^{NW}), R \in \{N, S, W\}$$

By revenue maximization, dual to equation (.) will give us a revenue function.



$$r_i^R = K \left[ \chi^{RN} (P^{RN})^\eta + \chi^{RS} (P^{RS})^\eta + \chi^{RW} (P^{RW})^\eta \right]^{\frac{1}{\eta}}, R \in \{N, S, W\}$$

By the envelope theorem, the supply function will then be,

$$s_i^{RN} = r_p^{RN} (P^{RN}) g_i^{RN}, R \in \{N, S, W\}$$

For the case of non-traded goods, gross output is just the single output,  $g_i$  for each industry  $i$ .

### A.3 Commodity Demands

We consider a set of unit expenditure functions where  $C$  denotes private consumption,  $G$  is government spending,  $M$  investment in machinery,  $B$  is investment in non-residential structures (buildings) and  $D$  is investment in residential structures (dwellings).

$$e^z(q), z \in \{C, G, M, B, D\}$$

By the envelope theorem, we derive the consumption demand functions generated by each component of final demand.

$$d_z = e_q^z(q) \frac{z}{e^z(q)}$$

where  $z = Q_z P_z$  and  $P_z = e^z(q)$

Intermediate demands are described by an  $n \times n$  intermediate use matrix  $A$  and the gross output,  $g$  of a region  $R$ ,

$$i^R = A^R g^R, R \in \{N, S, W\}$$

Aggregate government spending,  $\omega$ , is assumed to be determined by fixing aggregate spending as a proportion of GDP,  $Y^R$ .

$$\frac{G_t^R}{Y^R} = \omega, R \in \{N, S\}$$

### A.4 Investment Function

Physical capital investment stocks:  $V_{k,t}, k \in \{M, B, D\}$

Rental rates:  $w_{k,t}, k \in \{M, B, D\}$

Physical capital investment flows:  $Q_{k,t}, k \in \{M, B, D\}$

Investment price indices:  $E_{k,t}, k \in \{M, B, D\}$

World bond rate:  $1 + \rho$

Net capital income:  $u_{k,t} V_{k,t}$

Adjustment cost:  $C(Q_{k,t}, V_{k,t}) = \frac{b(Q_{k,t} - (\delta_k + g)V_{k,t})^2}{2V_{k,t}}$

Hence, the optimization decision for each household is given by the Lagrangian,

$$L = \sum_{t=0}^{\infty} \left( \frac{1}{1 + \rho} \right)^t (u_{k,t} V_{k,t} - u_{k,t} C(Q_{k,t}, V_{k,t}) - E_{k,t} Q_{k,t} + \Pi_{k,t} (K_{t+1} - K_t - Q_t + \delta K_t))$$

Assuming a depreciation rate of  $\delta$ , the first order conditions are,

$$\frac{\partial L}{\partial Q_{k,t}} = -u_{k,t} C_{Q,t} - E_{k,t} + \Pi_{k,t} = 0$$

$$\frac{\partial L}{\partial V_{k,t+1}} = \frac{1}{1 + \rho} (u_{k,t+1} (1 - C_{V_{k,t+1}}) + \Pi_{k,t+1} (1 - \delta)) - \Pi_{k,t} = 0$$

After taking first difference of the adjustment cost function and substituting that into the first order conditions, we will get an investment demand equation,

$$\frac{Q_{k,t}}{V_{k,t}} = \frac{1}{b} \left( \frac{\Pi_{k,t} - E_{k,t}}{u_{k,t}} \right) + (\delta_k + g)$$

## A.5 Equilibrium Conditions

A static equilibrium consists of a set of consumer prices ( $q_i^R$ ), factor prices ( $w_j^R$ ) and gross outputs, ( $g_i^R$ ) which satisfy the following conditions:

i) *Zero profit condition*

$$r^{iR} (p^{iR}) = \sum_{j=1}^n a_{ij}^R q_j^R - c_i^R (w^R), R \in \{N, S\}$$

ii) *Goods market clearing*

Goods market clearing in the North (N) for traded goods is given as,

$$r^N(i) g_i^N + r^S(i) g_i^S + r^W(i) V^W = \sum_{j=1}^n a_{ij}^N g_j^N + a_{ie}^N y_e^N + d_i^N, j = 1 \dots 6$$

and for non-traded goods it is given as,

$$g_i^N = \sum_{j=1}^n a_{ij}^N g_j^N + a_{ie}^N y_e^N + d_i^N, j = 7 \dots 10$$

The goods clearing equations are identical for the South (S).

ii) Factor market clearing

$$V_k^R - C(Q_k^R, V_k^R) = \sum_{i=1}^n c_{w_k}^{iR} (w_k^R) g^{iR}, k \in \{M, B, D\}, R \in \{N, S\}$$

## A.6 Dynamic Path

The dynamic path is determined by,

i) Factor accumulation:  $V_{k,t+1}^R = Q_{k,t}^R + (1 - \delta) V_{k,t,k}^R, k \in \{M, B, D, L_s, L_u\}, R \in \{N, S\}$

ii) Human capital accumulation :  $L_{s,t,t+1}^R = L_{s,t}^R (1 - \delta_s) + E_t^R, R \in \{N, S\}$

iv) Population growth :  $Pop_{t+1}^R = (1 + g_t) Pop_t^R, R \in \{N, S\}$

v) World endowment growth :  $V_{t+1}^W = (1 + g_t^W) V_t^W$

vi) Foreign asset balance:  $F_{t+1}^R = Surp_t^R + (1 + r) F_t^R, R \in \{N, S\}$

vii) Asset prices:  $\Pi_{k,t}^R = \frac{1}{1 + \rho} [u_{k,t+1}^R (1 - m_{k,t+1}^R) + (1 - \delta) \Pi_{k,t+1}^R]$

## A.7 Steady State

In the steady state, the growth rate of each capital stock must equal to the world long run growth rate,

$$\frac{Q_{k,t}}{V_{k,t}} - (\delta + g) = 0$$

Recall that the investment function is given as,

$$\frac{Q_{k,t}}{V_{k,t}} = \frac{1}{b} \left( \frac{\Pi_{k,t} - E_{k,t}}{u_{k,t}} \right) + (\delta_k + g)$$

Thus the steady state is satisfied when,

$$\Pi_{k,t} - E_{k,t} = 0$$

Also, the steady state condition for foreign assets stock,  $\bar{f}$  to be constant is given by,

$$\bar{f} = \frac{1 + g}{g - r} \left[ 1 - \left( \frac{c_{ss}}{y} \right) + \left( \frac{tax}{y} \right) - gov_t - invest_t \right]$$

## Appendix B: Calibrated Benchmark Values

**Table B.1: Base Values for Population, GDP and Spending**

Regions	Population (10,000 efficient workers)	GDP (PPP) (billion USD)	Spending as a Proportion of GDP				
			Consumption	Investment	Government	Exports	Imports
ASEAN	18329.9357	3187.5287	0.6015	0.2785	0.1200	0.4731	0.4731
Vietnam	3856.0060	153.3893	0.6330	0.3031	0.0639	0.5812	0.5812

**Table B.2: Base Values for Factor Endowments, Rental Rates and Productivity Levels**

	Machinery	Building	Dwellings	Skilled Labour	Unskilled Labour	Land	Nat. Resources
<b>Endowments ('000 units)</b>							
ASEAN	2516.0530	1780.8157	2540.9269	1832.9936	16313.6427	133.5530	77.4451
Vietnam	118.7973	114.4269	127.8363	192.8003	3624.6456	6.6379	2.5938
<b>Factor Rental Rates (units)</b>							
ASEAN	0.2889	0.2201	0.1100	0.2963	0.0571	1.0000	1.0000
Vietnam	0.3226	0.2458	0.1028	0.1973	0.0502	1.0000	1.0000
<b>Factor Productivity (efficiency units)</b>							
ASEAN				1.0000	1.0000		
Vietnam				0.2413	0.2413		

