Master Thesis

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Multilateral Free Trade Agreements: A Simulation Study.

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Abstract

This thesis analyzes the welfare effects as a result of trade liberalization between three countries, namely, the Netherlands, India and China using a general equilibrium scenario. Extending the Heckscher-Ohlin Trade model to a 3x3x3 setting, I use GAMS to simulate the trade results.

Milk is produced in the Netherlands capital intensively, followed by sugar which is produced labor intensively in India and electronics which is produced technological intensively in China. To analyze the welfare gains between the three countries, I have simulated two scenarios, namely, (a) a normal free-trade scenario and (b) an ambitious free trade scenario.

To liberalize trade, import tariffs between the Netherlands and India are reduced in a normal free trade scenario by 25% and these import tariffs are abolished completely in the ambitious free trade scenario. As a result of this trade liberalization, there is a rise in the welfare levels, more goods are produced and more goods are traded between these three countries.

The free trade scenarios lead to trade creation between the three countries. Market access for India into the Netherlands has improved in the sugar sector. There is also an improvement in market access for the Netherlands into India in the milk and electronics sector. However, there is a small decrease in market access into China for the Netherlands. There is also an increase of 26% in the production of milk in the Netherlands and Sugar in India. There is a mere 1% increase in the production of electronics in China.

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Chapter 1
Introduction

1.1 Background

According to Paul Samuelson (1983) international trade is the life blood of global economic growth. There is no denying this obvious fact. However what needs to be questioned are the terms and conditions on which such a trade is conducted. Joseph Stiglitz (2001) has qualified the above statement by stating that historical evidence suggests that unfair trade terms has led to colonization of whole continents and a majority of human populace by a few developed countries notably Great Britain, France and the United States of America; as a result of which large swathes of human populace have suffered untold miseries and deprivation for the benefit of a few. As such fair trade terms need to be ensured for the smooth flow of international trade leading to global economic growth which would be beneficial for all. In such circumstances the question that begs to be answered is how could one define which terms could be called fair and which are not! Furthermore it would also need to be explored whether such ‘fair’ terms are absolute in nature or would they vary from time to time and commodity to commodity. Furthermore it will also need to be verified whether such terms will continue to be considered as fair in multi-lateral trade between countries.

In my bachelor thesis, I had performed a partial equilibrium analysis using a simulation approach in order to analyze the welfare, output, trade of and the market price for produce sold by the Indian farmers. I paid special emphasis on the EU – India Free Trade Agreements (FTA) in the cotton and the wheat sectors. By utilizing the Global Simulation Model (GSIM), I found that the FTA was indeed beneficial to the Indian farmers. The simulation model results suggested that increase in trade results in increased output and dropping of the price of cotton and wheat. However it is obvious that such a bi-lateral free trade agreement, in this instance between India and EU would not lead to similar results in the case of a multilateral free trade agreement. Also, before engaging in any multilateral free trade agreements, the Indian Government may want to carefully analyze the comparative advantages derived by its trading partners. Hence I have undertaken to conduct an in depth analysis of such a multi-lateral trade agreement between China, India and the Netherlands.

1.2.The Research Objective

The basis of the Eli Heckscher and Bertil Ohlin (HO) model of international trade lies in the David Ricardo's theory of comparative advantage. According to Ricardian model of comparative advantage, countries trade because of the difference in labor productivity. However, according to the HO model, countries prefer to export those goods which use the relatively abundant domestic factors of production and import those goods that use relatively domestic scarce factors of production. One of the main assumptions of the HO model is that it is not necessary for these production "technologies" between countries to vary. As a result, there are identical technologies in all countries. Comparative advantage is thus determined by relative endowments of factors of production.

As such a country which is capital abundant will export the capital intensive good, and labor abundant country will import this good and export labor intensive good in return. Under free trade, this improves the terms of trade, thus both countries gain from trade. However according to the Stolper-Samuelson theorem, after trade liberalization, real wage falls (rises) and rent rises (falls) for the capital abundant (labor abundant) country. Also, we have factor price equalization (FPE), when there are no trade barriers, identical production technologies in both countries, and both countries produce both goods. If any of the above assumptions are violated, we will not have FPE.

The standard HO model is also popularly known as 2x2x2 model as it takes into consideration two countries, two goods that are produced and two factors of production. The model requires a variable factor proportions between countries, for instance; highly developed countries have a higher capital to labor ratio compared to developing countries. As a result, the developed country is capital abundant and the developing country labor abundant. Another assumption of the model is that production of goods exhibit constant returns to scale (CRS) technology. Both factors of production, labor and capital, are used as inputs to produce a single good. CRS technology implies that the production function is homogeneous of degree 1; that is if both inputs are doubled, the output of the good is also doubled.

According to the Rybczynski theorem, when the amount of one factor of production increases, the production of the good which uses that factor of production intensively increases relative to the increase in the factor of production. Formally, given relative prices, an increase in the relative endowment of a factor, will relatively increase output in the sector that uses that factor intensively, and will decrease output in the other sector.

In this thesis, I extend the standard 2x2x2 HO model to a 3x3x3 model by taking into consideration three countries (The Netherlands, India and China), three homogeneous goods (Milk, Sugar and Electronics), and three factors of production (Capital, Labor and Technology). I wish to estimate the effect of trade liberalization between the Netherlands, India and China on their welfare levels. A 2004 simulation study, based on the conclusions from the Doha Round, in which a free agricultural trade scenario was employed, studied the possible impact of trade liberalization on welfare using the Global Trade Analysis Project (GTAP). Results of this study indicated that not only developed countries but also developing countries benefit from welfare gains as a result of trade liberalization (Conforti et al. 2004).

I have assumed the Netherlands to be relatively more capital abundant and produce the capital intensive good milk, India to be relatively more labor abundant and produce the labor abundant good sugar and China to be relatively more technology abundant and produce the technology abundant good Electronics. Thus according to the Heckscher-Ohlin theorem, the Netherlands exports Milk, and is imported by India and China, India exports sugar, which is imported by the Netherlands and China, and China exports electronics, which is imported by the Netherlands and India.

As such this research looks at trilateral trade between the Netherlands, India and China. The Netherlands specializes in the production of Milk, India specializes in the production of Sugar and China specializes in the production of electronics. We use a general equilibrium approach and simulate a Heckscher-Ohlin model using General Algebraic Modeling System (GAMS) to understand as to what happens when the three countries are endowed with relative production technologies and factor endowments? What are the gains from trade? What is the impact of lowering import tariff on the price of Milk and Sugar? This leads us to the main research question, which is as follows;

1.3 Research Question: How does a trade liberalization agreement between the Netherlands, India, and China affect the welfare levels in these countries?

1.4. Thesis Structure

The thesis is divided into seven chapters. The first chapter explains the research objective and the methodology proposed to be adopted for answering the question. The second, third and fourth chapter discuss the Indian Sugar, The Dutch Milk and the Chinese Electronic industries respectively and the role the three factors of production (labor, capital and technology) play in the countries deriving competitive advantage while conducting tri-lateral trade with each other. The fifth chapter undertakes a literature review of the extended Heckscher-Ohlin (3x3x3) model and also expounds on the data sources while explaining the model in detail. The model is operationalized in chapter 6 and the results are displayed. The last and final chapter is the concluding chapter which explains the results along with policy recommendations followed by references and appendix.

Chapter 2

Indian Sugar Industry

2.1 Indian Sugar Industry

Indian agriculture, as in most other countries, is highly subsidized by provision of cheap inputs such as cheap fertilizers, free power and irrigation water and assured market price support by the Government of India. Furthermore the tropical climate of the country necessitates that the sugarcane crop be cultivated entirely on irrigated land, hence irrigation assumes tremendous importance. Due to lack of adequate capital resources and to promote the agriculture sector the government promoted creation of farm cooperatives. The remarkable success of few cooperatives resulted in the government deciding in 1954 to grant exclusive industrial licenses for manufacturing sugar to co-operatives alone. This decision of the government gave a major fillip to the growth of sugar cooperatives in India (Banerjee, et. al. 2001).

The government had by then decided to play a major role of a dominant stakeholder and market regulator in the agriculture sector. This not surprisingly led to the strengthening of the nexus between the sugar cooperatives and government. Hence it is not surprising to note that when there is an interlocking in the positions of the regulator and the regulated, the setting is provided for creation of distortion of markets by way of spending on selected projects, programs and grants that concentrate the benefits in geographically specific constituencies but are financed by broad-based taxation. Such being the ties between sugar cooperatives and the politics, it could inferred that, perhaps the beginning of cooperatives itself was a result of the political clout that the rich peasants enjoyed (Khekale, 1999).

Indian domestic sugar market is one of the largest markets in the world; in volume terms (KPMG, 2007). Considering that sugar is one of the most important cash crops in the world (Kansal, 2007) the sugar economy in many ways represents a “microcosm” of the Indian economy in which there are inter-meshed a wide range of interests of various inter regional and inter-class groups (Gulati and Narayanan,2003).

The world sugar market has experienced considerable price volatility in the recent past. The world indicator price for raw sugar has witnessed a succession of peaks and downward corrections in past decade (OECD-FAO Agricultural Outlook 2011).Market fundamentals driving volatile prices were large global sugar deficits in the previous and adverse weather in a number of countries that reduced the size of the expected production. Similar scenarios were also witnessed in India (Chakradeo, 2005).

Furthermore it would be relevant to note that sugarcane production is a labor intensive activity (Attwood, 1992); as such it would be of academic interest to ascertain the impact of changes in labor productivity on the competitive advantage availed by India while exporting sugar to other countries particularly the EU.

2.2 Role of Subsidies and Regulations

It is obvious to all that the generous government subsidies and the regulatory mechanism was designed with a view to appease masses for the sake of gaining political power, though it was cloaked in the garb of development of domestic industry and it all began in the immediate years following independence in 1947. For instance, most of the available water was diverted to the sugarcane crop alone at the expense of other crops (Thakkar, 2000). In addition to this, further covert subsidy was also offered by way of lower water rates to all the sugarcane growers (World Bank, 2004). This was despite the known fact that sugarcane is a water guzzler. It was also patently unfair to farmers of other crops such as groundnuts and jowar, which need very little water. Sugarcane cultivators are also large consumers of electrical power and as such also gain substantially from power subsidies. This further encourages sugarcane cultivation at the expense of other crops. The government further assists the sugar industry with cheap credit and storage facilities apart from export incentives (Khekale, 1999).

Sugar falls under the Essential Commodities Act, 1955 and hence the government has empowered itself to procure a certain quantity of the sugar manufactured at a certain price worked out by it and which is expected to cover the cost of production. The sugar procured in such a manner is then sold through the Public Distribution System (PDS) at prices lower than the “free market” price. The objective of this kind of transaction is to supply sugar to the poor sections of the society at a subsidized price. As a natural consequence of such procurement, the market for sugar is further distorted to the advantage of the sugarcane cultivator and sugar manufacturer.

Government controls with regards to sugarcane production were even more stringent particularly with regards to sale of cane sugar within a specified area or zones as they are called. The concept of zoning signifies reserving the sugarcane cultivated in a specific area around each factory for that factory alone. The rationale for this regulation is to ensure sugar factories from being starved of raw material. In turn the cane growers are also expected to benefit by way of an assured market price for their produce. In reality a possible implicit reason of zoning could be to keep the cane price and thereby the sugar price under check. This policy also prevents the cultivator from taking his produce to another factory which may offer a higher price.

The government has also formulated a policy whereby the cultivator is paid on the basis of sucrose content of the crop cultivated by him. However, this policy of setting cane prices based on 'average recovery rate' for the factory appears to be clearly in conflict with the government's own zoning policy as it ties down the farmer to an inefficient factory which just happens to be located near his farm.

2.3 Input Pricing Policy

The Sugarcane (Control) Order 1950 also empowered the central government to fix a uniform minimum cane price on an all India basis designated as statutory minimum price (SMP) The SMP is presently linked to a recovery rate of 8.5 per cent and is binding for all states of the country (Raghupathy et al. (2003)). The stated rationale for government intervention in setting a statutory minimum cane price is to protect the interests of farmers.

The factory owners have to shoulder the responsibility of transporting their cane to the factory gate from the cane producing fields. However the owners deduct the harvesting and transportation costs from the SMP and consider the net SMP as the price payable by them to the cultivators. The rationale for the factory undertaking harvesting and transportation activities is that it would result in better coordination of crushing and economies of scale in transportation. Such policies instead tend to distort the market even more to the detriment of fair trade terms.

2.4 Integration of Indian Sugar Market into World Sugar Market

One of the characteristics that differentiate the world sugar market from any other commodity market is the requirement of widespread production of sugar crops (OECD, 2007). Four countries, namely, Brazil, India, China and the European Union collectively represent 50% of world sugar production (FAO). Globally, India is the largest consumer of sugar and the second largest producer of sugar. Major countries producing sugar are also the leading exporters of sugar. India is however unique, since it has a large domestic consumption market. India has in the past managed its surplus and deficit using the world trade.

Chapter 3
Dairy Industry of the Netherlands

3.1. Background

The Netherlands is one of the most developed countries in the world with a long history of global trade. In addition to horticulture, the processed foods – particularly the dairy industry plays a major role in the growth and development of the Dutch economy. This high level of productivity in this sector is essentially driven by technological innovation, high regulatory standards, a skilled workforce and deployment of adequate capital. In addition the Netherlands' trade-oriented economy continues to be well-served by its networked waterways, strategic location in a wealthy neighborhood of innovative producers and sophisticated consumers, and access to global markets. (Fuller, Huang, et al. 2006).

3.2. The Role of the Government

The Dutch government has also been very supportive in providing a conducive environment for incubation of innovative products. Accordingly, the government has promoted policy and programs aimed at creating economic opportunities, ironing wrinkles and resolving bottlenecks in the interest of their national economic and business ecosystem. This is particularly so with regards to R&D collaboration, trade promotion, and invitation of foreign investments.

The government essentially promotes development of relevant clusters which would include large and small enterprises, knowledge institutes and trade promotion bodies to work collaboratively in the interest of a common strategic plan. The government also then deploys financial resources in addition to provision of guidance in implementation of the cluster development strategy. The national-level plans are then dovetailed into regional innovative strategies and connected to EU programs (FAO. 2006).

3.3. The Dutch Dairy Industry

The Netherlands is dairy country. It is a country of milk, butter and cheese, of farmland as far as the eye can see, windmills reaching into the sky and cattle grazing in their shadows. Dairy is the engine of the Dutch economy (Henriksen et al., 2009). Dairy farming and the dairy industry provides employment to thousands of people and generates billions of euros in revenue. Barn builders, livestock feed companies, breeding farms, wholesalers, business services and many other companies thrive around this sector. Together, they constitute a strong dairy cluster.

Its importance for the Dutch economy is underscored by the large and growing international trade. The dairy sector accounts for 9% of the Dutch trade surplus and significantly contributes to the earnings capacity of the Netherlands (Dutch House of Representatives Proceedings, 2014-2015).

The Dutch dairy sector is one of the most productive in the world. It possesses the knowledge and technology to meet this growing demand and to contribute to global food security. The country's climate, its soil and logistic prowess give the Netherlands an intrinsic competitive advantage as a production location, especially once the milk quota is abolished in 2015 (Nicholson et al., 2011).

The international reputation of the Dutch dairy sector's quality and entrepreneurship are important competitive advantages in serving the new middleclass in emerging countries. Behind the industry stands a modern, innovative and entrepreneurial economic sector of dairy farming and industry, 19,000 farms and 1.5 million cows produce 12 billion kilos of milk per year.

Milk production per cow is highest in the world and through gradual expansions Dutch dairy farms are realizing increasingly higher and more efficient yields. They do this with enormous care for the wellbeing of the animals. Most dairy farmers have organized themselves into cooperatives through which they sell their milk to the cooperative-owned milk processing company. The cooperative gives farmers security, market power and an investment in the next generations.

The dairy sector is part of a larger dairy cluster. Wholesalers buy dairy products which retailers and catering companies sell to consumers. There are companies that supply special semen for breeding new cattle with higher yields. Other companies supply animal feed, products to make or keep animals healthy, the newest barns and machinery, financial services, education, knowledge and technology.

The Dutch dairy sector exports not only dairy products, but also expertise, technology and dairy farmers. Friesland Campina's Dairy Development Program is one example: knowledge and people are sent to dairy farms in Asia and Africa to support their development.

Experienced people help local dairy farmers increase their yields and assist them in the process of joining the international quality system.

Growing demand offers the Netherlands many opportunities to export not only dairy, but also expertise. The OECD and FAO expect that producers in emerging countries in Asia and Africa will not be able to keep up with rising local demand for milk powder and ingredients.

Chapter 4

Electronic Industry of China

4.1 Chinese Electronics Industry

China's electronics industry has played a key role in the economic growth of the country. Hence the Chinese government continues to play a major role in promoting the rise of this industry by adopting selective market policies which facilitate the further growth of the industry. It also helps in pushing leading market players such as Huawei into dominant positions globally resulting to the strategic development of the industry as a whole. Apart from consumer electronics, the sector is dominated by foreign-invested enterprises (FIEs) such as Foxconn and Qualcomm which are the real owners of much of the core technologies used in production (China's Electronics Sector, WTO, 2011). Apart from government support, a combination of factors have driven industry growth in recent years which include strong domestic demand and technological development such as "Internet of Things", network convergence, and 3D visual displays.

In 2013, trade value of electronics comprised 35 percent of national foreign trade, totaling USD 971.9 billion (Eurostat, 2013). This industry has witnessed rapid growth in exports notably to EU and the United States due to the competitive advantage enjoyed by Chinese exporters. This phenomenon is largely dependent upon scale advantages availed by China. This is largely due to deployment of modern industrial production technology.

4.2. Growth of Electronic Industry

International trade from China's electronics industry comprised more than 30 percent of its overall trade in recent years, even during the global economic crisis. In 2014, China mainly exported electronics to Hong Kong, The United States, Japan, South Korea, Netherlands, Germany, Singapore, Taiwan, and India. The export value to the top 10 countries and regions accounted for up to 73.4 percent of overall export value of electronic products, equaling USD 534.54 billion. A number of drivers enabled China's electronics industry. These include strong market share, massive government support and technological competancy.

There is a big domestic demand for electronics, such as home appliances, even in rural areas where over 800 million people reside. As the divide between rural and urban population is shrinking and the rural areas are becoming more developed, there is a growing market demand and customer base for consumer electronics products (Cheung, et al. 2010). Another major reason for the rise of this sector is the 2009 boom in China's real estate market which has also driven up the demand for household appliances (Ahmed, 2009). The growth in the automobile industry also spurred the growth of demand for automotive electronics.

The Chinese government has boosted development of its electronics industry through a series of stimulus plans such as "Home Appliances to the Countryside", "Replace the Old with New" and "Automobiles to the Countryside" programs. Keeping in line with its macro-development policy objectives of increasing energy efficiency, energy conservation, and emissions reduction, Chinese government regulations and subsidies have also fostered development in the electronics industry (Chang-Tai et al., 2009).

4.3. Government Policy for Promoting Growth

The Chinese government's promotion of technologies that enable energy conservation and emissions reduction bring forth the opportunity for consumer electronics manufacturers to meet market demand and to develop and promote high efficiency and low carbon products per government requirements. Considering that China is searching for companies' possessing advanced expertise in electronics technologies, particularly energy conservation and environmental protection, it will welcome such enterprises to collaborate (Dani, 2006).

In September 2010, the State Council approved measures to accelerate the development of key strategic industries as well as continue reforms and improve the stability of the economic restructuring. The development of strategic industries include: energy conservation and environmental protection, new generation information technology, bio technology, high end equipment manufacturing, new energy, new materials and alternative fuel sources.

The "Internet of Things" is considered a strategic emerging industry and a key part of a new-generation information technology. It is reported that the government will invest RMB 3.86 trillion before 2020 into research and development related to sensor network technology, which includes components, systems integration, and data mining or analysis platforms to push forward Radio Frequency Identification (RFID) and sensor networks in China. (Sutherland, 2005). "Energy Saving Products Benefiting People" is a project to promote the use of energy efficient products, including high energy-efficient lighting products, air conditioners, TVs, washing machines, automobiles and others.

Domestic manufacturers have spent substantial time and money on research and design of new products, aiming to incorporate the latest trends. Such appliance manufacturers are also beginning to target the high-end market, which is more profitable and less competitive (Amiti et al., 2010). They are beginning to invest more in product efficiency and differentiation as well as personalized and fashionable design.

4.4. A SWOT Analysis of the Electronic Industry

China's major domestic consumer electronics firms have made great progress in technological development of general electronics such as color TVs, washing machines, and refrigerators. However, compared with leading global electronics manufacturers, such as Sony, Samsung or Apple, most Chinese companies are lacking in indigenous innovation and are of falling behind in core technologies and R&D capacities. This has resulted in a concentration of industries using older technologies and hence must compete on price (Meng, et al., 2013).

China began issuing 3G licenses in January 2009, which spurred ample opportunities for mobile phones, communication-related IC and chip businesses and will continue to do so. Statistics showed that by the end of 2009, there were about 11.4 million 3G mobile phone users in China, about 1.5 percent among total mobile users. But by the end of September 2013, this number grew to 134.99 million, with a growth rate of over 300 percent. The number of 3G mobile phone users is likely to keep growing given the large market potential in China.

In order to develop its network convergence, China's government will introduce preferential fiscal and taxation policies to promote R&D and industrialization if key technologies, basic technologies and other network convergence-related technologies (Lall, 2000). Additionally, the government will add convergence products and services into the government procurement list.

The huge growth in China's automobile industry has also driven the growth of the automotive electronics industry. Statistics show that market value of the automotive electronics industry in China in 2013 reached RMB 448.43 billion (USD 26.4 billion) and is expected to reach RMB 800 billion (USD 65 billion) in 2014. Medical and industrial electronics will also rapidly develop in the next few years.

4.5. Dominance of Television Industry

There is currently a strong market demand of Flat Panel Display (FPD) in China, particularly in the areas of TVs, mobile phones, and computers. In 2014, production of FPD TVs was over 66 million units, the largest color TV manufacturer in the world. FPDs can broadly be divided into Liquid Crystal Displays (LCD), Plasma Display Panels (PDP), and Organic Light Emitting Diodes (OLED). Currently the majority of Chinese companies have only developed capabilities for Thin Film Transistor (TFT)-LCDs (Schott, Peter, 2008).

Over 10 cities in China planned to build 13 6G and above TFT-LCD projects and 6 8G and above TFT-LCD projects, which will greatly increase production capacities of TFT-LCD in China in the near future. It is predicted that output value of TFT-LCD will be over USD 130 billion by 2015, accounting for 90 percent of the whole FPD industry. The PDP and OLED segments have yet to reach a stage of development similar to the TFT-LCD segment and much of the recent R&D efforts by industry and government have focused on PDP and OLED (Di Giovanni, Julian et al., 2007).

4.6. Future Challenges

China's electronics industry is still in a nascent stage of development due to a relative lack of scale, R&D capabilities, capital, and integrated supply chains. One of the reasons that Japanese and Korean enterprises are quite successful in the development of FPD is that they have complete industry chains from upstream to downstream to provide them with high quality and competitive raw materials and equipment. China is still dependent on foreign companies to import manufacturing equipment and raw materials, which increases the costs of production and reduces the competitiveness in global market.

Chapter 5

Literature Review, Data Sources, Model, Methodology

I begin this chapter by giving a brief literature overview of the Heckscher-Ohlin Model in section 5.1. In section 5.2 I explain the extension of the 2X2X2 Heckscher-Ohlin setting to a 3X3X3 setting. This is followed by a brief overview of my data collected in a tabular form in section 5.3. Section 5.4 explains the scenario in autarkic situation where there is no trade at all. In section 5.5 I explain the Micro-Consistency Matrix, which is an input-output matrix that helps fit the data collected into the model. Section 5.6 shows the comparative static to be performed in the model. Section 5.7 looks at the sensitivity analysis.

5.1 Literature Review

Eli Heckscher (1919) and Bertil Ohlin (1933) developed the theory of international trade by considering the relationships between factor endowments possessed by different nations and commodities exported/imported by them. The theorem is based on the general equilibrium form of analysis. In other words the Heckscher-Ohlin (H-O) theorem states that countries will export those commodities which intensively use in their production those productive factors which are found locally in relative abundance. It is but natural then to witness that such commodities are more freely exported than others. This happens because the productive factors are not completely mobile. The theorem also assumes identical levels of technology in both countries.

Let us assume a country possesses a larger quantum of all factor endowments than another. However only one factor will assume greater importance due to absence of scale advantages where other factors are concerned. For instance; a country would said to be relatively labor abundant if the ratio of its endowment of labor to that of capital exceeds the corresponding proportion elsewhere. Similarly the same country could also be defined to be relatively labor abundant if its wage rate is lower before trade than is the foreign wage.

The H-O Theorem was first tested by Wassily Leontief. He analyzed the data of U.S. trade in 1947 and attempted to determine whether the U.S., which was the most capital abundant country in the world, was exporting capital intensive goods and importing labor intensive goods as predicted by the theory. However he found that exports were 30% more labor intensive than capital intensive. These findings were indeed contrary to what the theorem predicted and became known as the Leontief Paradox.

Yet another scholar, Wood, (1947), who reviewed the theorem, appeared to be more willing to give the H-O theorem a second chance. His paper was appropriately titled "Give Heckscher and Ohlin a Chance!". He criticized past critiques of the H-O Theorem as erroneous and misleading because according to him they wrongly treated capital as immobile and similar to land. Wood concluded that because capital is internationally mobile, it doesn't actually influence the flow of trade, and went on to suggest that when capital is excluded, the H-O Theorem often seems to perform rather well. Instead Wood compared trade between pairs of countries deploying different levels of skill in manufacturing of goods which were then traded. He then found the predictions made by the theorem to be more accurate.

Subsequently, another team of economists led by Bowen, H.P; (1974) conducted further analysis of the factor relationships highlighted by the theorem. Their study analyzed 12 factors of production for 27 countries. It also expanded the H-O Theorem to allow for technological differences. Naturally the expectation under the H-O theorem would be that a country would export those goods for which its factor share exceeded the income share. However the researchers were surprised to note that trade did not occur in the direction as predicted by the H-O theorem.

While the studies mentioned above seem to conclude that the H-O theorem is an insufficient model of international trade, some two-country studies do find support for H-O. In a 1993 study Richard A. Brecher and Ehsan U. Choudhri analyzed bilateral trade data between the U.S. and Canada, using a different variation of the H-O model. They found that the most robust results come when factor-price differences between industries as consequences of imperfect factor mobility are taken into consideration. Hence the authors concluded that the empirical evidence does indeed support the H-O model after modifications to account for inter-industry differences in factor prices are considered.

Krugman, P., (2000) also had pointed out that though various results have confirmed the Leontief paradox yet on a broader level trade often does run in the direction that the H-O theorem predicts. However he has also stated that although the H- O model does poorly, we do not have anything that does better.

However not everybody agrees with the proposed theory, for instance; Trefler (2005) who tested the theory empirically several times and found it to be wanting. He went on to say that factor endowments do correctly predict the general direction of trade yet fails when more factor endowments and countries are added to the model. Despite this, the theorem continues to be relied on because variations of the theory have proven to be useful in analyzing the different factors that which trade.

Several other researchers also made notable contributions with regards to modifications and applications of this theorem for instance; as Bardhan (1965) and Oniki and Uzawa (1965) studied the patterns of trade specialization in which consumers have fixed savings rates whereas Deardorff and Hanson (1978) considered a model in which these fixed savings rates differ across countries and then went on to show that the country with the higher savings rate will export more capital intensive goods. Chen (1992) studied the long-run equilibrium of two-country, dynamic H-O models with utility-maximizing agents and identical preferences in both countries. He found that a steady state is reached where almost all participants have positive trade growth.

Welfare gains of about 4 – 20 % in real GNP can be realized according to a study conducted in 1999 which researched on the Free trade possibilities between the Mediterranean countries and the EU (Hoekman, 1999)

A recent simulation study in 2003, shows that there is a significant impact on the welfare of Japan when there is FTA between Japan and its neighboring countries in Asia (Kawasaki, 2003). Kawasaki further suggests that liberalization in not just trade but also investment would be important for economic partnership in Asia.

Despite all this, results from the various tests of the H-O theorem do vary. Yet they reveal to us some important things about the underlying principles of international trade theory. The most important difficulty appears to be ascertaining a methodology which will accurately measure a country's factor abundance ratio particularly that of capital and labor. Another difficulty that the studies demonstrate is in measuring factor intensity, since it is difficult to measure exactly labor and capital levels within a certain goods, and harder still when one takes into consideration more factors of production. In the final analysis the theorem appears to be more reliable when only two factors of production and two countries are considered and becomes more unwieldy when additional factors and countries are added.

5.2 The Model

The standard 2x2x2 HO model is extended to a 3x3x3 model. The three countries are Netherlands (NL), India (IN) and China (CN). All countries are identical in the production technologies used. Three input factors, namely Capital (K), Labor (L) and Technology (T) are used to produce three final goods Milk (M), Sugar (S) and Electronics (E). The Cobb Douglas production function is given as:

$$\boldsymbol{X_i = L^{\alpha_i} K^{\beta_i} T^{\gamma_i} \quad i \in \{1, 2, 3\}} \qquad \textbf{(Equation 5.1)}$$

The production function for Milk, Sugar and Electronics is obtained by substituting $i = 1$, $i = 2, and\ i = 3$ in equation 5.1. The exponents in the above equation add up to one, that is the production function exhibits constant returns to scale (CRS). In other words the function is homogeneous of degree one. The amount of labor used in the production of good i is given by L^{α_i}, the amount of capital used in the production of good i is given by K^{β_i} and the amount of technology used in the production of good i is given by T^{γ_i}.