**Table B.3: Base Tariff Schedule for Traded Commodities in Vietnam, ASEAN and ROW**

	<i>Agriculture &amp; Minerals</i>	<i>Rice</i>	<i>Low-tech</i>	<i>Intermediate Manufac.</i>	<i>Durables</i>	<i>Traded Services</i>
ASEAN's tariffs on Vietnam	3.55%	29.47%	2.08%	4.52%	15.41%	16.53%
ASEAN's tariffs on RoW	6.54%	18.74%	1.97%	5.45%	5.54%	16.53%
Vietnam's tariffs on ASEAN	55.66%	16.87%	13.97%	7.60%	18.06%	22.65%
Vietnam's tariffs on RoW	25.72%	13.86%	22.53%	6.97%	20.65%	22.65%
RoW's tariffs on ASEAN	11.06%	48.40%	3.89%	6.59%	4.35%	0.00%
RoW's tariffs on Vietnam	4.39%	26.97%	8.50%	10.34%	2.83%	0.00%

**Table B.4: Base Values for Commodity Prices and Output**

	<i>Agriculture &amp; Minerals</i>	<i>Rice</i>	<i>Low-tech</i>	<i>Intermediate Manufac.</i>	<i>Durables</i>	<i>Traded Services</i>	<i>Construction</i>	<i>Non-Traded Services</i>	<i>Public</i>	<i>Housing</i>	<i>Education</i>
<b>Commodity Prices (units)</b>											
ASEAN	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.4722
Vietnam	1.5569	1.1687	1.1397	1.0760	1.1806	1.0690	1.0000	1.0000	1.0000	1.0000	0.1979
ROW	1.1106	1.4840	1.0389	1.0659	1.0435	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
<b>Commodity Output (real units, '000)</b>											
ASEAN	938.5964	155.9387	1281.5762	691.8220	559.8642	949.7332	612.7275	794.5665	378.0674	363.8781	
Vietnam	46.0997	20.0075	68.3067	40.7357	21.9972	40.2576	34.2820	35.4726	7.6668	35.8290	
ASEAN, % of total output	13.9532	2.3182	19.0519	10.2846	8.3229	14.1187	9.1088	11.8120	5.6203	5.4094	
Vietnam, % of total output	13.1467	5.7058	19.4798	11.6170	6.2732	11.4807	9.7766	10.1161	2.1864	10.2177	

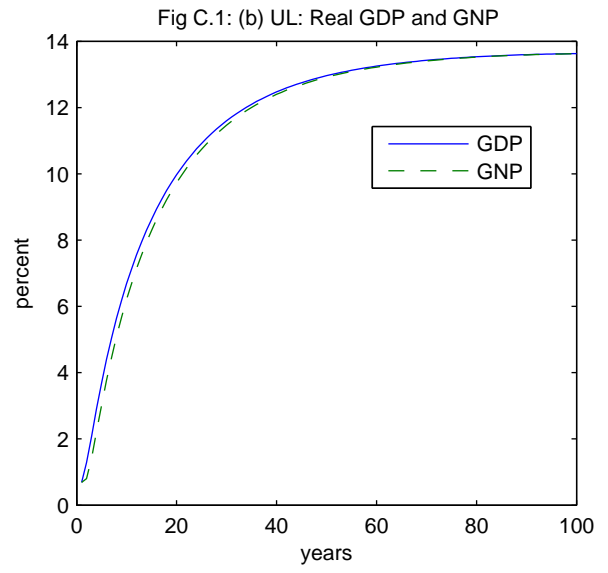
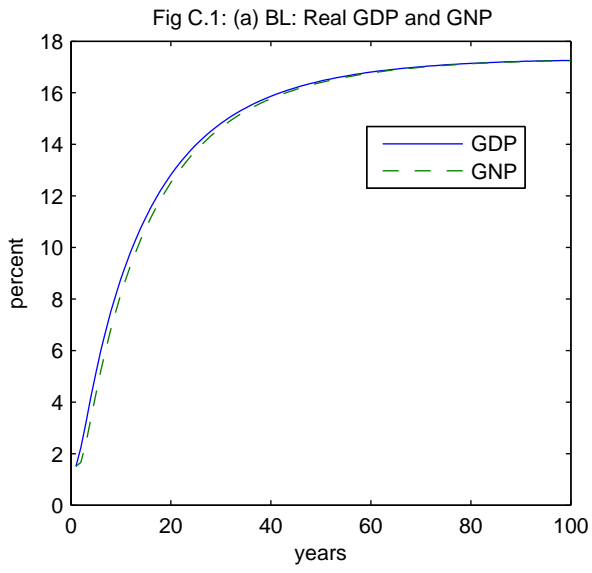
**Table B.5: Base Values for Human Capital Variables**

<i>Regions</i>	<i>Number of Students Acquiring Human Capital (H)</i>	<i>Factor Productivity (Efficiency Units)</i>	<i>Ratio of Skilled to Unskilled Labour (L<sub>s</sub>/L<sub>u</sub>)</i>	<i>Ratio of Skilled to Unskilled Wages (w<sub>s</sub>/w<sub>u</sub>)</i>
ASEAN	1830000	1.0000	0.1124	5.1905
Vietnam	390000	0.2413	0.0532	3.9331