Table 5.1 below shows the abbreviations used for each parameter and variable in the model code

Table 5.1: Parameters and Variables used in the model

Parameters:	
tariffMilkNLCN	tariff on Milk imports in NL from CN
tariffMilkNLIN	tariff on Milk imports in NL from IN
tariffMilkCNNL	tariff on Milk imports in CN from NL
tariffMilkINNL	tariff on Milk imports in IN from NL
tariffMilkCNIN	tariff on Milk imports in CN from IN
tariffMilkINCN	tariff on Milk imports in IN from CN
tariffSugarNLIN	tariff on Sugar imports in NL from IN
tariffSugarNLCN	tariff on Sugar imports in NL from CN
tariffSugarCNNL	tariff on Sugar imports in CN from NL
tariffSugarINNL	tariff on Sugar imports in IN from NL
tariffSugarCNIN	tariff on Sugar imports in CN from IN
tariffSugarINCN	tariff on Sugar imports in IN from CN
tariffElecNLIN	tariff on Electronics imports in NL from IN

tariffElecNLCN	tariff on Electronics imports in NL from CN
tariffElecCNNL	tariff on Electronics imports in CN from NL
tariffElecINNL	tariff on Electronics imports in IN from NL
tariffElecCNIN	tariff on Electronics imports in CN from IN
tariffElecINCN	tariff on Electronics imports in IN from CN
LNL	labor endowment in NL
KNL	capital endowment in NL
TNL	technology endowment in NL
LIN	labor endowment in IN
KIN	capital endowment in IN
TIN	technology endowment in IN
LCN	labor endowment in CN
KCN	capital endowment in CN
TCN	technology endowment in CN
alpha1	exponent for labor in Milk production
beta1	exponent for capital in Milk production
gamma1	exponent for technology in Milk production
alpha2	exponent for labor in Sugar production
beta2	exponent for capital in Sugar production
gamma2	exponent for technology in Sugar production
alpha3	exponent for labor in Electronics production
beta3	exponent for capital in Electronics production
gamma3	exponent for technology in Electronics production
Variables:	
MilkNL	production of Milk in NL
SugarNL	production of Sugar in NL
ElecNL	production of Electronics in NL
MilkIN	production of Milk in IN
SugarIN	production of Sugar in IN
ElecIN	production of Electronics in IN

MilkCN	production of Milk in CN
SugarCN	production of Sugar in CN
ElecCN	production of Electronics in CN
ExpMilkNLIN	milk exports from NL to IN
ExpMilkINNL	milk exports from IN to NL
ExpMilkNLCN	milk exports from NL to CN
ExpMilkCNNL	milk exports from CN to NL
ExpMilkINCN	milk exports from IN to CN
ExpMilkCNIN	milk exports from CN to IN
ExpSugarNLIN	sugar exports from NL to IN
ExpSugarINNL	sugar exports from IN to NL
ExpSugarNLCN	sugar exports from NL to CN
ExpSugarCNNL	sugar exports from CN to NL
ExpSugarINCN	sugar exports from IN to CN
ExpSugarCNIN	sugar exports from CN to IN
ExpElecNLIN	electronics exports from NL to IN
ExpElecINNL	electronics exports from IN to NL
ExpElecNLCN	electronics exports from NL to CN
ExpElecCNNL	electronics exports from CN to NL
ExpElecINCN	electronics exports from IN to CN
ExpElecCNIN	electronics exports from CN to IN
WFNL	welfare level in NL
WFIN	welfare level in IN
WFCN	welfare level in CN
pMilkNL	price of milk in NL
pMilkIN	price of milk in IN
pMilkCN	price of milk in CN
pSugarNL	price of sugar in NL
pSugarIN	price of sugar in IN
pSugarCN	price of sugar in CN
pElecNL	price of electronics in NL
pElecIN	price of electronics in IN

pElecCN	price of electronics in CN
wNL	price per unit labor in NL
wIN	price per unit labor in IN
wCN	price per unit labor in CN
rNL	price per unit capital in NL
rIN	price per unit capital in IN
rCN	price per unit capital in CN
zNL	price per unit technology in NL
zIN	price per unit technology in IN
zCN	price per unit technology in CN
INL	total income level in NL
IIN	total income level in IN
ICN	total income level in CN

The production functions are modelled using constant returns to scale technology (CRS) that implies they are homogeneous functions of degree 1.

$$\frac{\partial X_i}{\partial K_i} > 0, \frac{\partial X_i^2}{\partial^2 K_i} < 0; \quad \frac{\partial X_i}{\partial L_i} > 0, \frac{\partial X_i^2}{\partial^2 L_i} < 0; \quad \frac{\partial X_i}{\partial T_i} > 0, \frac{\partial X_i^2}{\partial^2 T_i} < 0 \qquad \textbf{(Equation 5.2)}$$

The factor input coefficients for labor, capital and technology are as follows

$$\frac{L_i}{Q_i} = \left(\frac{r.z}{w} . \frac{\alpha_i}{1-\beta_i-\gamma_i}\right)^{1-\beta_i-\gamma_i} \qquad \textbf{(Equation 5.3)}$$

$$\frac{K_i}{Q_i} = \left(\frac{w.z}{r} . \frac{\beta_i}{1-\alpha_i-\gamma_i}\right)^{1-\alpha_i-\gamma_i} \qquad \textbf{(Equation 5.4)}$$

$$\frac{T_i}{Q_i} = \left(\frac{r.w}{z} . \frac{\alpha_i}{1-\beta_i-\alpha_i}\right)^{1-\beta_i-\alpha_i} \qquad \textbf{(Equation 5.5)}$$

The cost of production has to be minimized under the constraint that the total production cannot be lower than the total demand for that particular good.

The first order conditions for the Netherlands with respect to Capital, Labor and Technology for profit maximization are given as follows

$$\frac{\partial X_i}{\partial K_{NL}} = \sum_{i=1}^{3} \frac{\beta_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{K^{\beta_i}} \qquad \textbf{(Equation 5.6)}$$

$$\frac{\partial X_i}{\partial L_{NL}} = \sum_{i=1}^{3} \frac{\alpha_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{L^{\alpha_i}} \qquad \textbf{(Equation 5.7)}$$

$$\frac{\partial X_i}{\partial T_{NL}} = \sum_{i=1}^{3} \frac{\gamma_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{T^{\gamma_i}} \qquad \textbf{(Equation 5.8)}$$

The first order conditions for India with respect to Capital, Labor and Technology for profit maximization are given as follows

$$\frac{\partial X_i}{\partial K_{IN}} = \sum_{i=1}^{3} \frac{\beta_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{K^{\beta_i}} \qquad \textbf{(Equation 5.9)}$$

$$\frac{\partial X_i}{\partial L_{IN}} = \sum_{i=1}^{3} \frac{\alpha_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{L^{\alpha_i}} \qquad \textbf{(Equation 5.10)}$$

$$\frac{\partial X_i}{\partial T_{IN}} = \sum_{i=1}^{3} \frac{\gamma_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{T^{\gamma_i}} \qquad \textbf{(Equation 5.11)}$$

The first order conditions for China with respect to Capital, Labor and Technology for profit maximization are given as follows

$$\frac{\partial X_i}{\partial K_{CN}} = \sum_{i=1}^{3} \frac{\beta_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{K^{\beta_i}} \qquad \textbf{(Equation 5.12)}$$

$$\frac{\partial X_i}{\partial L_{CN}} = \sum_{i=1}^{3} \frac{\alpha_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{L^{\alpha_i}} \qquad \textbf{(Equation 5.13)}$$

$$\frac{\partial X_i}{\partial T_{CN}} = \sum_{i=1}^{3} \frac{\gamma_i L^{\alpha_i} K^{\beta_i} T^{\gamma_i}}{T^{\gamma_i}} \qquad \textbf{(Equation 5.14)}$$

The goods market equilibrium in the Netherlands (NL) for Milk, Sugar and Electronics are given as follows

$$\boldsymbol{Milk_{NL}}:\ \boldsymbol{Q_{MilkNL} \geq \frac{1}{3} \frac{welfare_{NL} . P_{milkNL}^{\frac{1}{3}} . P_{sugarNL}^{\frac{1}{3}} . P_{electronicsNL}^{\frac{1}{3}}}{P_{milkNL}} + NL\ Milk\ Exports}$$

(Equation 5.15)

$$\boldsymbol{Sugar_{NL}}:\ \boldsymbol{Q_{SugarNL} \geq \frac{1}{3} \frac{welfare_{NL} . P_{milkNL}^{\frac{1}{3}} . P_{sugarNL}^{\frac{1}{3}} . P_{electronicsNL}^{\frac{1}{3}}}{P_{sugarNL}} + NL\ sugar\ Exports}$$

(Equation 5.16)

$$\boldsymbol{Electronics_{NL}}: \ \boldsymbol{Q_{ElectronicsNL}} \geq \frac{1}{3}\frac{welfare_{NL}.P_{milkNL}^{\frac{1}{3}}.P_{sugarNL}^{\frac{1}{3}}.P_{electronicsNL}^{\frac{1}{3}}}{P_{electronicsNL}} + \boldsymbol{NL\ electronics\ Exports}$$

(Equation 5.17)

Where Q represents total production of the good in the country plus imports of the same good from the remaining two countries. Hence Q_{MilkNL}represents the production of milk in the Netherlands plus the import of milk from India and China. P is the price of the good in a country. Hence, $P_{sugarNL}$ represents the price of sugar in the Netherlands.

Similarly, the goods market equilibrium in India (IN) for Milk, Sugar and Electronics are given as follows

$$\boldsymbol{Milk_{IN}}: \ \boldsymbol{Q_{MilkIN}} \geq \frac{1}{3}\frac{welfare_{IN}.P_{milkIN}^{\frac{1}{3}}.P_{sugarIN}^{\frac{1}{3}}.P_{electronicsIN}^{\frac{1}{3}}}{P_{milkIN}} + \boldsymbol{IN\ milk\ Exports}$$

(Equation 5.18)

$$\boldsymbol{Sugar_{IN}}: \ \boldsymbol{Q_{SugarIN}} \geq \frac{1}{3}\frac{welfare_{IN}.P_{milkIN}^{\frac{1}{3}}.P_{sugarIN}^{\frac{1}{3}}.P_{electronicsIN}^{\frac{1}{3}}}{P_{sugarIN}} + \boldsymbol{IN\ sugar\ Exports}$$

(Equation 5.19)

$$\boldsymbol{Electronics_{IN}}: \ \boldsymbol{Q_{ElectronicsIN}} \geq \frac{1}{3}\frac{welfare_{IN}.P_{milkIN}^{\frac{1}{3}}.P_{sugarIN}^{\frac{1}{3}}.P_{electronicsIN}^{\frac{1}{3}}}{P_{electronicsIN}} + \boldsymbol{IN\ electronics\ Exports}$$

(Equation 5.20)

Also, the goods market equilibrium in China (CN) for Milk, Sugar and Electronics are given as follows

$$\boldsymbol{Milk_{CN}}: \ \boldsymbol{Q_{MilkCN}} \geq \frac{1}{3}\frac{welfare_{CN}.P_{milkCN}^{\frac{1}{3}}.P_{sugarCN}^{\frac{1}{3}}.P_{electronicsCN}^{\frac{1}{3}}}{P_{milkCN}} + \boldsymbol{CN\ milk\ Exports}$$

(Equation 5.21)

$$\boldsymbol{Sugar_{CN}}: \ \boldsymbol{Q_{SugarCN}} \geq \frac{1}{3}\frac{welfare_{CN}.P_{milkCN}^{\frac{1}{3}}.P_{sugarCN}^{\frac{1}{3}}.P_{electronicsCN}^{\frac{1}{3}}}{P_{sugarCN}} + \boldsymbol{CN\ sugar\ Exports}$$

(Equation 5.22)

$$\boldsymbol{Electronics_{CN}}: \; \boldsymbol{Q_{ElectronicsCN}} \geq \frac{1}{3}\frac{welfare_{CN}.P_{milkCN}^{\frac{1}{3}}.P_{sugarCN}^{\frac{1}{3}}.P_{electronicsCN}^{\frac{1}{3}}}{P_{electronicsCN}} + \boldsymbol{CN\ electronics\ Exports} \qquad \textbf{(Equation 5.23)}$$

Next, the equations for the zero profit conditions for all the three goods in the Netherlands (NL) are given as follows

$$\boldsymbol{Milk}: \; \boldsymbol{P_{milkNL}} \geq \boldsymbol{w_{NL}^{\alpha_1} r_{NL}^{\beta_1} z_{NL}^{\gamma_1}} \qquad \textbf{(Equation 5.24)}$$

$$\boldsymbol{Sugar}: \; \boldsymbol{P_{sugarNL}} \geq \boldsymbol{w_{NL}^{\alpha_2} r_{NL}^{\beta_2} z_{NL}^{\gamma_2}} \qquad \textbf{(Equation 5.25)}$$

$$\boldsymbol{Electronics}: \; \boldsymbol{P_{electronicsNL}} \geq \boldsymbol{w_{NL}^{\alpha_3} r_{NL}^{\beta_3} z_{NL}^{\gamma_3}} \qquad \textbf{(Equation 5.26)}$$

Where $w, r\ and\ z$ are the per unit price of labor, capital and technology respectively. Next, the equations for the zero profit conditions for all the three goods in India (IN) are given as follows

$$\boldsymbol{Milk}: \; \boldsymbol{P_{milkIN}} \geq \boldsymbol{w_{IN}^{\alpha_1} r_{IN}^{\beta_1} z_{IN}^{\gamma_1}} \qquad \textbf{(Equation 5.27)}$$

$$\boldsymbol{Sugar}: \; \boldsymbol{P_{sugarIN}} \geq \boldsymbol{w_{IN}^{\alpha_2} r_{IN}^{\beta_2} z_{IN}^{\gamma_2}} \qquad \textbf{(Equation 5.28)}$$

$$\boldsymbol{Electronics}: \; \boldsymbol{P_{electronicsIN}} \geq \boldsymbol{w_{IN}^{\alpha_3} r_{IN}^{\beta_3} z_{IN}^{\gamma_3}} \qquad \textbf{(Equation 5.29)}$$

Next, the equations for the zero profit conditions for all the three goods in China (CN) are given as follows

$$\boldsymbol{Milk}: \; \boldsymbol{P_{milkCN}} \geq \boldsymbol{w_{CN}^{\alpha_1} r_{CN}^{\beta_1} z_{CN}^{\gamma_1}} \qquad \textbf{(Equation 5.30)}$$

$$\boldsymbol{Sugar}: \; \boldsymbol{P_{sugarCN}} \geq \boldsymbol{w_{CN}^{\alpha_2} r_{CN}^{\beta_2} z_{CN}^{\gamma_2}} \qquad \textbf{(Equation 5.31)}$$

$$\boldsymbol{Electronics}: \; \boldsymbol{P_{electronicsCN}} \geq \boldsymbol{w_{CN}^{\alpha_3} r_{CN}^{\beta_3} z_{CN}^{\gamma_3}} \qquad \textbf{(Equation 5.32)}$$

The next step is to model the zero profit conditions for exports and imports between countries. For any good *X* exported from country *A* to *B* this condition is given by:

$$\boldsymbol{P_{XA}} * (\boldsymbol{1} + \boldsymbol{tariff_{XBA}}) \geq \; \boldsymbol{P_{XB}}$$

$$\boldsymbol{P_{MilkNL}} * (\boldsymbol{1} + \boldsymbol{tariff_{MilkCNNL}}) \geq \; \boldsymbol{P_{MilkCN}} \qquad \textbf{(Equation 5.33)}$$

$$\boldsymbol{P_{MilkCN}} * (\boldsymbol{1} + \boldsymbol{tariff_{MilkNLCN}}) \geq \; \boldsymbol{P_{MilkNL}} \qquad \textbf{(Equation 5.34)}$$

$$\boldsymbol{P_{MilkNL}} * (\boldsymbol{1} + \boldsymbol{tariff_{MilkINNL}}) \geq \; \boldsymbol{P_{MilkIN}} \qquad \textbf{(Equation 5.35)}$$

$$P_{MilkIN} * (1 + tariff_{MilkNLIN}) \geq P_{MilkNL}$$ **(Equation 5.36)**

$$P_{MilkCN} * (1 + tariff_{MilkINCN}) \geq P_{MilkIN}$$ **(Equation 5.37)**

$$P_{MilkIN} * (1 + tariff_{MilkCNIN}) \geq P_{MilkCN}$$ **(Equation 5.38)**

$$P_{SugarNL} * \left(1 + tariff_{SugarCNNL}\right) \geq P_{SugarCN}$$ **(Equation 5.39)**

$$P_{SugarCN} * \left(1 + tariff_{SugarNLCN}\right) \geq P_{SugarNL}$$ **(Equation 5.40)**

$$P_{SugarNL} * \left(1 + tariff_{SugarINNL}\right) \geq P_{SugarIN}$$ **(Equation 5.41)**

$$P_{SugarIN} * \left(1 + tariff_{SugarNLIN}\right) \geq P_{SugarNL}$$ **(Equation 5.42)**

$$P_{SugarCN} * \left(1 + tariff_{SugarINCN}\right) \geq P_{SugarIN}$$ **(Equation 5.43)**

$$P_{SugarIN} * \left(1 + tariff_{SugarCNIN}\right) \geq P_{SugarCN}$$ **(Equation 5.44)**

$$P_{ElectronicsNL} * (1 + tariff_{ElectronicsCNNL}) \geq P_{ElectronicsCN}$$ **(Equation 5.45)**

$$P_{ElectronicsCN} * (1 + tariff_{ElectronicsNLCN}) \geq P_{ElectronicsNL}$$ **(Equation 5.46)**

$$P_{ElectronicsNL} * (1 + tariff_{ElectronicsINNL}) \geq P_{ElectronicsIN}$$ **(Equation 5.47)**

$$P_{ElectronicsIN} * (1 + tariff_{ElectronicsNLIN}) \geq P_{ElectronicsNL}$$ **(Equation 5.48)**

$$P_{ElectronicsCN} * (1 + tariff_{ElectronicsINCN}) \geq P_{ElectronicsIN}$$ **(Equation 5.49)**

$$P_{ElectronicsIN} * (1 + tariff_{ElectronicsCNIN}) \geq P_{ElectronicsCN}$$ **(Equation 5.50)**

Next the model requires income definitions per country. These are given below as follows:

$$Income_{NL} = (w_{NL}.L + r_{NL}.K + z_{NL}.T) + Milk\ Imported\ from\ India\ and\ China + Sugar\ Imported\ from\ India\ and\ China + Electronics\ Imported\ from\ India\ and\ China$$ **(Equation 5.51)**

$$Income_{CN} = (w_{CN}.L + r_{CN}.K + z_{CN}.T) + Milk\ Imported\ from\ India\ and\ the\ Netherlands + Sugar\ Imported\ from\ India\ and\ the\ Netherlands + Electronics\ Imported\ from\ India\ and\ the\ Netherlands$$ **(Equation 5.52)**

$$Income_{IN} = (w_{IN}.L + r_{IN}.K + z_{IN}.T) + Milk\ Imported\ from\ the\ Netherlands\ and\ China + Sugar\ Imported\ from\ the\ Netherlands\ and\ China + Electronics\ Imported\ from\ the\ Netherlands\ and\ China$$ **(Equation 5.53)**

Lastly in order to solve the model, we need equations for the welfare level in each country. These are as follows

$$\boldsymbol{Welfare_{NL}} = \frac{\boldsymbol{IncomeNL}}{P_{MilkNL}^{\frac{1}{3}} . P_{SugarNL}^{\frac{1}{3}} . P_{ElectronicsNL}^{\frac{1}{3}}} \quad \textbf{(Equation 5.54)}$$

$$\boldsymbol{Welfare_{IN}} = \frac{\boldsymbol{IncomeIN}}{P_{MilkIN}^{\frac{1}{3}} . P_{SugarIN}^{\frac{1}{3}} . P_{ElectronicsIN}^{\frac{1}{3}}} \quad \textbf{(Equation 5.55)}$$

$$\boldsymbol{Welfare_{CN}} = \frac{\boldsymbol{IncomeCN}}{P_{MilkCN}^{\frac{1}{3}} . P_{SugarCN}^{\frac{1}{3}} . P_{ElectronicsCN}^{\frac{1}{3}}} \quad \textbf{(Equation 5.56)}$$

The table below shows which equations/inequality help determine which variables. These are called the complementary variables.

Table 5.2: Complementary Variables

Equations	Variables
labor_NL	wNL
labor_IN	wIN
abor_CN	wCN
capital_NL	rNL
capital_IN	rIN
capital_CN	rCN
technology_NL	zNL
technology_IN	zIN
tehnology_CN	zCN
Milk_NL	pMilkNL
Milk_IN	pMilkIN
Milk_CN	pMilkCN
Sugar_NL	pSugarNL
Sugar_IN	pSugarIN
Sugar_CN	pSugarCN
Elec_NL	pElecNL
Elec_IN	pElecIN
Elec_CN	pElecCN
ZPCMilk_NL	MilkNL
ZPCMilk_IN	MilkIN
ZPCMilk_CN	MilkCN
ZPCSugar_NL	SugarNL
ZPCSugar_IN	SugarIN
ZPCSugar_CN	SugarCN
ZPCElec_NL	ElecNL
ZPCElec_IN	ElecIN
ZPCElec_CN	ElecCN
income_NL	INL
income_IN	IIN

income_CN	ICN
priceMilk_NLCN	ExpMilkNLCN
priceMilk_CNNL	ExpMilkCNNL
priceMilk_NLIN	ExpMilkNLIN
priceMilk_INNL	EcpMilkINNL
priceMilk_INCN	ExpMilkINCN
priceMilk_CNIN	ExpMilkCNIN
priceSugar_NLCN	ExpSugarNLCN
priceSugar_CNNL	ExpSugarCNNL
priceSugar_NLIN	ExpSugarNLIN
priceSugar_INNL	ExpSugarINNL
priceSugar_INCN	ExpSugarINCN
priceSugar_CNIN	ExpSugarCNIN
priceElec_NLCN	ExpElecNLCN
priceElec_CNNL	ExpElecCNNL
priceElec_NLIN	ExpElecNLIN
priceElec_INNL	ExpElecINNL
priceElec_INCN	ExpElecINCN
priceElec_CNIN	ExpElecCNIN
welfare_NL	WFNL
welfare_IN	WFIN
welfare_CN	WFCN

5.3 Data Sources

Data	Value	Year	Source
China Population	1350695 thousand	2012	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=CN
China Import tariff agricultural goods	15.6 %	2011	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=CN
China import tariff non agricultural goods	8.7 %	2011	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=CN
India Population	1236687 thousand	2012	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Cou

			ntry=IN
India import tariff agricultural goods	33.5%	2012	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=IN
India import tariff non agricultural goods	10.4%	2012	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=IN
Netherlands Population	16768 thousand	2012	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=NL

NL import tariff agricultural goods	13.2%	2012	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=NL
NL import tariff non agricultural goods	4.2%	2012	WTO http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=NL
China Electronics production			
India Sugar production	3390 lakh tons	2012-13	Indian sugar mills association http://www.indiansugar.com/Statics.aspx
Netherlands milk production			

Commodity	Trading	Value	Data Source
Sugar - India	Exported to Netherlands 2013	$15,281,959 trade value	COMTRADE http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=17&px=H1&r=699&y=2013&p=528&rg=1,2&so=9999
Sugar - India	Imported from Netherlands 2013	$15,150,230 trade value	COMTRADE http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=17&px=H1&r=699&y=2013&p=528&rg=1,2&so=9999
Sugar - India	Exported to China 2013	$4,598,512 trade value	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=17&px=H1&r=699&y=2013&p=156&rg=1,2&so=9999
Sugar - India	Imported from China 2013	$6,287,339 trade value	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=17&px=H1&r=699&y=2013&p=156&rg=1,2&so=9999
Electronics - China	Exported to Netherlands 2013	$16,152,310,206	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=85&px=HS&r=156&y=2013&p=528,%20699&rg=1,2&so=9999
Electronics - China	Exported to India 2013	$10,195,774,061	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=85&px=HS&r=156&y=2013&p=528,%20699&rg=1,2&so=9999

Electronics - China	Imported from Netherlands 2013	$622,264,759	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=85&px=HS&r=156&y=2013&p=528,%20699&rg=1,2&so=9999
Electronics - China	Imported from India 2013	$380,846,734	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=85&px=HS&r=156&y=2013&p=528,%20699&rg=1,2&so=9999
Netherlands Dairy	Exported to India 2013	$2,949,485	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=04&px=HS&r=528&y=2013&p=156,%20699&rg=1,2&so=9999
Netherlands Dairy	Exported to China 2013	$124,523,368	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=04&px=HS&r=528&y=2013&p=156,%20699&rg=1,2&so=9999
Netherlands Dairy	Imported from India 2013	$337,272	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=04&px=HS&r=528&y=2013&p=156,%20699&rg=1,2&so=9999
Netherlands Dairy	Imported from China 2013	$9,056,068	http://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=04&px=HS&r=528&y=2013&p=156,%20699&rg=1,2&so=9999

Good Production	2010	2011	2012	2013	2014	Source

IN - Sugar	20,637,000 metric tonnes	26,574,000 metric tonnes	28,620,000 metric tonnes	27,337,000 metric tonnes	27,900,000 metric tonnes	http://apps.fas.usda.gov/psdonline/circulars/Sugar.pdf

Good Domestic Consumption	2010	2011	2012	2013	2014	
IN- Sugar	22,500,000 metric tonnes	23,050,000 metric tonnes	24,180,000 metric tonnes	25,000,000 metric tonnes	26,000,000 metric tonnes	http://apps.fas.usda.gov/psdonline/circulars/Sugar.pdf

5.4 The Autarky

In autarky all three countries produce all three goods. There is no trade between countries. The reason for this is that all three countries are identical and good are produced using identical factor intensities. The following changes to the variables are required

KNL = 120; LNL = 85; TNL = 95;
KIN = 100; LIN = 110; TIN = 90;
KCN = 80; LCN = 105; TCN = 115;

alpha1 = 1/5; beta1 = 1/2; gamma1 = 3/10;
alpha2 = 3/5; beta2 = 1/5; gamma2 = 1/5;
alpha3 = 8/35; beta3 = 1/5; gamma3 = 4/7;

Also high initial tariffs prohibit countries from trading.

Each country in autarky produces 100 units of each goods. Thus Netherlands produces 100 units of Milk, 100 units of Sugar and 100 units of Electronics. Similarly India and China each also produce 100 units of Milk, 100 units of Sugar and 100 units of Electronics.

All countries in autarky have the same welfare level. Netherlands, India and China have 300 units of welfare each. Furthermore the prices of Milk, Sugar and Electronics in all countries are unity. Next, price per unit of labor, price per unit of capital and price per unit of technology for all three countries is also unity in autarky. Lastly each country has an income level of 300 units.

5.5 Micro-Consistency Matrix

After creating the first autarky scenario my next aim was to create an Micro-consistency matrix (MCM), also called the input-output matrix. The MCM is an representation of the initial data required for the model. The matrix is split into two columns, one for the production sector and one for the consumers. Rows in the MCM represent the markets. Both positive and negative values are valid in the MCM. A positive input implies commodity flow into the economy and a negative value represents a commodity flow out of the economy. I filled up the columns and the rows in the MCM in such a way that these values represent the true values of data collected by me for the year 2010. The MCM is attached as an annexure to this thesis.

5.6 Trade Liberalization Scenarios (Reduction in Tariff's)

After successfully creating the model and the autarky scenario, my next step was to modify the autarky model in such a way that the output from the GAMS file represents the MCM values for the data collected for the year 2010. I had to modify the model by adjusting the relative factor endowments of labor (L), capital (K) and technology (T) for Netherlands, India and China in a way that it reflects the data for the year 2010. I further modified each countries factor endowments by making Netherlands a capital intensive country, India a labor intensive country and China a technologically intensive country.

Between India and the EU, there are bilateral Free Trade Agreements (FTA) since 2006. What the free trade scenario does is all trade tariff barriers are abolished. In this model I apply the FTA to simulate its effect on the welfare of all the three countries. I allow for some spill-over effect to third countries (China) trading with either the EU (Netherlands) or India in terms of non-tariff barriers[1]. Under a normal free trade scenario, bilateral import tariff for goods is 2.5% to account for any non-tariff barriers. Below are the changes in the tariffs in the model.

tariffMilkNLIN = 0.025; tariffSugarNLIN = 0.025; tariffElecNLIN = 0.025;
tariffMilkINNL = 0.025; tariffSugarINNL = 0.025; tariffElecINNL = 0.025;
tariffMilkCNNL = 0.080; tariffSugarCNNL = 0.079; tariffElecCNNL = 0.157;
tariffMilkNLCN = 0.102; tariffSugarNLCN = 0.085; tariffElecNLCN = 0.09;
tariffMilkINCN = 0.091; tariffSugarINCN = 0.13; tariffElecINCN = 0.08;

[1] Non-tariff barriers can be in form of quantitative restrictions, import-licensing, mandatory testing and certification for a large number of products, as well as customs procedure as defined by the European Commission.

tariffMilkCNIN = 0.086; tariffSugarCNIN = 0.084; tariffElecCNIN = 0.13;

The second scenario is called ambitious free trade scenario, where even the non- tariff barriers along with the import tariff for goods imported in each country is 0%. It is important to note that this kind of a free trade scenario is almost impossible. The applicable changes in the model codes are shown below to reflect this ambitious free trade scenario.

tariffMilkNLIN = 0; tariffSugarNLIN = 0; tariffElecNLIN = 0;
tariffMilkINNL = 0; tariffSugarINNL = 0; tariffElecINNL = 0;
tariffMilkCNNL = 0.080; tariffSugarCNNL = 0.079; tariffElecCNNL = 0.157;
tariffMilkNLCN = 0.102; tariffSugarNLCN = 0.085; tariffElecNLCN = 0.09;
tariffMilkINCN = 0.091; tariffSugarINCN = 0.13; tariffElecINCN = 0.08;
tariffMilkCNIN = 0.086; tariffSugarCNIN = 0.084; tariffElecCNIN = 0.13;

In both the above scenarios all countries levy the stipulated import tariffs when trading between China and India and China and the Netherlands as there is no free trade agreements between China and the EU or China and India. With the import tariffs reducing when compared to the autarky scenario we should now observe trade in our model.

5.7 Sensitivity Analysis

In this section I evaluate the results by checking whether the results change quantitatively by changing a few input parameters. I made the factor endowments for each country a little different as shown below. On simulating the model once again I did not observe any significant change to the results obtained previously. I have attached the results of the sensitivity analysis as an annexure (annexure 7, 8 and 9) to this thesis.

Factor endowments in the original model:

KNL = 120; LNL = 85; TNL = 95;
KIN = 100; LIN = 110; TIN = 90;
KCN = 80; LCN = 105; TCN = 115;

Factor endowments modified for sensitivity anslysis:

KNL = 130; LNL = 80; TNL = 90;
KIN = 95; LIN = 120; TIN = 85;
KCN = 75; LCN = 100; TCN = 125;

Chapter 6
Results and Analysis

In this chapter I present my quantitative results and findings based on our data and model. I discuss the welfare effects, price effects, trade effects, production effects, and income effects for the Netherlands, India and China

6.1 Welfare effects for the Netherlands, India and China

In the benchmark model where the relative factor endowments and production technologies are modified to reflect real data, the welfare for the Netherlands is 293.46 units, compared to 294.69 units and 294.76 units in both the normal free trade scenario and the ambitious free trade scenario respectively. Thus the ambitious free trade scenario leads to the highest welfare effects for the Netherlands. For India, the welfare under the normal free trade scenario is the highest with 299.17 units compared with the ambitious free trade scenario with 298.99 units and the benchmark with 297.72 units. China also witnesses highest welfare under the normal free trade scenario with 299.65 units compared with 299.2 units under the ambitious free trade scenario and 299.1 units under the benchmark. The detailed summary effects for the scenarios are shown below.

Table 6.1: Welfare effects for the Netherlands, India and China

Country	**Welfare Levels**
Benchmark	
The Netherlands	293.4
India	297.7
China	299.1
Normal Free Trade Scenario	
The Netherlands	294.7
India	299.2
China	299.6
Ambitious Free Trade Scenario	
The Netherlands	294.8
India	299.0
China	299.2

So from our analysis we conclude that both the free trade scenarios – in terms of overall welfare levels – are beneficial for the Netherlands, India and China. The welfare increase is as a result of welfare maximization subject to lesser constraints after trade liberalization. Under autarky, welfare is maximized under the constraints that (i) the value of production equals the value of consumption, and (ii) that consumption equals production. After trade liberalization this second constraint is relaxed. Compared with the benchmark the Netherlands has an increase of about 1.5 units of welfare and India has an increase in welfare of about just more than 2 units. China has a mere 0.5 unit increase in welfare under the free trade scenarios. Hence with the reduction in import tariff the welfare of countries increases.

6.2 Price effects for the Netherlands, India and China

Since the price of Milk in the Netherlands in the model was the numeraire good, that is the price of Milk in the Netherlands was fixed to unity, we observe that this price of milk in the Netherlands is also unity in the benchmark and the free trade scenarios. The price of milk in the benchmark for India was 1.3 as compared with 1.03 in the normal free trade scenario and 1 under the ambitious free trade scenario. For China, the price of milk in the benchmark was 1.25, compared with 1.08 in both the free trade scenarios.