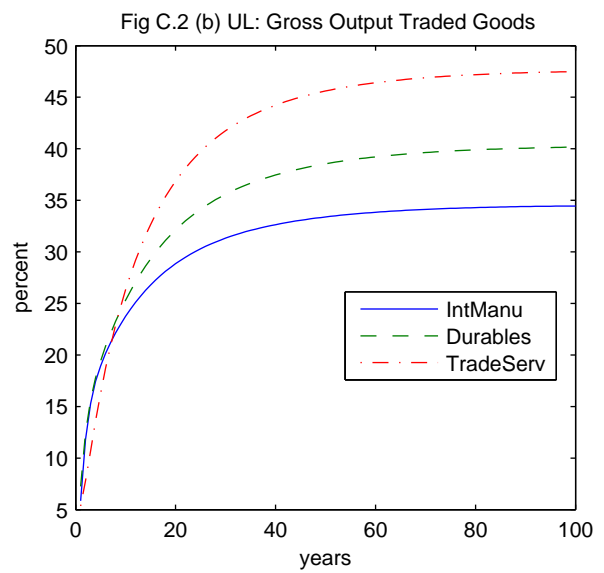
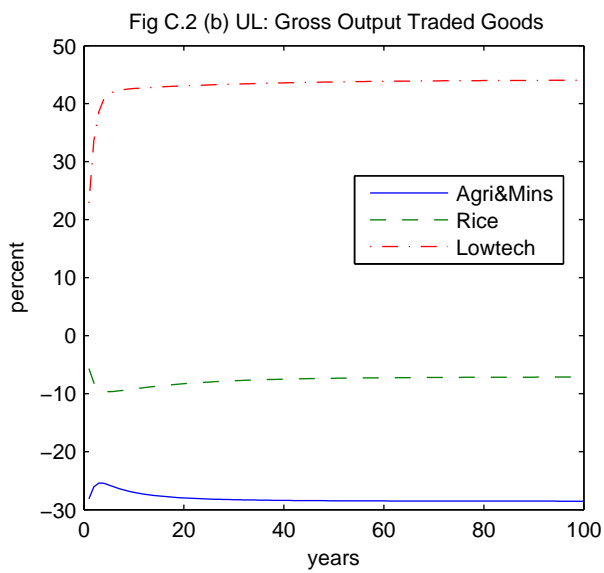
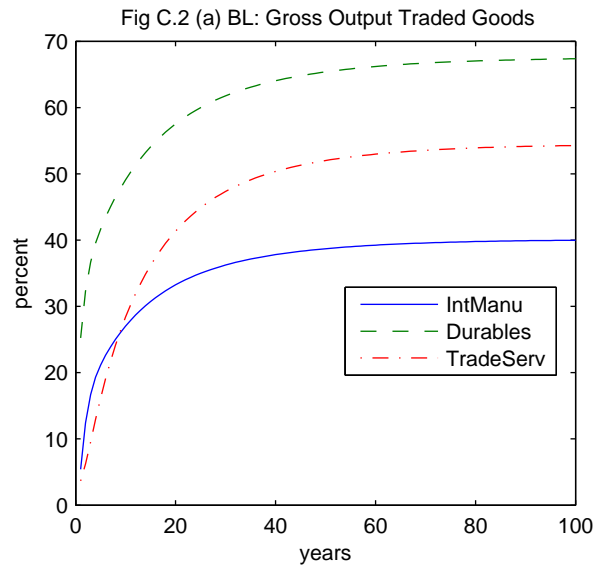
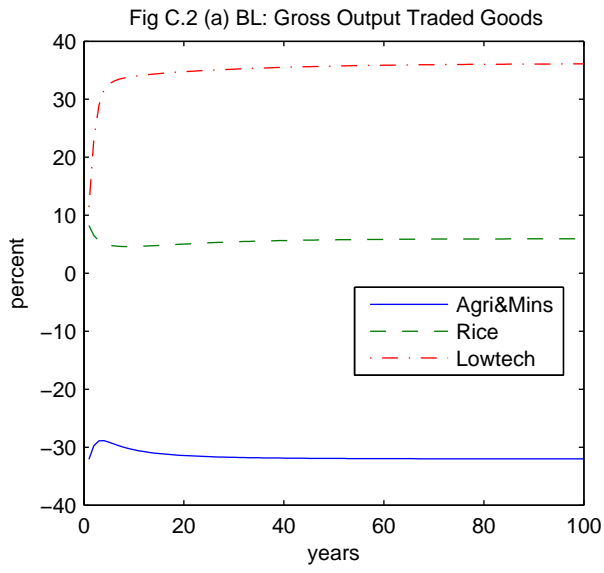
## Appendix C

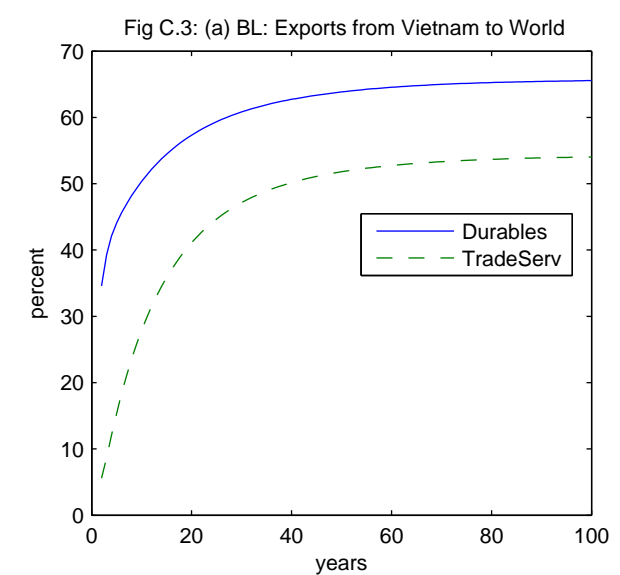
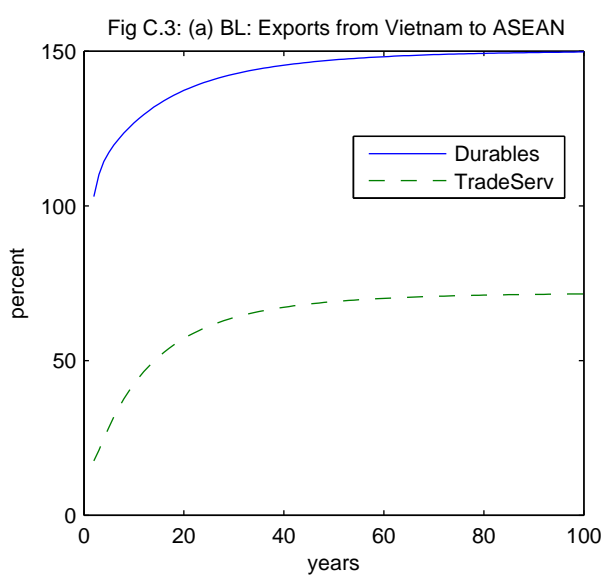
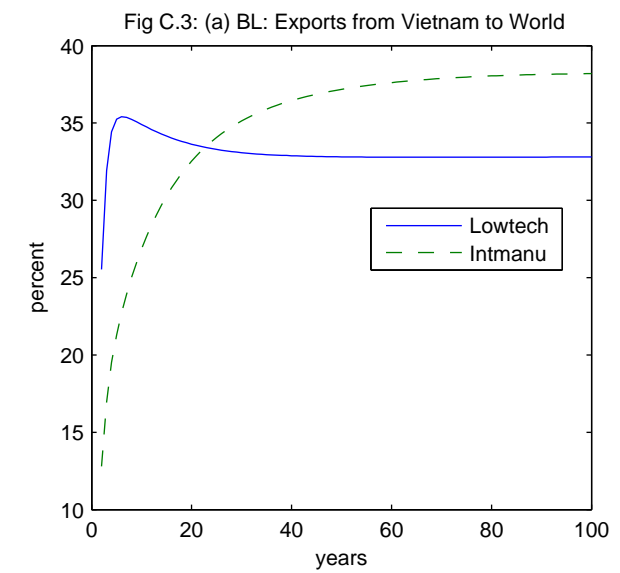
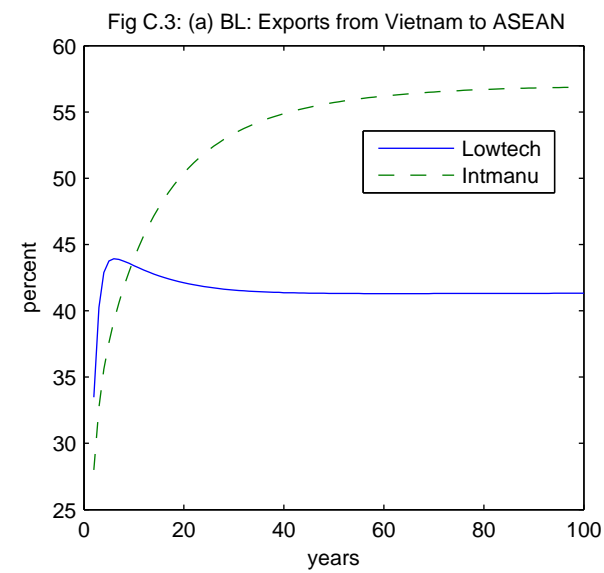
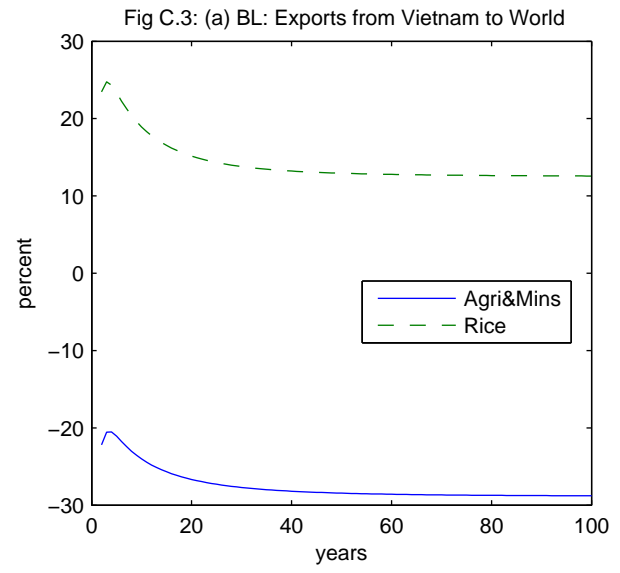
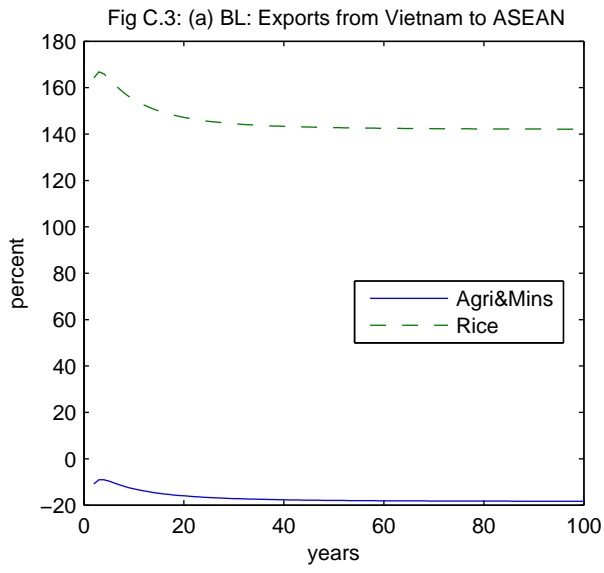
**Table C.1: Static Results**