We also observe a drop in Sugar and Electronics prices in the Netherlands in the benchmark compared with prices of sugar in the normal and the ambitious free trade scenarios. The same holds true for India and China. The table below shows the impact on the price of Milk, Sugar and Electronics in the Netherlands, India and China

Table 6.2: Price effects for the Netherlands, India and China (percentage change compared to the benchmark)

Country	**Price Milk**	**Price Sugar**	**Price Electronics**
Benchmark			
The Netherlands	1	1.162	1.132
India	1.339	1.322	1.446
China	1.248	1.204	1.181
Normal Free Trade Scenario (percentage change compared to benchmark)			
The Netherlands	No change	-5.85%	-1.77%
India	-23.45%	-19.89%	-22.82%
China	-13.46%	-12.96%	-12.45%

Ambitious Free Trade Scenario (percentage change compared to benchmark)			
The Netherlands	No change	-8.0%	-2.3%
India	-25.31%	-19.74%	-23.51%
China	-13.46%	-13.46%	-13.3%

From these findings we observe that as the import tariffs are reduced and finally abolished between the Netherlands and India, the price of milk between these two countries converge to the same value. The free trade scenario is also beneficial for China in that it also reduces the prices of milk in China. Note that after the decrease in import tariffs to 0, prices of all Milk, Sugar and Electronics are equal in the Netherlands and India. Furthermore it is important to note that as import tariffs reduce, the price of goods decreases tremendously for both India and China and not so much for the Netherlands.

6.3 Trade effects for the Netherlands, India and China

In the benchmark, as a result of high import tariffs there is no trade at all between the three countries. In the normal free trade scenario where there is no import tariff but some non-tariff barriers are present between India and the Netherlands we do observe some trade. Note that import tariffs are applied when trading with China. Only 17 units of milk are exported from the Netherlands to India and 7 units of milk are exported from the Netherlands to China. There is no further trade in the milk sector among the three countries. For the sugar sector, 22 units are exported from India to the Netherlands. There is no further trade in the sugar sector among the three countries. China exports 7 units of Electronics to India. Once again there is no further trade in the electronics sector among the three countries.

However, once even the non-tariff barriers are abolished, we see an increase in trade between the Netherlands and India. 31 units of milk are exported from the Netherlands to India compared with 17 units in the normal free trade scenario with non-tariff barriers. There is however a decline in the amount of milk exported from the Netherlands to China. In the ambitious scenario Netherlands only exports 2 units of milk compared with 7 units of milk in the normal free trade scenario. In the sugar sector, 31 units (increase of 9) of sugar are exported from India to the Netherlands. In the normal free trade scenario China did not export electronics to the Netherlands at all. However, in the ambitious scenario China exports a mere 2 units of electronics to the Netherlands. Also, there is a decrease in the amount of electronics exported by China to India. In the ambitious scenario China only exports 2 units of electronics to India. The table illustrates the trade effects is more detail.

Table 6.3: Trade effects for the Netherlands, India and China (percentage change

Goods exports	**Benchmark**	**Normal Free Trade Scenario**	**Ambitious Free Trade Scenario**
Milk Sector			
Netherlands to India	0	16.677	30.233
India to Netherlands	0	0	0
Netherlands to China	0	6.677	1.117
China to Netherlands	0	0	0
India to China	0	0	0
China to India	0	0	0
Sugar Sector			
Netherlands to India	0	0	0
India to Netherlands	0	21.980	30.625
Netherlands to China	0	0	0
China to Netherlands	0	0	0
India to China	0	0	0
China to India	0	0	0
Electronics Sector			
Netherlands to India	0	0	1.247
India to Netherlands	0	0	0
Netherlands to China	0	0	0
China to Netherlands	0	0	0
India to China	0	0	0
China to India	0	6.460	1.091

From our analysis on trade effects we conclude the above trade pattern is in line in the predictions of the Heckscher-Ohlin Model. A country exports that good that uses the relatively abundant factor intensively and imports other goods. Both the free trade scenarios (reduction in import tariff) lead to trade creation between the three countries. This implies that market access for India into the Netherlands as improved in the sugar sector. Market access has also improved for the Netherlands into India in the milk sector and the electronics sector. However, market access for the Netherlands into China in the milk sector has declined. Also market access for China into India has declined.

6.4 Production effects for the Netherlands, India and China

Since Milk is produced capital intensively and the Netherlands being endowed with abundant capital, production of milk is the highest in the Netherlands. Similarly, Sugar is produced labor intensively and Indian being endowed with abundant labor, production of sugar is the highest in India. Also, electronics are produced technology intensively and China being endowed with abundant technology, production of electronics is the highest in China.

When import tariffs reduce, in the normal free trade scenario, there is a 19.66% increase in the production of Milk in the Netherlands, a 18.6% increase in the production of Sugar in India and a 6% increase in the production of Electronics in China compared with the benchmark scenario with high import tariffs. This is in line with the Rybczynski Theorem, which states that given relative prices, an increase in a factor endowment will increase output in the sector that uses that factor intensively, and decrease output in the other sectors. This can be seen in table 6.4 below.

Furthermore, in the ambitious free trade scenario, there is a 26% increase in the production of Milk in the Netherlands, a 26% increase in the production of Sugar in India, and a mere 1% increase in the production of Electronics in China, compared with the benchmark scenario of high import tariffs. The table 6.4 below summarizes the output/production effects.

Table 6.4: Production effects for the Netherlands, India and China (percentage change compared to the benchmark)

Country	Production Milk	Production Sugar	Production Electronics
Benchmark			
The Netherlands	107.210	92.225	94.669
India	101.390	102.684	93.874
China	96.702	100.297	102.183
Normal Free Trade Scenario (percentage change compared to benchmark)			
The Netherlands	+19.66%	-19.89%	-0.37%

India	-13.99%	+18.68%	-5.18%
China	-6.14%	+0.15%	+5.96%
Ambitious Free Trade Scenario (percentage change compared to benchmark)			
The Netherlands	+26.14%	-27.81%	+0.54%
India	-25.89%	+25.85%	-1.0%
China	-1.03%	+0.02%	+1.01%

6.5 Income effects for the Netherlands, India and China

There is a direct and positive association between a reduction in import tariffs and a reduction in income. There is a decrease in the income of all three countries as import tariffs decrease. The table below highlights this relation.

Table 6.5: Income effects for the Netherlands, India and China (difference compared with benchmark)

Country	**Benchmark**	**Normal Free Trade Scenario**		**Ambitious Free Trade Scenario**	
Netherlands	321.6	-	314.5	-	311.6
India	407.3	- - -	319.7	- - -	316.1
China	362.2	- -	315.7	- -	313.7

6.6 Impact of Trilateral trade on India's terms of trade

The above inferences help understand the answer to the research question "**To what extent does the trilateral trade between India, China and the Netherlands affect the welfare levels in these countries?**"

India being a labor intensive country produces sugar (a labor intensive good) more abundantly. In line with the Heckscher-Ohlin theorem, India exports sugar, and imports milk and electronics. There is an increase in India's welfare as import tariffs are lowered and the constraint that consumption equals production no longer holds. Under trade liberalization there is a considerable decrease in prices of goods for India. There is a 25% reduction in milk prices, 20% reduction in sugar prices, and a 22% reduction in electronics prices as a result of trade liberalization. In the ambitious free trade scenario prices of milk, sugar and electronics are exactly same in India and the Netherlands. India imports about 30 units of Milk from the Netherlands and exports 31 units of Sugar to the Netherlands. Netherlands also exports just above 1 unit of electronics to India and China exports about 6 units of electronics to India. As a result of this reduction in import tariff, India has improved market access to the Netherlands in the sugar sector. After trade liberalization India sees a 19% increase in the production of sugar under the normal free trade scenario and a 26% increase in the production of sugar under the ambitious scenario. However, there is a drastic decline in the income level of India after trade liberalization (407 in the benchmark against 316 in the free trade scenario).

According to Factor Price Equilization (FPE) Theorem, when there are no barriers to trade, technologies are identical and both countries produce both goods, we have factor price equalization. The price of goods (milk, sugar and electronics) in India and the Netherlands are exactly equal. This implies, according to FPE that even relative factor prices (wages and rents on capital) are equal in both countries. This only holds for India and the Netherlands.

India gains by producing sugar, since it uses abundantly available factor of production, labor, in producing sugar. However, India loses by producing milk and electronics, both of which use scarcely available factors; capital and technology. However, the gains from trade is more than the losses from trade for India since the gains from trade can be used to compensate the loses. The Indian economy as a whole gains from the trade since the consumption possibilities of the country is expanded by trade.

As a brief answer to the research question, I can conclude on the basis of the simulation that the welfare level across these three countries seems to marginally increase across these scenarios. All countries gain from trade liberalization.

Chapter 7
Conclusion

This thesis examined the welfare levels of the Netherlands, India and China as a result of trade liberalization. Using the Heckscher-Ohlin Theorem, a simulation study was conducted to study these effects. Once the benchmark was established, import tariffs were reduced (normal free trade scenario) and finally abolished (ambitious free trade scenario) to simulate trade liberalization between the three countries.

In general, all three countries showed increase in welfare levels as a result of trade liberalization. The simulations also showed a reduction in prices for milk, sugar and electronics as a result of trade. As the import tariffs were abolished, the price of milk, sugar and electronics became equal in the Netherlands and India. The rate of decrease in prices is more for India and China.

The free trade scenarios lead to trade creation between the three countries. Market access for India into the Netherlands has improved in the sugar sector. There is also an improvement in market access for the Netherlands into India in the milk and electronics sector. However, there is a small decrease in market access into China for the Netherlands. There is also an increase of 26% in the production of milk in the Netherlands and Sugar in India. There is a mere 1% increase in the production of electronics in China.

The Heckscher-Ohlin theory concludes that a capital rich country specialises in capital intensive goods and only exports the capital intensive goods. Netherlands, being capital rich, produces capital intensive milk and exports milk to China and India. India, being a labor rich country produces labor intensive sugar and exports sugar to the Netherlands. China, being technological rich country, produces technological intensive electronic goods and exports these to India.

Limitations of the study:

The Heckscher Ohlin model assumes similar factors of production, identical production function and constant returns to scale. All these assumptions make the theory in this thesis an unrealistic model.

The Heckscher-Ohlin Model gives more importance to the supply and less to the demand by assuming that relative factor prices reflect relative factor endowments. But it is known that demand conditions are also capable to explain the existence of international trade.

The Heckscher Ohlin theory is also static in nature. It accepts the state of the economy and the production function as given and assumes no change in the state. There are other factors that reflect commodity prices and international trade other than factor endowments

Further research/simulations are needed which in line with a realistic model that closely replicates the real world findings to provide more accurate results.

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Annexure 1:
GAMS Model Codes

```
$TITLE Model Thesis 2015

PARAMETERS

tariffMilkNLCN        tariff on Milk imports in NL from CN
tariffMilkNLIN        tariff on Milk imports in NL from IN
tariffMilkCNNL        tariff on Milk imports in CN from NL
tariffMilkINNL        tariff on Milk imports in IN from NL
tariffMilkCNIN        tariff on Milk imports in CN from IN
tariffMilkINCN        tariff on Milk imports in IN from CN

tariffSugarNLIN       tariff on Sugar imports in NL from IN
tariffSugarNLCN       tariff on Sugar imports in NL from CN
tariffSugarCNNL       tariff on Sugar imports in CN from NL
tariffSugarINNL       tariff on Sugar imports in IN from NL
tariffSugarCNIN       tariff on Sugar imports in CN from IN
tariffSugarINCN       tariff on Sugar imports in IN from CN

tariffElecNLIN        tariff on electronics imports in NL from IN
tariffElecNLCN        tariff on electronics imports in NL from CN
tariffElecCNNL        tariff on electronics imports in CN from NL
tariffElecINNL        tariff on electronics imports in IN from IN
tariffElecCNIN        tariff on electronics imports in CN from IN
tariffElecINCN        tariff on electronics imports in IN from CN

LNL                   labor endowment NL
KNL                   capital endowment NL
TNL                   technology endowment NL

LIN                   labor endowment IN
KIN                   capital endowment IN
TIN                   technology endowment IN

LCN                   labor endowment CN
KCN                   capital endowment CN
TCN                   technology endowment CN

alpha1                exponent for labor in Milk production
beta1                 exponent for capital in Milk production
gamma1                exponent for technology in Milk production

alpha2                exponent for labor in Sugar production
beta2                 exponent for capital in sugar production
gamma2                expoenent for technology in sugar production

alpha3                exponent for labor in electronics production
beta3                 exponent for capital in electronics production
gamma3                exponent for technology in electronics
production;


tariffMilkNLCN = 0.5; tariffMilkCNNL = 0.5; tariffMilkINNL = 0.5;
tariffMilkNLIN = 0.5; tariffMilkCNIN = 0.5; tariffMilkINCN = 0.5;
tariffSugarNLCN = 0.5; tariffSugarCNNL = 0.5; tariffSugarINNL = 0.5;
tariffSugarNLIN = 0.5; tariffSugarCNIN = 0.5; tariffSugarINCN = 0.5;
```

```
tariffElecNLCN = 0.5; tariffElecCNNL = 0.5; tariffElecINNL = 0.5;
tariffElecNLIN = 0.5; tariffElecCNIN = 0.5; tariffElecINCN = 0.5;

LNL = 100; KNL = 100; TNL = 100;
LIN = 100; KIN = 100; TIN = 100;
LCN = 100; KCN = 100; TCN = 100;

alpha1 = (1/3); beta1 = (1/3); gamma1 = (1/3);
alpha2 = (1/3); beta2 = (1/3); gamma2 = (1/3);
alpha3 = (1/3); beta3 = (1/3); gamma3 = (1/3);


POSITIVE VARIABLES

MilkNL                Milk production NL
SugarNL               Sugar production NL
ElecNL                Electronics production NL
MilkIN                Milk production IN
SugarIN               Sugar production IN
ElecIN                Electronics production IN
MilkCN                Milk production CN
SugarCN               Sugar production CN
ElecCN                Electronics production CN

ExpMilkNLIN           milk exports from NL to IN
ExpMilkINNL           milk exports from IN to NL
ExpMilkNLCN           milk exports from NL to CN
ExpMilkCNNL           milk exports from CN to NL
ExpMilkINCN           milk exports from IN to CN
ExpMilkCNIN           milk exports from CN to IN

ExpSugarNLIN          sugar exports from NL to IN
ExpSugarINNL          sugar exports from IN to NL
ExpSugarNLCN          sugar exports from NL to CN
ExpSugarCNNL          sugar exports from CN to NL
ExpSugarCNIN          sugar exports from CN to IN
ExpSugarINCN          sugar exports from IN to CN

ExpElecNLIN           electronics exports from NL to IN
ExpElecINNL           electronics exports from IN to NL
ExpElecNLCN           electronics exports from NL to CN
ExpElecCNNL           electronics exports from CN to NL
ExpElecINCN           electronics exports from IN to CN
ExpElecCNIN           electronics exports from CN to IN

WFNL                  welfare level NL
WFCN                  welfare level CN
WFIN                  welfare level IN

pMilkNL               milk price NL
pMilkIN               milk price IN
pMilkCN               milk price CN

pSugarNL              sugar price NL
pSugarIN              sugar price IN
pSugarCN              sugar price CN

pElecNL               electronics price NL
```

```
pElecIN               electronics price IN
pElecCN               electronics price CN

wNL                   price per unit labor NL
wIN                   price per unit labor IN
wCN                   price per unit labor CN

rNL                   price per unit capital NL
rIN                   price per unit capital IN
rCN                   price per unit capital CN

zNL                   price per unit technology NL
zIN                   price per unit technology IN
zCN                   price per unit technology CN

INL                   total income NL
IIN                   total income IN
ICN                   total income CN;


EQUATIONS

labor_NL              labor market equilibrium NL
capital_NL            capital market equilibrium NL
technology_NL         technology market equilibrium NL

labor_IN              labor market equilibrium INL
capital_IN            capital market equilibrium IN
technology_IN         technology market equilibrium IN

labor_CN              labor market equilibrium CN
capital_CN            capital market equilibrium CN
technology_CN         technology market equilibrium CN


Milk_NL               milk market equilibrium NL
Sugar_NL              sugar market equilibrium NL
Elec_NL               electronics market equilibrium NL

Milk_IN               milk market equilibrium IN
Sugar_IN              sugar market equilibrium IN
Elec_IN               electronics market equilibrium IN

Milk_CN               milk market equilibrium CN
Sugar_CN              sugar market equilibrium CN
Elec_CN               electronics market equilibrium CN

ZPCMilk_NL            ZPC Milk NL
ZPCSugar_NL           ZPC Sugar NL
ZPCElec_NL            ZPC Electronics NL

ZPCMilk_IN            ZPC Milk IN
ZPCSugar_IN           ZPC Sugar IN
ZPCElec_IN            ZPC Electronics IN

ZPCMilk_CN            ZPC Milk CN
ZPCSugar_CN           ZPC Sugar CN
ZPCElec_CN            ZPC Electronics CN
```

```
income_NL             income definition NL
income_CN             income definition CN
income_IN             income definition IN

welfare_NL            welfare level NL
welfare_IN            welfare level IN
welfare_CN            welfare level CN

priceMilk_NLIN        ZPC exports milk NL IN
priceMilk_INNL        ZPC exports milk IN NL
priceMilk_NLCN        ZPC exports milk NL CN
priceMilk_CNNL        ZPC exports milk CN NL
priceMilk_INCN        ZPC exports milk IN CN
priceMilk_CNIN        ZPC exports milk CN IN

priceSugar_NLIN       ZPC exports sugar NL IN
priceSugar_INNL       ZPC exports sugar IN NL
priceSugar_NLCN       ZPC exports sugar NL CN
priceSugar_CNNL       ZPC exports sugar CN NL
priceSugar_INCN       ZPC exports sugar IN CN
priceSugar_CNIN       ZPC exports sugar CN IN

priceElec_NLIN        ZPC exports Electronics NL IN
priceElec_INNL        ZPC exports Electronics IN NL
priceElec_NLCN        ZPC exports Electronics NL CN
priceElec_CNNL        ZPC exports Electronics CN NL
priceElec_CNIN        ZPC exports Electronics CN IN
priceElec_INCN        ZPC exports Electronics IN CN
;


*        now equations for factor market equilibrium conditions
*        first NL

labor_NL..        LNL =G=
                   MilkNL * alpha1 * wNL**alpha1 * rNL**beta1 *
zNL**gamma1 / wNL
                + SugarNL * alpha2 * wNL**alpha2 * rNL**beta2 *
zNL**gamma2 / wNL
                 + ElecNL * alpha3 * wNL**alpha3 * rNL**beta3 *
zNL**gamma3 / wNL;

capital_NL..        KNL =G=
                   MilkNL * beta1 * wNL**alpha1 * rNL**beta1 *
zNL**gamma1 / rNL
                + SugarNL * beta2 * wNL**alpha2 * rNL**beta2 *
zNL**gamma2 / rNL
                 + ElecNL * beta3 * wNL**alpha3 * rNL**beta3 *
zNL**gamma3 / rNL;

technology_NL..        TNL =G=
                   MilkNL * gamma1 * wNL**alpha1 * rNL**beta1 *
zNL**gamma1 / zNL
                + SugarNL * gamma2 * wNL**alpha2 * rNL**beta2 *
zNL**gamma2 / zNL
                 + ElecNL * gamma3 * wNL**alpha3 * rNL**beta3 *
zNL**gamma3 / zNL;
```

```
*        next IN

labor_IN..         LIN =G=
                   MilkIN * alpha1 * wIN**alpha1 * rIN**beta1 *
zIN**gamma1 / wIN
                 + SugarIN * alpha2 * wIN**alpha2 * rIN**beta2 *
zIN**gamma2 / wIN
                 + ElecIN * alpha3 * wIN**alpha3 * rIN**beta3 *
zIN**gamma3 / wIN;

capital_IN..         KIN =G=
                   MilkIN * beta1 * wIN**alpha1 * rIN**beta1 *
zIN**gamma1 / rIN
                 + SugarIN * beta2 * wIN**alpha2 * rIN**beta2 *
zIN**gamma2 / rIN
                 + ElecIN * beta3 * wIN**alpha3 * rIN**beta3 *
zIN**gamma3 / rIN;

technology_IN..        TIN =G=
                   MilkIN * gamma1 * wIN**alpha1 * rIN**beta1 *
zIN**gamma1 / zIN
                 + SugarIN * gamma2 * wIN**alpha2 * rIN**beta2 *
zIN**gamma2 / zIN
                 + ElecIN * gamma3 * wIN**alpha3 * rIN**beta3 *
zIN**gamma3 / zIN;

*        next CN

labor_CN..         LCN =G=
                   MilkCN * alpha1 * wCN**alpha1 * rCN**beta1 *
zCN**gamma1 /wCN
                 + SugarCN * alpha2 * wCN**alpha2 * rCN**beta2 *
zCN**gamma2 / wCN
                 + ElecCN * alpha3 * wCN**alpha3 * rCN**beta3 *
zCN**gamma3 / wCN;

capital_CN..         KCN =G=
                   MilkCN * beta1 * wCN**alpha1 * rCN**beta1 *
zCN**gamma1 / rCN
                 + SugarCN * beta2 * wCN**alpha2 * rCN**beta2 *
zCN**gamma2 / rCN
                 + ElecCN * beta3 * wCN**alpha3 * rCN**beta3 *
zCN**gamma3 / rCN;


technology_CN..        TCN =G=
                   MilkCN * gamma1 * wCN**alpha1 * rCN**beta1 *
zCN**gamma1 / zCN
                 + SugarCN * gamma2 * wCN**alpha2 * rCN**beta2 *
zCN**gamma2 / zCN
                 + ElecCN * gamma3 * wCN**alpha3 * rCN**beta3 *
zCN**gamma3 / zCN;

*        now equations for the goods market equilibrium conditions
*        first NL
```

```
Milk_NL..        MilkNL + ExpMilkCNNL + ExpMilkINNL =G=
                WFNL * (1/3) * pMilkNL**(1/3) * pSugarNL**(1/3) *
pElecNL**(1/3) / pMilkNL + ExpMilkNLCN + ExpMilkNLIN;

Sugar_NL..        SugarNL + ExpSugarCNNL + ExpSugarINNL =G=
                WFNL * (1/3) * pMilkNL**(1/3) * pSugarNL**(1/3) *
pElecNL**(1/3) / pSugarNL + ExpSugarNLCN + ExpSugarNLIN;

Elec_NL..        ElecNL + ExpElecCNNL + ExpElecINNL =G=
                WFNL * (1/3) * pMilkNL**(1/3) * pSugarNL**(1/3) *
pElecNL**(1/3) / pElecNL + ExpElecNLCN + ExpElecNLIN;

*        next IN
Milk_IN..        MilkIN + ExpMilkCNIN + ExpMilkNLIN =G=
                WFIN * (1/3) * pMilkIN**(1/3) * pSugarIN**(1/3) *
pElecIN**(1/3) / pMilkIN + ExpMilkINNL + ExpMilkINCN;

Sugar_IN..        SugarIN + ExpSugarCNIN + ExpSugarNLIN =G=
                WFIN * (1/3) * pMilkIN**(1/3) * pSugarIN**(1/3) *
pElecIN**(1/3) / pSugarIN + ExpSugarINNL + ExpSugarINCN;

Elec_IN..        ElecIN + ExpElecNLIN + ExpElecCNIN =G=
                WFIN * (1/3) * pMilkIN**(1/3) * pSugarIN**(1/3) *
pElecIN**(1/3) / pElecIN + ExpElecINCN + ExpElecINNL;

*        next CN
Milk_CN..        MilkCN + ExpMilkINCN + ExpMilkNLCN =G=
                WFCN * (1/3) * pMilkCN**(1/3) * pSugarCN**(1/3) *
pElecCN**(1/3) / pMilkCN + ExpMilkCNIN + ExpMilkCNNL;

Sugar_CN..        SugarCN + ExpSugarINCN + ExpSugarNLCN =G=
                WFCN * (1/3) * pMilkCN**(1/3) * pSugarCN**(1/3) *
pElecCN**(1/3) / pSugarCN + ExpSugarCNIN + ExpSugarCNNL;

Elec_CN..        ElecCN + ExpElecINCN + ExpElecNLCN =G=
                WFCN * (1/3) * pMilkCN**(1/3) * pSugarCN**(1/3) *
pElecCN**(1/3) / pElecCN + ExpElecCNIN + ExpElecCNNL;


*        equations for the zero profic conditions
*        first NL

ZPCMilk_NL..        wNL**(alpha1) * rNL**(beta1) * zNL**(gamma1) =G=
pMilkNL;
ZPCSugar_NL..        wNL**(alpha2) * rNL**(beta2) * zNL**(gamma2) =G=
pSugarNL;
ZPCElec_NL..        wNL**(alpha3) * rNL**(beta3) * zNL**(gamma3) =G=
pElecNL;

*        next IN

ZPCMilk_IN..        wIN**(alpha1) * rIN**(beta1) * zIN**(gamma1) =G=
pMilkIN;
ZPCSugar_IN..        wIN**(alpha2) * rIN**(beta2) * zIN**(gamma2) =G=
pSugarIN;
ZPCElec_IN..        wIN**(alpha3) * rIN**(beta3) * zIN**(gamma3) =G=
pElecIN;
```

```
*        next CN

ZPCMilk_CN..        wCN**(alpha1) * rCN**(beta1) * zCN**(gamma1) =G=
pMilkCN;
ZPCSugar_CN..        wCN**(alpha2) * rCN**(beta2) * zCN**(gamma2) =G=
pSugarCN;
ZPCElec_CN..        wCN**(alpha3) * rCN**(beta3) * zCN**(gamma3) =G=
pElecCN;

*        equations for income definitions
*        first NL

income_NL..        INL =E=
                wNL * LNL + rNL * KNL + zNL * TNL
                + tariffMilkNLCN * pMilkCN * ExpMilkCNNL +
tariffMilkNLIN * pMilkIN * ExpMilkINNL
                + tariffSugarNLCN * pSugarCN * ExpSugarCNNL +
tariffSugarNLIN * pSugarIN * ExpSugarINNL
                + tariffElecNLCN * pElecCN * ExpElecCNNL +
tariffElecNLIN * pElecIN * ExpElecINNL;

*        next IN

income_IN..        IIN =E=
                wIN * LIN + rIN * KIN + zIN * TIN
                + tariffMilkINCN * pMilkCN * ExpMilkCNIN +
tariffMilkINNL * pMilkNL * ExpMilkNLIN
                + tariffSugarINCN * pSugarCN * ExpSugarCNIN +
tariffSugarINNL * pSugarNL * ExpSugarNLIN
                + tariffElecINCN * pElecCN * ExpElecCNIN +
tariffElecINNL * pElecNL * ExpElecNLIN;

*        next CN

income_CN..        ICN =E=
                wCN * LCN + rCN * KCN + zCN * TCN
                + tariffMilkCNNL * pMilkNL * ExpMilkNLCN +
tariffMilkCNIN * pMilkIN * ExpMilkINCN
                + tariffSugarCNNL * pSugarNL * ExpSugarNLCN +
tariffSugarCNIN * pSugarIN * ExpSugarINCN
                + tariffElecCNNL * pElecNL * ExpElecNLCN +
tariffElecCNIN * pElecIN * ExpElecINCN;


*        zero profit conditions for imports and exports
*        first for Milk

priceMilk_NLCN..        pMilkNL * (1 + tariffMilkCNNL) =G= pMilkCN;
priceMilk_CNNL..        pMilkCN * (1 + tariffMilkNLCN) =G= pMilkNL;
priceMilk_NLIN..        pMilkNL * (1 + tariffMilkINNL) =G= pMilkIN;
priceMilk_INNL..        pMilkIN * (1 + tariffMilkNLIN) =G= pMilkNL;
priceMilk_INCN..        pMilkIN * (1 + tariffMilkCNIN) =G= pMilkCN;
priceMilk_CNIN..        pMilkCN * (1 + tariffMilkINCN) =G= pMilkIN;


*        next for sugar

priceSugar_NLCN..        pSugarNL * (1 + tariffSugarCNNL) =G= pSugarCN;
```

```
priceSugar_CNNL..        pSugarCN * (1 + tariffSugarNLCN) =G= pSugarNL;
priceSugar_NLIN..        pSugarNL * (1 + tariffSugarINNL) =G= pSugarIN;
priceSugar_INNL..        pSugarIN * (1 + tariffSugarNLIN) =G= pSugarNL;
priceSugar_INCN..        pSugarIN * (1 + tariffSugarCNIN) =G= pSugarCN;
priceSugar_CNIN..        pSugarCN * (1 + tariffSugarINCN) =G= pSugarIN;


*        next for Electronics

priceElec_NLCN..        pElecNL * (1 + tariffElecCNNL) =G= pElecCN;
priceElec_CNNL..        pElecCN * (1 + tariffElecNLCN) =G= pElecNL;
priceElec_NLIN..        pElecNL * (1 + tariffElecINNL) =G= pElecIN;
priceElec_INNL..        pElecIN * (1 + tariffElecNLIN) =G= pElecNL;
priceElec_INCN..        pElecIN * (1 + tariffElecCNIN) =G= pElecCN;
priceElec_CNIN..        pElecCN * (1 + tariffElecINCN) =G= pElecIN;




*        welfare level equations for all countries

welfare_NL..                WFNL =E= INL / (pMilkNL**(1/3) *
pSugarNL**(1/3) * pElecNL**(1/3));
welfare_IN..                WFIN =E= IIN / (pMilkIN**(1/3) *
pSugarIN**(1/3) * pElecIN**(1/3));
welfare_CN..                WFCN =E= ICN / (pMilkCN**(1/3) *
pSugarCN**(1/3) * pElecCN**(1/3));


*        what are the equations of the model?

MODEL HOM
        /labor_NL.wNL, labor_IN.wIN, labor_CN.wCN, capital_NL.rNL,
capital_IN.rIN, capital_CN.rCN, technology_NL.zNL, technology_IN.zIN,
technology_CN.zCN,
        Milk_NL.pMilkNL, Milk_IN.pMilkIN, Milk_CN.pMilkCN,
Sugar_NL.pSugarNL, Sugar_IN.pSugarIN, Sugar_CN.pSugarCN,
Elec_NL.pElecNL, Elec_CN.pElecCN, Elec_IN.pElecIN,
        ZPCMilk_NL.MilkNL, ZPCMilk_IN.MilkIN, ZPCMilk_CN.MilkCN,
ZPCSugar_NL.SugarNL, ZPCSugar_CN.SugarCN, ZPCSugar_IN.SugarIN,
ZPCElec_NL.ElecNL, ZPCElec_IN.ElecIN, ZPCElec_CN.ElecCN,
        income_NL.INL, income_CN.ICN, income_IN.IIN,
        priceMilk_NLCN.ExpMilkNLCN, priceMilk_CNNL.ExpMilkCNNL,
priceMilk_NLIN.ExpMilkNLIN, priceMilk_INNL.ExpMilkINNL,
priceMilk_INCN.ExpMilkINCN, priceMilk_CNIN.ExpMilkCNIN,
        priceSugar_NLCN.ExpSugarNLCN, priceSugar_CNNL.ExpSugarCNNL,
priceSugar_NLIN.ExpSugarNLIN, priceSugar_INNL.ExpSugarINNL,
priceSugar_INCN.ExpSugarINCN, priceSugar_CNIN.ExpSugarCNIN,
        priceElec_NLCN.ExpElecNLCN, priceElec_CNNL.ExpElecCNNL,
priceElec_NLIN.ExpElecNLIN, priceElec_INNL.ExpElecINNL,
priceElec_INCN.ExpElecINCN, priceElec_CNIN.ExpElecCNIN,
        welfare_NL.WFNL, welfare_IN.WFIN, welfare_CN.WFCN/;

*        numeraire good?

pMilkNL.FX = 1;
```

```
*        lower bounds for goods and factor prices so that no problem
with division by 0.

wNL.LO = 0.0001; rNL.LO = 0.0001; zNL.LO = 0.0001;
wIN.LO = 0.0001; rIN.LO = 0.0001; zIN.LO = 0.0001;
wCN.LO = 0.0001; rCN.LO = 0.0001; zCN.LO = 0.0001;
pSugarNL.LO = 0.0001; pElecNL.LO = 0.0001;
pMilkIN.LO = 0.0001; pSugarIN.LO = 0.0001; pElecIN.LO = 0.0001;
pMilkCN.LO = 0.0001; pSugarCN.LO = 0.0001; pElecCN.LO = 0.0001;

*        what would be the starting values?

wNL.L = 1; rNL.L = 1; zNL.L = 1; wCN.L = 1; rCN.L = 1; zCN.L = 1; wIN.L
= 1; rIN.L = 1; zIN.L = 1; pSugarNL.L = 1; pElecNL.L = 1; pMilkCN.L =
1;
pSugarCN.L = 1; pElecCN.L = 1; pMilkIN.L = 1; pSugarIN.L = 1; pElecIN.L
= 1; MilkCN.L = 100; SugarCN.L = 100; ElecCN.L = 100; MilkNL.L = 100;
SugarNL.L = 100;
ElecNL.L = 100; MilkIN.L =100; ElecIN.L = 100; SugarIN.L = 100; INL.L =
100; ICN.L = 100; IIN.L = 100;
ExpMilkNLCN.L = 0; ExpMilkNLIN.L = 0; ExpMilkCNNL.L = 0; ExpMilkINNL.L
= 0; ExpMilkINCN.L = 0; ExpMilkCNIN.L = 0;
ExpElecNLCN.L = 0; ExpElecCNNL.L = 0; ExpElecINNL.L =0; ExpElecNLIN.L =
0; ExpElecINCN.L = 0;ExpElecCNIN.L = 0;
ExpSugarNLCN.L = 0; ExpSugarCNNL.L = 0; ExpSugarNLIN.L =
0;ExpSugarINNL.L = 0; ExpSugarINCN.L = 0; ExpSugarCNIN.L = 0;
WFNL.L = 100; WFCN.L = 100; WFIN.L = 100;

SOLVE HOM USING MCP;

* Comparative static 1
* change the countries relative factor endowment

KNL = 120; LNL = 85; TNL = 95;
KIN = 100; LIN = 110; TIN = 90;
KCN = 80; LCN = 105; TCN = 115;

* change the countries relative production technologies

alpha1 = 1/5; beta1 = 1/2; gamma1 = 3/10;
alpha2 = 3/5; beta2 = 1/5; gamma2 = 1/5;
alpha3 = 8/35; beta3 = 1/5; gamma3 = 4/7;

SOLVE HOM USING MCP;

*  free trade scenario between India and the EU/NL 2.5%

tariffMilkNLIN = 0.025; tariffSugarNLIN = 0.025; tariffElecNLIN =
0.025;
tariffMilkINNL = 0.025; tariffSugarINNL = 0.025; tariffElecINNL =
0.025;
tariffMilkCNNL = 0.080; tariffSugarCNNL = 0.079; tariffElecCNNL =
0.157;
tariffMilkNLCN = 0.102; tariffSugarNLCN = 0.085; tariffElecNLCN = 0.09;
tariffMilkINCN = 0.091; tariffSugarINCN = 0.13; tariffElecINCN = 0.08;
tariffMilkCNIN = 0.086; tariffSugarCNIN = 0.084; tariffElecCNIN = 0.13;

SOLVE HOM USING MCP;
```

```
* free trade scenario between India and the EU/NL 0%

tariffMilkNLIN = 0; tariffSugarNLIN = 0; tariffElecNLIN = 0;
tariffMilkINNL = 0; tariffSugarINNL = 0; tariffElecINNL = 0;
tariffMilkCNNL = 0.080; tariffSugarCNNL = 0.079; tariffElecCNNL =
0.157;
tariffMilkNLCN = 0.102; tariffSugarNLCN = 0.085; tariffElecNLCN = 0.09;
tariffMilkINCN = 0.091; tariffSugarINCN = 0.13; tariffElecINCN = 0.08;
tariffMilkCNIN = 0.086; tariffSugarCNIN = 0.084; tariffElecCNIN = 0.13;

SOLVE HOM USING MCP;

SOLVE HOM USING MCP;
```