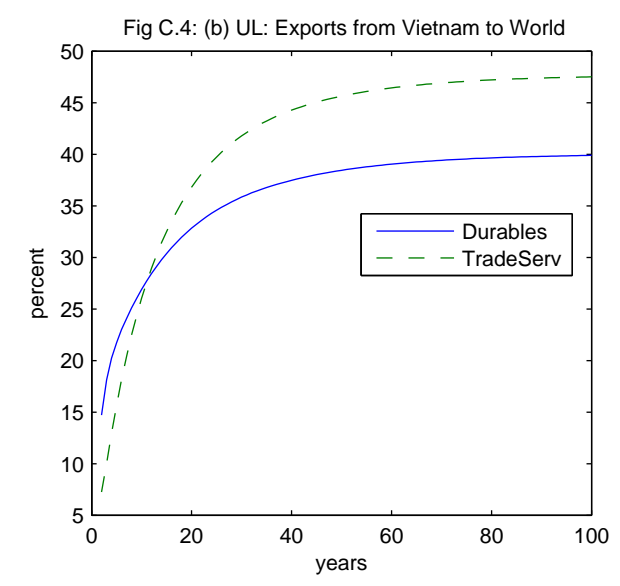
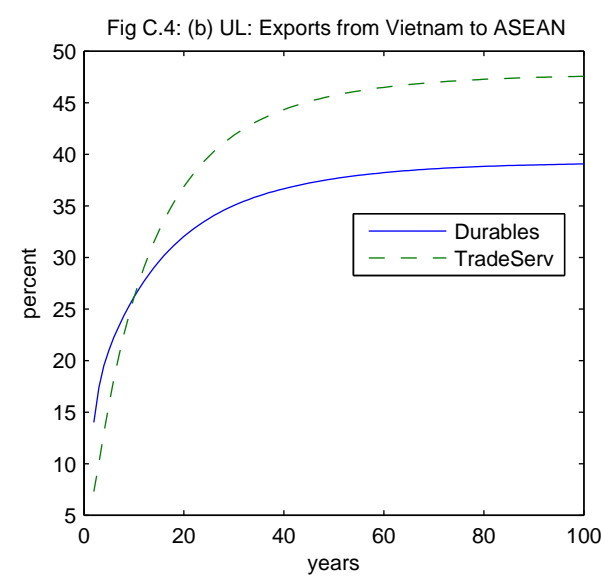
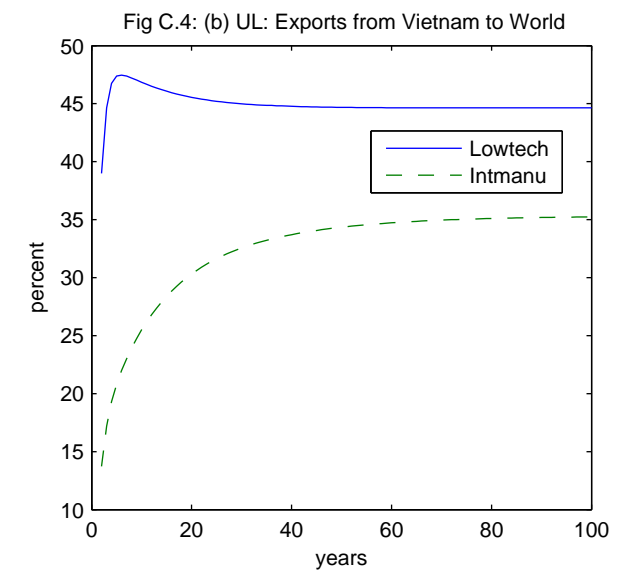
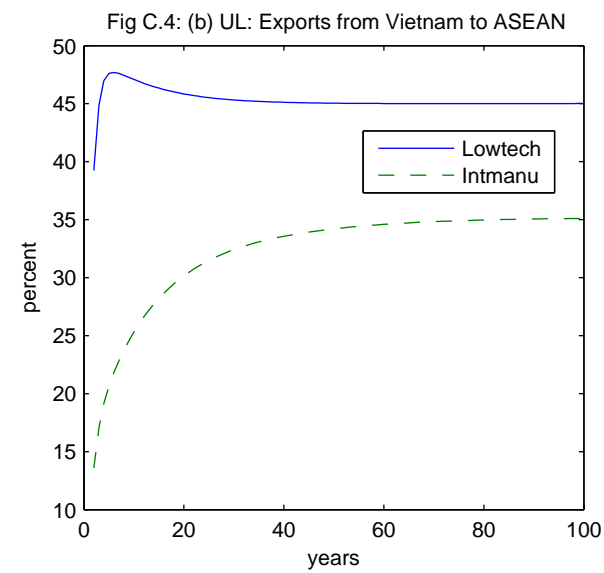
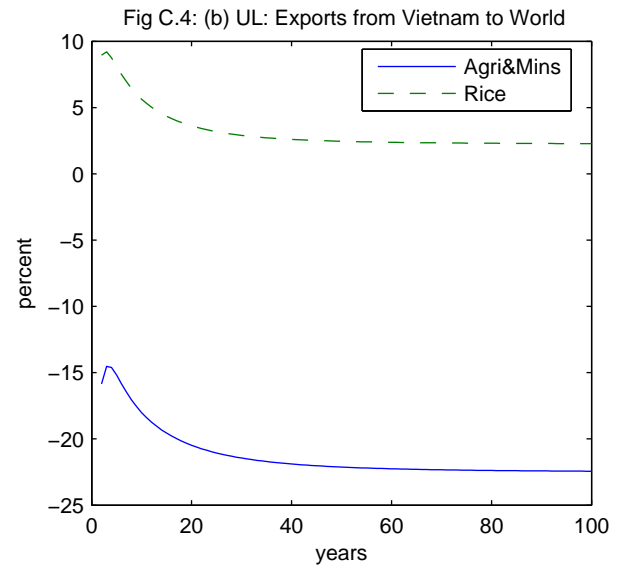
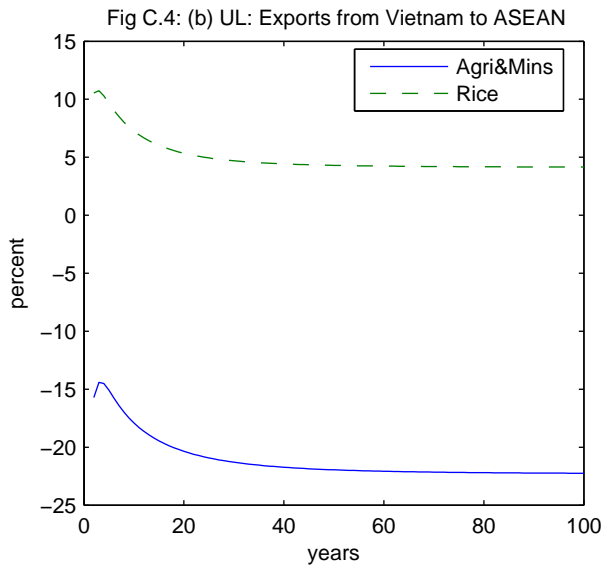
<b>Variables</b>	<b>Unilateral Liberalisation</b>	<b>Complete Removal of Tariffs</b>
<i>Real GDP</i>	13.7	17.4
<i>Real Aggregate Consumption</i>	4.6	7.0
<i>ASEAN exports to Vietnam</i>		
Agriculture & Minerals	376.7	402.1
Rice	38.5	32.6
Lowtech	39.9	48.3
Int Manufac.	23.2	25.6
Durables	66.4	59.4
Traded Services	15.7	15.7
<i>Vietnam exports to ASEAN</i>		
Agriculture & Minerals	-22.3	-18.4
Rice	4.1	142.0
Lowtech	45.0	41.3
Int Manufac.	35.3	57.1
Durables	39.3	150.1
Traded Services	47.9	71.9
<i>Sectoral Output</i>		
Agriculture & Minerals	-28.6	-32.0
Rice	-7.1	6.0
Lowtech	44.1	36.2
Int Manufac.	34.7	40.2
Durables	40.4	67.7
Traded Services	47.8	54.6
Construction	18.8	23.5
Non-Traded Services	20.1	23.6
Public	9.3	11.8
House	2.4	3.9
<i>Real Factor Returns</i>		
Machinery	0.1	-1.2
Structures	0.3	-0.1
Residential Buildings	0.3	-0.1
Skilled Labour	3.2	4.7
Unskilled Labour	4.0	6.1
Land	-12.7	-7.7
Natural Resources	-14.7	-16.4
<i>Endowments</i>		
Machinery	27.1	32.4
Structures	21.5	26.4
Residential Buildings	7.2	12.0
Skilled Labour	13.7	16.7
Unskilled Labour	-0.9	-1.1