<u>* sensitivity analysis</u>

```
* change the countries relative factor endowment

KNL = 130; LNL = 80; TNL = 90;
KIN = 95; LIN = 120; TIN = 85;
KCN = 75; LCN = 100; TCN = 125;

* change the countries relative production technologies

alpha1 = 1/5; beta1 = 1/2; gamma1 = 3/10;
alpha2 = 3/5; beta2 = 1/5; gamma2 = 1/5;
alpha3 = 8/35; beta3 = 1/5; gamma3 = 4/7;

SOLVE HOM USING MCP;

*  free trade scenario between India and the EU/NL 2.5%

tariffMilkNLIN  =  0.025;  tariffSugarNLIN  =  0.025;  tariffElecNLIN  =
0.025;
tariffMilkINNL  =  0.025;  tariffSugarINNL  =  0.025;  tariffElecINNL  =
0.025;
tariffMilkCNNL  =  0.080;  tariffSugarCNNL  =  0.079;  tariffElecCNNL  =
0.157;
tariffMilkNLCN = 0.102; tariffSugarNLCN = 0.085; tariffElecNLCN = 0.09;
tariffMilkINCN = 0.091; tariffSugarINCN = 0.13; tariffElecINCN = 0.08;
tariffMilkCNIN = 0.086; tariffSugarCNIN = 0.084; tariffElecCNIN = 0.13;

SOLVE HOM USING MCP;

* free trade scenario between India and the EU/NL 0%

tariffMilkNLIN = 0; tariffSugarNLIN = 0; tariffElecNLIN = 0;
tariffMilkINNL = 0; tariffSugarINNL = 0; tariffElecINNL = 0;
tariffMilkCNNL  =  0.080;  tariffSugarCNNL  =  0.079;  tariffElecCNNL  =
0.157;
tariffMilkNLCN = 0.102; tariffSugarNLCN = 0.085; tariffElecNLCN = 0.09;
tariffMilkINCN = 0.091; tariffSugarINCN = 0.13; tariffElecINCN = 0.08;
tariffMilkCNIN = 0.086; tariffSugarCNIN = 0.084; tariffElecCNIN = 0.13;

SOLVE HOM USING MCP;
```

Annexure 2:
GAMS results: Autarky

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR MilkNL	.	100.000	+INF	.
---- VAR SugarNL	.	100.000	+INF	.
---- VAR ElecNL	.	100.000	+INF	.
---- VAR MilkIN	.	100.000	+INF	.
---- VAR SugarIN	.	100.000	+INF	.
---- VAR ElecIN	.	100.000	+INF	.
---- VAR MilkCN	.	100.000	+INF	.
---- VAR SugarCN	.	100.000	+INF	.
---- VAR ElecCN	.	100.000	+INF	.
---- VAR ExpMilkNLIN	.	.	+INF	0.500
---- VAR ExpMilkINNL	.	.	+INF	0.500
---- VAR ExpMilkNLCN	.	.	+INF	0.500
---- VAR ExpMilkCNNL	.	.	+INF	0.500
---- VAR ExpMilkINCN	.	.	+INF	0.500
---- VAR ExpMilkCNIN	.	.	+INF	0.500
---- VAR ExpSugarNLIN	.	.	+INF	0.500
---- VAR ExpSugarINNL	.	.	+INF	0.500
---- VAR ExpSugarNLCN	.	.	+INF	0.500
---- VAR ExpSugarCNNL	.	.	+INF	0.500
---- VAR ExpSugarCNIN	.	.	+INF	0.500
---- VAR ExpSugarINCN	.	.	+INF	0.500
---- VAR ExpElecNLIN	.	.	+INF	0.500
---- VAR ExpElecINNL	.	.	+INF	0.500
---- VAR ExpElecNLCN	.	.	+INF	0.500
---- VAR ExpElecCNNL	.	.	+INF	0.500
---- VAR ExpElecINCN	.	.	+INF	0.500
---- VAR ExpElecCNIN	.	.	+INF	0.500
---- VAR WFNL	.	300.000	+INF	.
---- VAR WFCN	.	300.000	+INF	.
---- VAR WFIN	.	300.000	+INF	.
---- VAR pMilkNL	1.000	1.000	1.000	4.263E-14
---- VAR pMilkIN	1.0000E-4	1.000	+INF	.
---- VAR pMilkCN	1.0000E-4	1.000	+INF	.
---- VAR pSugarNL	1.0000E-4	1.000	+INF	.
---- VAR pSugarIN	1.0000E-4	1.000	+INF	.
---- VAR pSugarCN	1.0000E-4	1.000	+INF	.
---- VAR pElecNL	1.0000E-4	1.000	+INF	.
---- VAR pElecIN	1.0000E-4	1.000	+INF	.
---- VAR pElecCN	1.0000E-4	1.000	+INF	.
---- VAR wNL	1.0000E-4	1.000	+INF	.
---- VAR wIN	1.0000E-4	1.000	+INF	.
---- VAR wCN	1.0000E-4	1.000	+INF	.
---- VAR rNL	1.0000E-4	1.000	+INF	.
---- VAR rIN	1.0000E-4	1.000	+INF	.
---- VAR rCN	1.0000E-4	1.000	+INF	.
---- VAR zNL	1.0000E-4	1.000	+INF	.
---- VAR zIN	1.0000E-4	1.000	+INF	.
---- VAR zCN	1.0000E-4	1.000	+INF	.
---- VAR INL	.	300.000	+INF	.
---- VAR IIN	.	300.000	+INF	.
---- VAR ICN	.	300.000	+INF	.

Annexure 3:
Excel Sheet: Input-Output Matrix (Micro-Consistency Matrix)

	production of all goods in NL			production of all goods in IN			production of all goods in CN			Milk exports from NL		Milk Exports from IN		Milk Exports from CN		Sugar Exports from NL		Sugar Exports from IN		Sugar Exports from CN		Elec Exports from NL		Elec Exports from IN		Elec Exports from CN		welfare countries					
	MILK NL	SUGAR NL	ELEC NL	MILK IN	SUGAR IN	ELEC IN	MILK CN	SUGAR CN	ELEC CN	MILK NLIN	MILK NLCN	MILK INNL	MILK INCN	MILK CNNL	MILK CNIN	SUGAR NLIN	SUGAR NLCN	SUGAR INNL	SUGAR INCN	SUGAR CNNL	SUGAR CNIN	ELEC NLIN	ELEC NLCN	ELEC INNL	ELEC INCN	ELEC CNNL	ELEC CNIN	WNL	WIN	WCN	ConsNL	CONSIND	CONSCN
pMILK NL	85			110			105			2.6	38.4	2.6	3.48	38.4	3.48													-100	-100	-100	25.77	103.29	98.15
pSUGAR NL		120			100			80								32.1	19.3	32.1	20.9	19.3	20.9							-100	-100	-100	34.2	109.2	94.11
pELEC NL			95			90			115													19.6	50.6	19.6	28.4	50.6	28.4	-100	-100	-100	215.7	85.6	103.4
pMILK IN																																	
pSUGAR IN																																	
pELEC IN																																	
pMILK CN																																	
pSUGAR CN																																	
pELEC CN																																	
PWNL																												300			-300		
PWIN																													300			-300	
PWCN																														300			-300
wNL	-30	-90	-30																												150		
rNL	-25	-10	-15																												50		
zNL	-30	-20	-50																												100		
wIN				-20	-60	-20																										100	
rIN				-75	-30	-45																										150	
zIN				-15	-10	-25																										50	
wCN							-15	-40	-45																								100
rCN							-20	-10	-20																								50
zCN							-70	-30	-50																								150

price Welfare

Annexure 4:
GAMS results: Benchmark

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR MilkNL	.	107.210	+INF	.
---- VAR SugarNL	.	92.225	+INF	.
---- VAR ElecNL	.	94.669	+INF	.
---- VAR MilkIN	.	101.390	+INF	.
---- VAR SugarIN	.	102.684	+INF	.
---- VAR ElecIN	.	93.874	+INF	.
---- VAR MilkCN	.	96.702	+INF	.
---- VAR SugarCN	.	100.297	+INF	.
---- VAR ElecCN	.	102.183	+INF	.
---- VAR ExpMilkNLIN	.	.	+INF	0.161
---- VAR ExpMilkINNL	.	.	+INF	1.009
---- VAR ExpMilkNLCN	.	.	+INF	0.252
---- VAR ExpMilkCNNL	.	.	+INF	0.873
---- VAR ExpMilkINCN	.	.	+INF	0.760
---- VAR ExpMilkCNIN	.	.	+INF	0.533
---- VAR ExpSugarNLIN	.	.	+INF	0.421
---- VAR ExpSugarINNL	.	.	+INF	0.821
---- VAR ExpSugarNLCN	.	.	+INF	0.540
---- VAR ExpSugarCNNL	.	.	+INF	0.643
---- VAR ExpSugarCNIN	.	.	+INF	0.483
---- VAR ExpSugarINCN	.	.	+INF	0.780
---- VAR ExpElecNLIN	.	.	+INF	0.252
---- VAR ExpElecINNL	.	.	+INF	1.037
---- VAR ExpElecNLCN	.	.	+INF	0.517
---- VAR ExpElecCNNL	.	.	+INF	0.640
---- VAR ExpElecINCN	.	.	+INF	0.988
---- VAR ExpElecCNIN	.	.	+INF	0.326
---- VAR WFNL	.	293.462	+INF	.
---- VAR WFCN	.	299.104	+INF	.
---- VAR WFIN	.	297.716	+INF	.
---- VAR pMilkNL	1.000	1.000	1.000	3.0328E-8
---- VAR pMilkIN	1.0000E-4	1.339	+INF	.
---- VAR pMilkCN	1.0000E-4	1.248	+INF	.
---- VAR pSugarNL	1.0000E-4	1.162	+INF	.
---- VAR pSugarIN	1.0000E-4	1.322	+INF	.
---- VAR pSugarCN	1.0000E-4	1.204	+INF	.
---- VAR pElecNL	1.0000E-4	1.132	+INF	.
---- VAR pElecIN	1.0000E-4	1.446	+INF	.
---- VAR pElecCN	1.0000E-4	1.181	+INF	.
---- VAR wNL	1.0000E-4	1.297	+INF	.
---- VAR wIN	1.0000E-4	1.270	+INF	.
---- VAR wCN	1.0000E-4	1.183	+INF	.
---- VAR rNL	1.0000E-4	0.804	+INF	.
---- VAR rIN	1.0000E-4	1.222	+INF	.
---- VAR rCN	1.0000E-4	1.358	+INF	.
---- VAR zNL	1.0000E-4	1.209	+INF	.
---- VAR zIN	1.0000E-4	1.616	+INF	.
---- VAR zCN	1.0000E-4	1.125	+INF	.
---- VAR INL	.	321.629	+INF	.
---- VAR IIN	.	407.343	+INF	.
---- VAR ICN	.	362.166	+INF	.