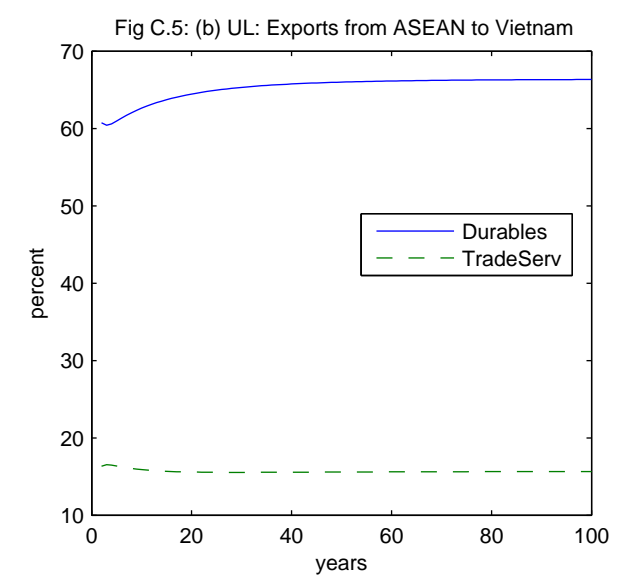
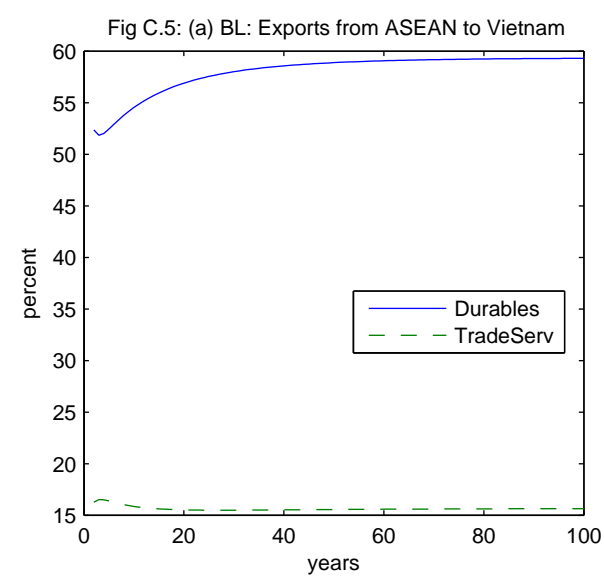
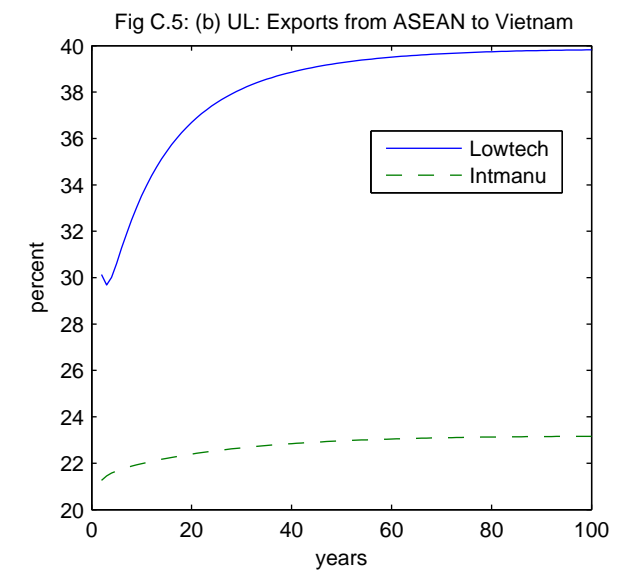
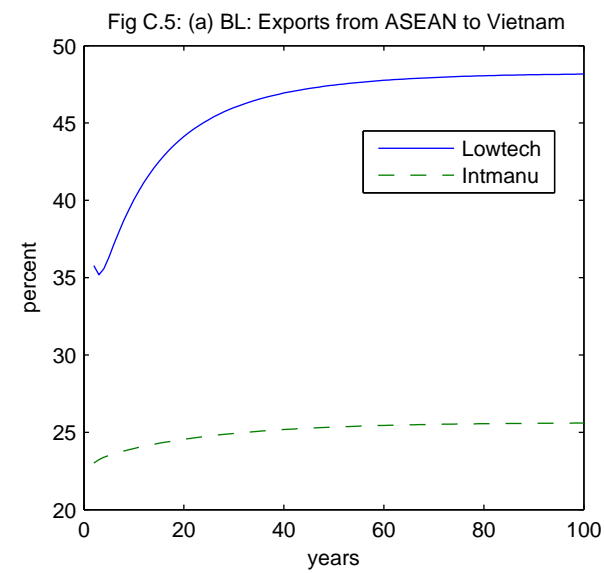
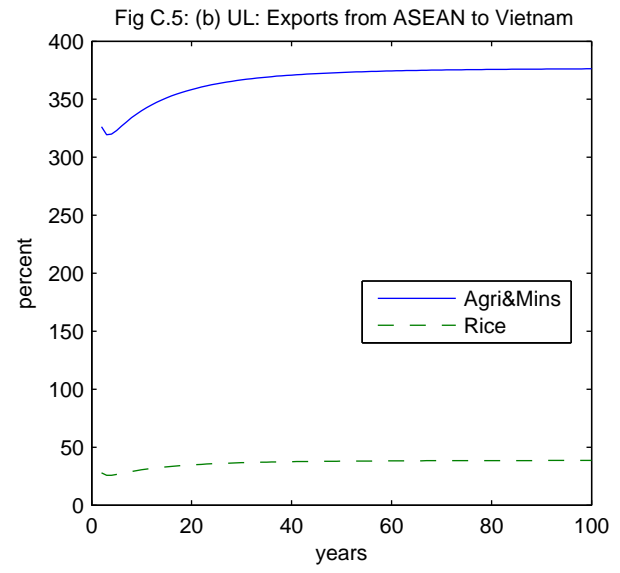
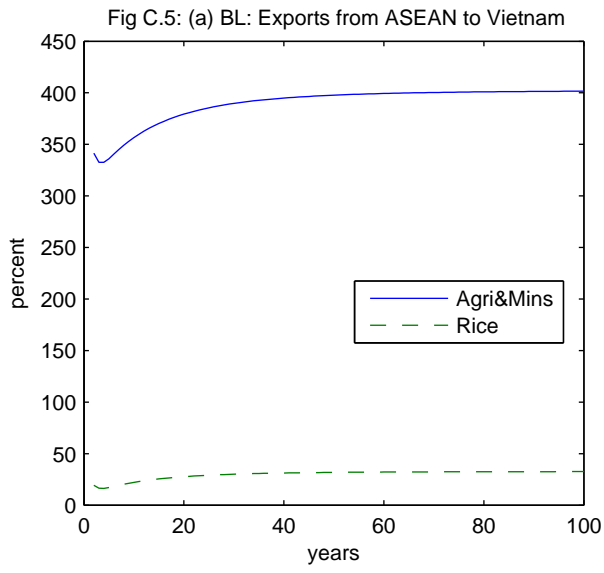












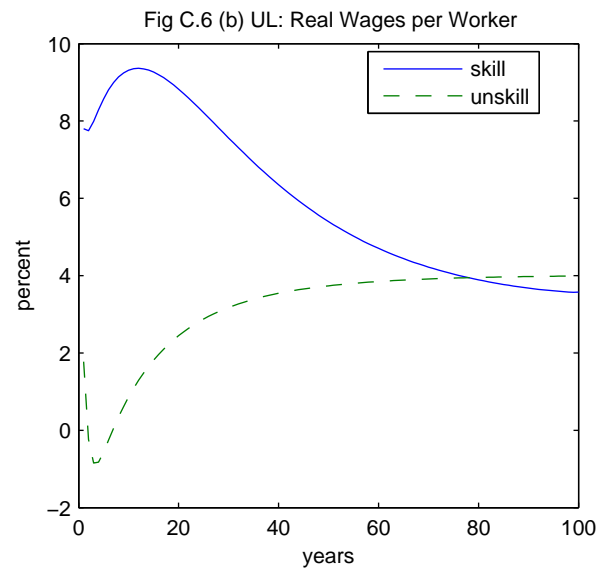
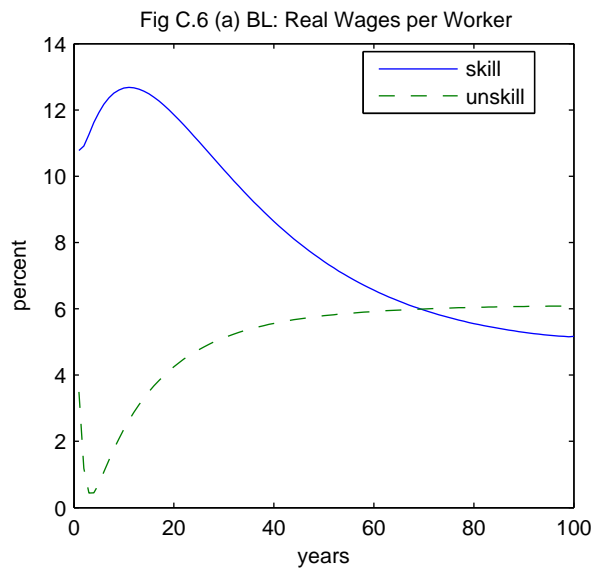
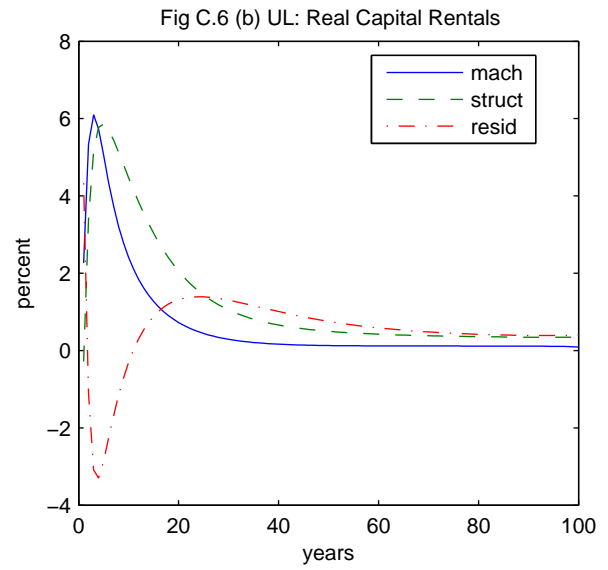
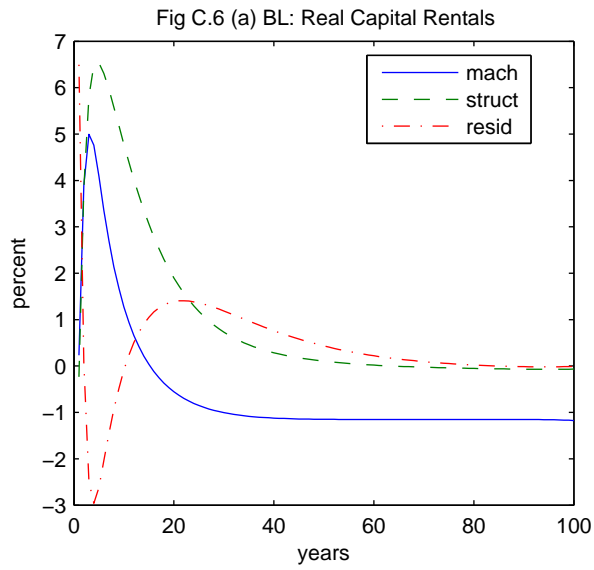


Fig C.7: (a) BL: Gross Capital Stocks

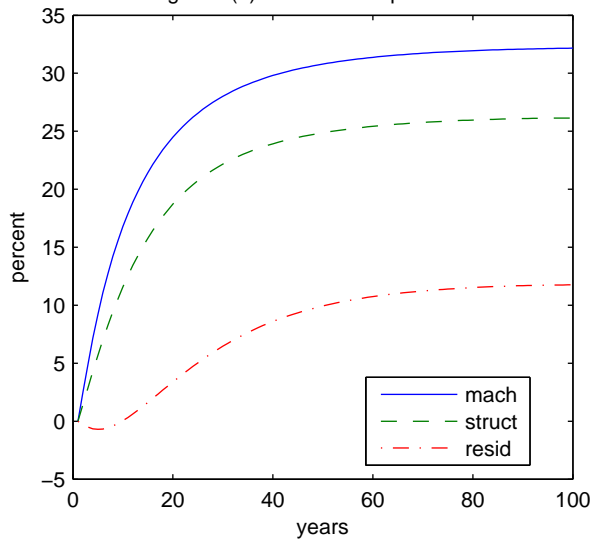


Fig C.7: (b) UL: Gross Capital Stocks

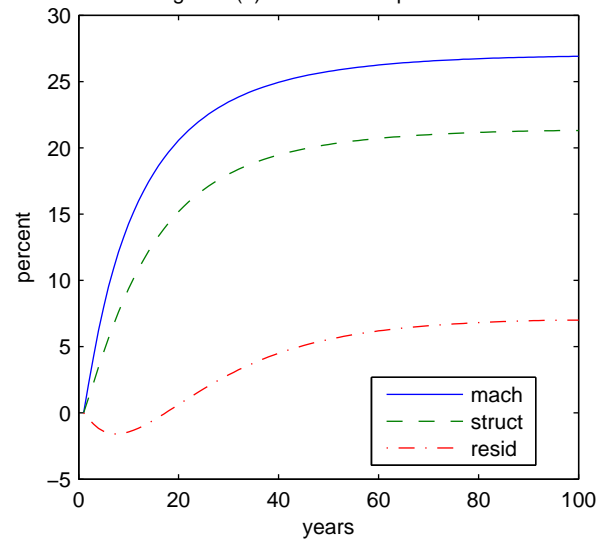


Fig C.7: (a) BL: Labour Supply

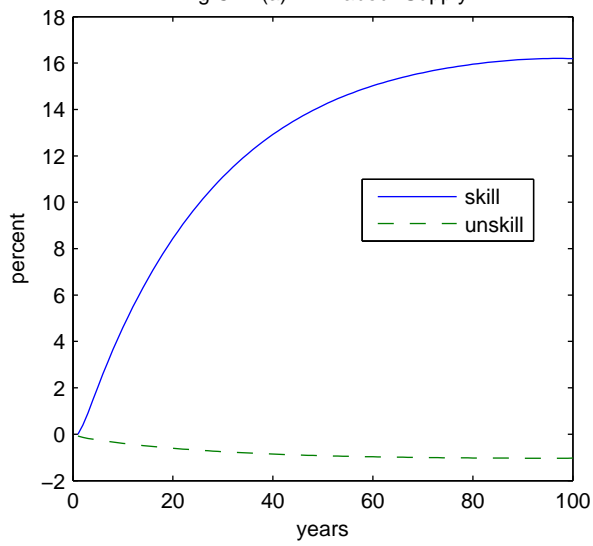
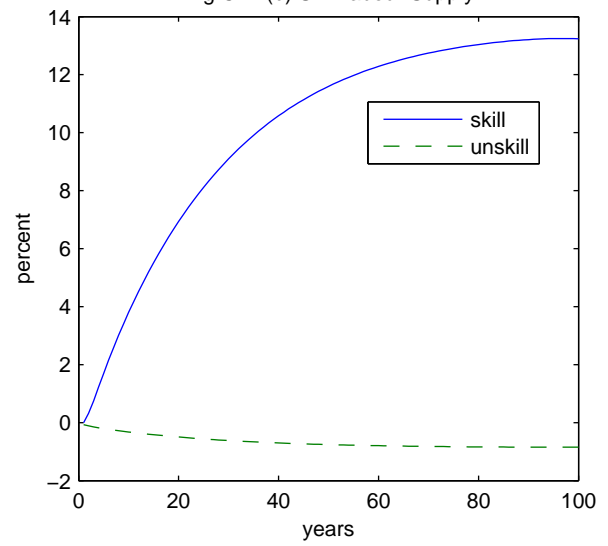
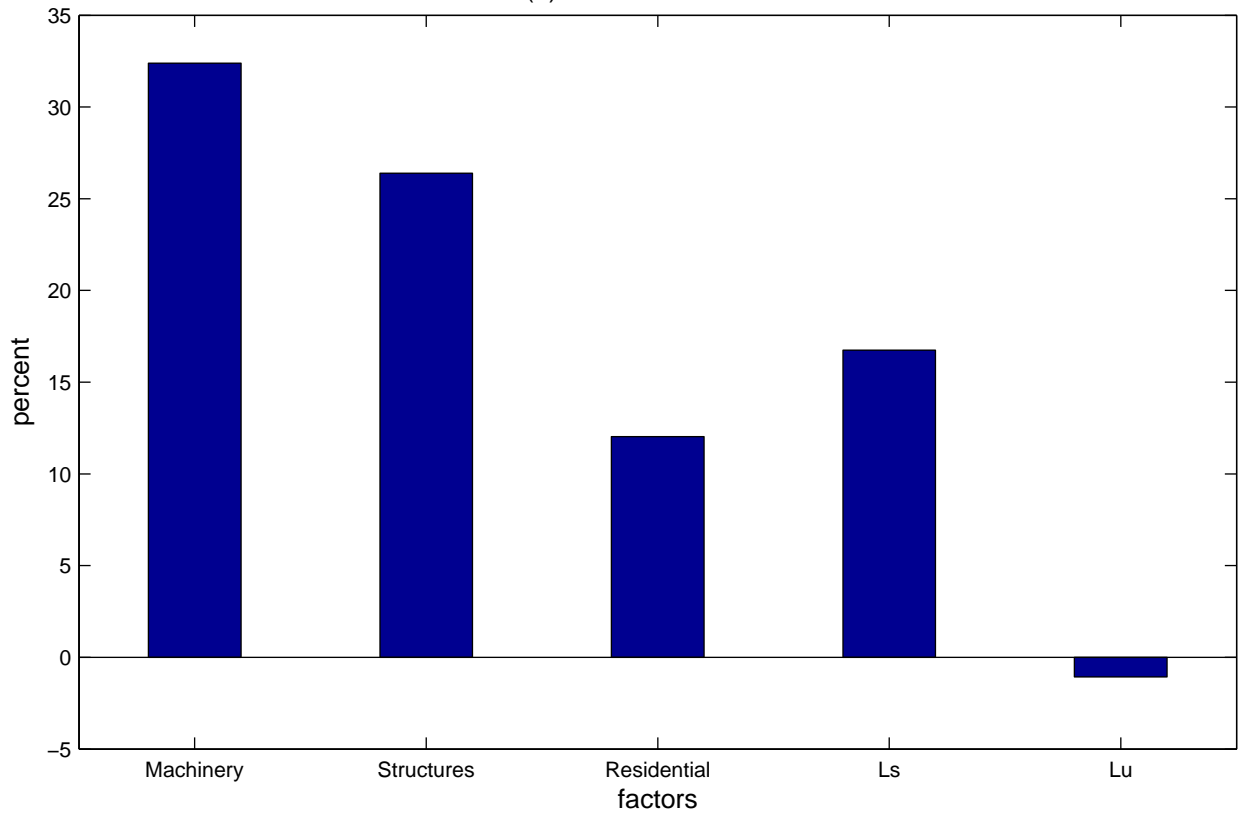


Fig C.7: (b) UL: Labour Supply



C.8: (a) BL: Factor Endowments



C.8: (b) UL: Factor Endowments

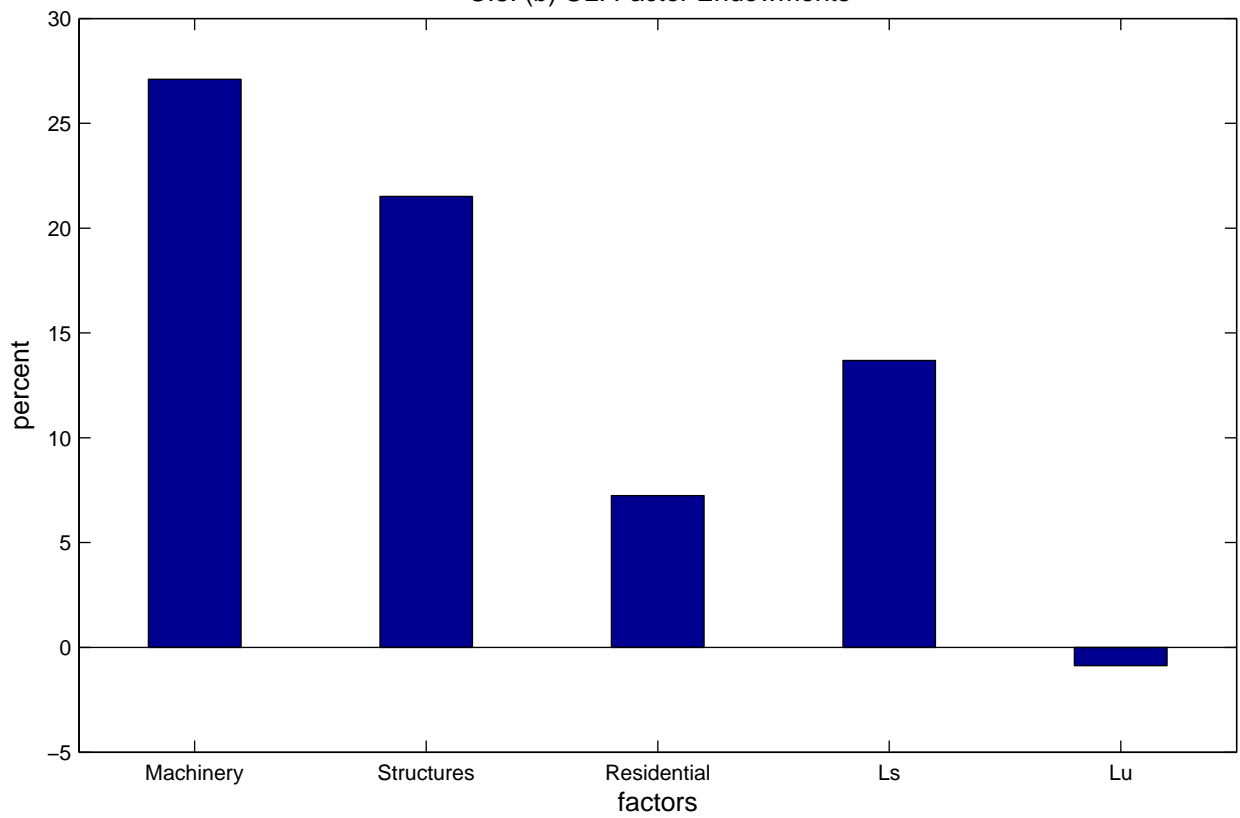


Fig C.9 (a) BL: Price of Rice

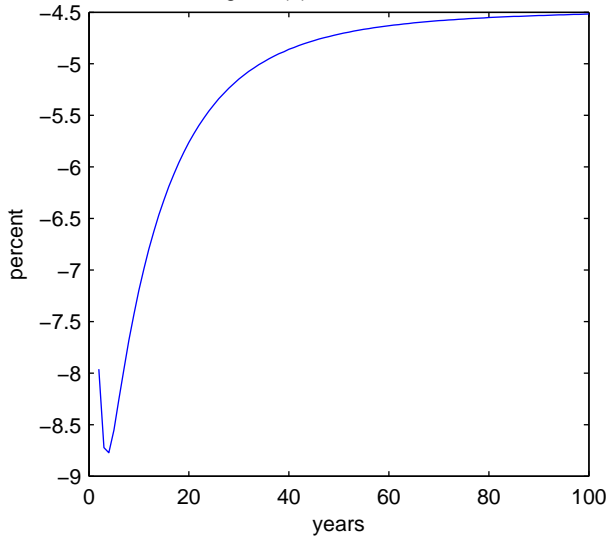


Fig C.9 (b) UL: Price of Rice

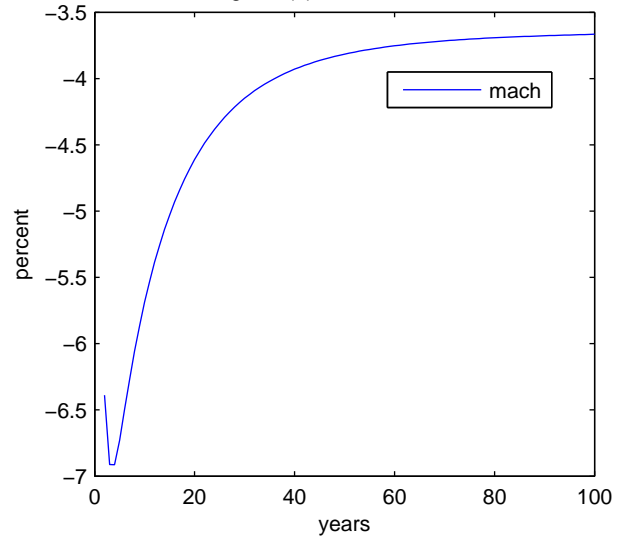


Fig C.9 (a) BL: Real Wages w.r.t Price of Rice

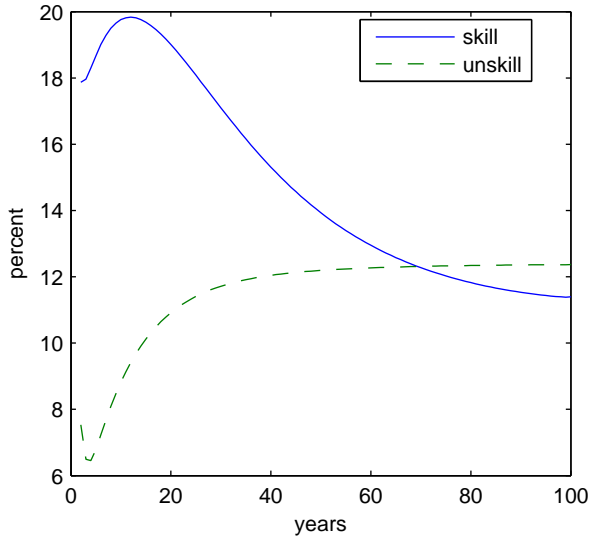


Fig C.9 (b) UL: Real Wages w.r.t Price of Rice