Annexure 5:
GAMS results: Normal Free Trade Scenario

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR MilkNL	.	128.292	+INF	.
---- VAR SugarNL	.	73.882	+INF	.
---- VAR ElecNL	.	94.314	+INF	.
---- VAR MilkIN	.	87.207	+INF	.
---- VAR SugarIN	.	121.870	+INF	.
---- VAR ElecIN	.	89.015	+INF	.
---- VAR MilkCN	.	90.763	+INF	.
---- VAR SugarCN	.	100.446	+INF	.
---- VAR ElecCN	.	108.272	+INF	.
---- VAR ExpMilkNLIN	.	16.775	+INF	.
---- VAR ExpMilkINNL	.	.	+INF	0.051
---- VAR ExpMilkNLCN	.	6.677	+INF	.
---- VAR ExpMilkCNNL	.	.	+INF	0.190
---- VAR ExpMilkINCN	.	.	+INF	0.033
---- VAR ExpMilkCNIN	.	.	+INF	0.153
---- VAR ExpSugarNLIN	.	.	+INF	0.054
---- VAR ExpSugarINNL	.	21.980	+INF	.
---- VAR ExpSugarNLCN	.	.	+INF	0.132
---- VAR ExpSugarCNNL	.	.	+INF	0.043
---- VAR ExpSugarCNIN	.	.	+INF	0.117
---- VAR ExpSugarINCN	.	.	+INF	0.109
---- VAR ExpElecNLIN	.	.	+INF	0.023
---- VAR ExpElecINNL	.	.	+INF	0.033
---- VAR ExpElecNLCN	.	.	+INF	0.252
---- VAR ExpElecCNNL	.	.	+INF	0.015
---- VAR ExpElecINCN	.	.	+INF	0.228
---- VAR ExpElecCNIN	.	6.460	+INF	.
---- VAR WFNL	.	294.694	+INF	.
---- VAR WFCN	.	299.648	+INF	.
---- VAR WFIN	.	299.165	+INF	1.6844E-8
---- VAR pMilkNL	1.000	1.000	1.000	2.6152E-7
---- VAR pMilkIN	1.0000E-4	1.025	+INF	.
---- VAR pMilkCN	1.0000E-4	1.080	+INF	.
---- VAR pSugarNL	1.0000E-4	1.094	+INF	.
---- VAR pSugarIN	1.0000E-4	1.067	+INF	.
---- VAR pSugarCN	1.0000E-4	1.048	+INF	.
---- VAR pElecNL	1.0000E-4	1.112	+INF	.
---- VAR pElecIN	1.0000E-4	1.116	+INF	.
---- VAR pElecCN	1.0000E-4	1.034	+INF	.
---- VAR wNL	1.0000E-4	1.154	+INF	-7.792E-8
---- VAR wIN	1.0000E-4	1.078	+INF	-1.430E-7
---- VAR wCN	1.0000E-4	1.032	+INF	.
---- VAR rNL	1.0000E-4	0.844	+INF	4.4982E-8
---- VAR rIN	1.0000E-4	0.906	+INF	3.6176E-8
---- VAR rCN	1.0000E-4	1.156	+INF	.
---- VAR zNL	1.0000E-4	1.206	+INF	.
---- VAR zIN	1.0000E-4	1.218	+INF	3.5125E-8
---- VAR zCN	1.0000E-4	0.995	+INF	.
---- VAR INL	.	314.520	+INF	.
---- VAR IIN	.	319.743	+INF	.
---- VAR ICN	.	315.708	+INF	.

Annexure 6:

GAMS results: Ambitious Free Trade Scenario

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR MilkNL	.	135.231	+INF	.
---- VAR SugarNL	.	66.577	+INF	.
---- VAR ElecNL	.	95.179	+INF	.
---- VAR MilkIN	.	75.141	+INF	.
---- VAR SugarIN	.	129.223	+INF	.
---- VAR ElecIN	.	92.943	+INF	.
---- VAR MilkCN	.	95.706	+INF	.
---- VAR SugarCN	.	100.321	+INF	.
---- VAR ElecCN	.	103.210	+INF	.
---- VAR ExpMilkNLIN	.	30.233	+INF	.
---- VAR ExpMilkINNL	.	.	+INF	.
---- VAR ExpMilkNLCN	.	1.117	+INF	.
---- VAR ExpMilkCNNL	.	.	+INF	0.190
---- VAR ExpMilkINCN	.	.	+INF	0.006
---- VAR ExpMilkCNIN	.	.	+INF	0.178
---- VAR ExpSugarNLIN	.	.	+INF	.
---- VAR ExpSugarINNL	.	30.625	+INF	.
---- VAR ExpSugarNLCN	.	.	+INF	0.111
---- VAR ExpSugarCNNL	.	.	+INF	0.062
---- VAR ExpSugarCNIN	.	.	+INF	0.109
---- VAR ExpSugarINCN	.	.	+INF	0.116
---- VAR ExpElecNLIN	.	1.247	+INF	.
---- VAR ExpElecINNL	.	.	+INF	.
---- VAR ExpElecNLCN	.	.	+INF	0.256
---- VAR ExpElecCNNL	.	.	+INF	0.010
---- VAR ExpElecINCN	.	.	+INF	0.226
---- VAR ExpElecCNIN	.	1.091	+INF	.
---- VAR WFNL	.	294.756	+INF	.
---- VAR WFCN	.	299.190	+INF	.
---- VAR WFIN	.	298.990	+INF	.
---- VAR pMilkNL	1.000	1.000	1.000	3.212E-11
---- VAR pMilkIN	1.0000E-4	1.000	+INF	.
---- VAR pMilkCN	1.0000E-4	1.080	+INF	.
---- VAR pSugarNL	1.0000E-4	1.069	+INF	.
---- VAR pSugarIN	1.0000E-4	1.069	+INF	.
---- VAR pSugarCN	1.0000E-4	1.042	+INF	.
---- VAR pElecNL	1.0000E-4	1.106	+INF	.
---- VAR pElecIN	1.0000E-4	1.106	+INF	.
---- VAR pElecCN	1.0000E-4	1.024	+INF	.
---- VAR wNL	1.0000E-4	1.103	+INF	.
---- VAR wIN	1.0000E-4	1.103	+INF	.
---- VAR wCN	1.0000E-4	1.024	+INF	.
---- VAR rNL	1.0000E-4	0.857	+INF	.
---- VAR rIN	1.0000E-4	0.857	+INF	.
---- VAR rCN	1.0000E-4	1.172	+INF	.
---- VAR zNL	1.0000E-4	1.210	+INF	.
---- VAR zIN	1.0000E-4	1.210	+INF	.
---- VAR zCN	1.0000E-4	0.977	+INF	.
---- VAR INL	.	311.643	+INF	.
---- VAR IIN	.	316.120	+INF	.
---- VAR ICN	.	313.708	+INF	.

Annexure 7:
GAMS results: Sensitivity Anslysis: Benchmark

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR MilkNL	.	108.469	+INF	.
---- VAR SugarNL	.	89.394	+INF	.
---- VAR ElecNL	.	91.986	+INF	.
---- VAR MilkIN	.	98.848	+INF	.
---- VAR SugarIN	.	105.866	+INF	.
---- VAR ElecIN	.	91.737	+INF	.
---- VAR MilkCN	.	95.071	+INF	.
---- VAR SugarCN	.	97.772	+INF	.
---- VAR ElecCN	.	104.622	+INF	.
---- VAR ExpMilkNL~	.	.	+INF	0.317
---- VAR ExpMilkIN~	.	.	+INF	0.774
---- VAR ExpMilkNL~	.	.	+INF	0.118
---- VAR ExpMilkCN~	.	.	+INF	1.073
---- VAR ExpMilkIN~	.	.	+INF	0.392
---- VAR ExpMilkCN~	.	.	+INF	0.890
---- VAR ExpSugarN~	.	.	+INF	0.716
---- VAR ExpSugarI~	.	.	+INF	0.443
---- VAR ExpSugarN~	.	.	+INF	0.477
---- VAR ExpSugarC~	.	.	+INF	0.802
---- VAR ExpSugarC~	.	.	+INF	0.911
---- VAR ExpSugarI~	.	.	+INF	0.313
---- VAR ExpElecNL~	.	.	+INF	0.494
---- VAR ExpElecIN~	.	.	+INF	0.732
---- VAR ExpElecNL~	.	.	+INF	0.513
---- VAR ExpElecCN~	.	.	+INF	0.704
---- VAR ExpElecIN~	.	.	+INF	0.656
---- VAR ExpElecCN~	.	.	+INF	0.609
---- VAR WFNL	.	288.780	+INF	.
---- VAR WFCN	.	297.223	+INF	.
---- VAR WFIN	.	295.944	+INF	.
---- VAR pMilkNL	1.000	1.000	1.000	3.4376E-8
---- VAR pMilkIN	1.0000E-4	1.183	+INF	.
---- VAR pMilkCN	1.0000E-4	1.382	+INF	.
---- VAR pSugarNL	1.0000E-4	1.213	+INF	.
---- VAR pSugarIN	1.0000E-4	1.104	+INF	.
---- VAR pSugarCN	1.0000E-4	1.344	+INF	.
---- VAR pElecNL	1.0000E-4	1.179	+INF	.
---- VAR pElecIN	1.0000E-4	1.274	+INF	.
---- VAR pElecCN	1.0000E-4	1.256	+INF	.
---- VAR wNL	1.0000E-4	1.395	+INF	.
---- VAR wIN	1.0000E-4	1.002	+INF	.
---- VAR wCN	1.0000E-4	1.351	+INF	.
---- VAR rNL	1.0000E-4	0.751	+INF	.
---- VAR rIN	1.0000E-4	1.107	+INF	.
---- VAR rCN	1.0000E-4	1.576	+INF	.
---- VAR zNL	1.0000E-4	1.291	+INF	.
---- VAR zIN	1.0000E-4	1.474	+INF	.
---- VAR zCN	1.0000E-4	1.126	+INF	.
---- VAR INL	.	325.407	+INF	.
---- VAR IIN	.	350.698	+INF	2.2886E-8
---- VAR ICN	.	394.072	+INF	.

Annexure 8:

GAMS results: Sensitivity Anslysis: Normal Free Trade Scenario

```
                             LOWER      LEVEL      UPPER    MARGINAL

---- VAR MilkNL                .       157.385     +INF         .
---- VAR SugarNL               .        56.199     +INF         .
---- VAR ElecNL                .        82.415     +INF         .
---- VAR MilkIN                .        77.953     +INF         .
---- VAR SugarIN               .       141.704     +INF         .
---- VAR ElecIN                .        78.652     +INF         .
---- VAR MilkCN                .        70.480     +INF         .
---- VAR SugarCN               .        98.477     +INF         .
---- VAR ElecCN                .       130.305     +INF         .
---- VAR ExpMilkNL~            .        25.432     +INF         .
---- VAR ExpMilkIN~            .          .        +INF       0.051
---- VAR ExpMilkNL~            .        27.869     +INF         .
---- VAR ExpMilkCN~            .          .        +INF       0.190
---- VAR ExpMilkIN~            .          .        +INF       0.033
---- VAR ExpMilkCN~            .          .        +INF       0.153
---- VAR ExpSugarN~            .          .        +INF       0.053
---- VAR ExpSugarI~            .        40.643     +INF         .
---- VAR ExpSugarN~            .          .        +INF       0.081
---- VAR ExpSugarC~            .          .        +INF       0.095
---- VAR ExpSugarC~            .          .        +INF       0.170
---- VAR ExpSugarI~            .          .        +INF       0.058
---- VAR ExpElecNL~            .          .        +INF       0.038
---- VAR ExpElecIN~            .          .        +INF       0.017
---- VAR ExpElecNL~            .          .        +INF       0.269
---- VAR ExpElecCN~            .        10.383     +INF         .
---- VAR ExpElecIN~            .          .        +INF       0.227
---- VAR ExpElecCN~            .        16.701     +INF         .
---- VAR WFNL                  .       293.392     +INF         .
---- VAR WFCN                  .       299.972     +INF         .
---- VAR WFIN                  .       299.626     +INF         .
---- VAR pMilkNL             1.000       1.000      1.000 1.6838E-6
---- VAR pMilkIN         1.0000E-4       1.025     +INF         .
---- VAR pMilkCN         1.0000E-4       1.080     +INF         .
---- VAR pSugarNL        1.0000E-4       1.075     +INF         .
---- VAR pSugarIN        1.0000E-4       1.049     +INF         .
---- VAR pSugarCN        1.0000E-4       1.079     +INF         .
---- VAR pElecNL         1.0000E-4       1.122     +INF         .
---- VAR pElecIN         1.0000E-4       1.111     +INF         .
---- VAR pElecCN         1.0000E-4       1.029     +INF         .
---- VAR wNL             1.0000E-4       1.111     +INF         .
---- VAR wIN             1.0000E-4       1.043     +INF         .
---- VAR wCN             1.0000E-4       1.096     +INF         .
---- VAR rNL             1.0000E-4       0.840     +INF  -1.086E-8
---- VAR rIN             1.0000E-4       0.917     +INF         .
---- VAR rCN             1.0000E-4       1.148     +INF         .
---- VAR zNL             1.0000E-4       1.246     +INF  -1.502E-8
---- VAR zIN             1.0000E-4       1.219     +INF         .
---- VAR zCN             1.0000E-4       0.966     +INF         .
---- VAR INL                   .       312.252     +INF         .
---- VAR IIN                   .       317.909     +INF         .
---- VAR ICN                   .       318.651     +INF         .
```

Annexure 9:
GAMS results: Sensitivity Anslysis: Ambitious Free Trade Scenario

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR MilkNL	.	168.997	+INF	.
---- VAR SugarNL	.	50.144	+INF	.
---- VAR ElecNL	.	77.763	+INF	.
---- VAR MilkIN	.	64.164	+INF	.
---- VAR SugarIN	.	147.938	+INF	.
---- VAR ElecIN	.	85.346	+INF	.
---- VAR MilkCN	.	72.708	+INF	.
---- VAR SugarCN	.	98.403	+INF	.
---- VAR ElecCN	.	128.040	+INF	.
---- VAR ExpMilkNL~	.	41.122	+INF	.
---- VAR ExpMilkIN~	.	.	+INF	.
---- VAR ExpMilkNL~	.	25.321	+INF	.
---- VAR ExpMilkCN~	.	.	+INF	0.190
---- VAR ExpMilkIN~	.	.	+INF	0.006
---- VAR ExpMilkCN~	.	.	+INF	0.178
---- VAR ExpSugarN~	.	.	+INF	.
---- VAR ExpSugarI~	.	47.595	+INF	.
---- VAR ExpSugarN~	.	.	+INF	0.056
---- VAR ExpSugarC~	.	.	+INF	0.118
---- VAR ExpSugarC~	.	.	+INF	0.166
---- VAR ExpSugarI~	.	.	+INF	0.062
---- VAR ExpElecNL~	.	.	+INF	.
---- VAR ExpElecIN~	.	14.913	+INF	.
---- VAR ExpElecNL~	.	.	+INF	0.256
---- VAR ExpElecCN~	.	.	+INF	0.010
---- VAR ExpElecIN~	.	.	+INF	0.226
---- VAR ExpElecCN~	.	24.712	+INF	.
---- VAR WFNL	.	292.720	+INF	.
---- VAR WFCN	.	299.672	+INF	.
---- VAR WFIN	.	300.516	+INF	.
---- VAR pMilkNL	1.000	1.000	1.000	2.305E-11
---- VAR pMilkIN	1.0000E-4	1.000	+INF	.
---- VAR pMilkCN	1.0000E-4	1.080	+INF	.
---- VAR pSugarNL	1.0000E-4	1.049	+INF	.
---- VAR pSugarIN	1.0000E-4	1.049	+INF	.
---- VAR pSugarCN	1.0000E-4	1.076	+INF	.
---- VAR pElecNL	1.0000E-4	1.107	+INF	.
---- VAR pElecIN	1.0000E-4	1.107	+INF	.
---- VAR pElecCN	1.0000E-4	1.025	+INF	.
---- VAR wNL	1.0000E-4	1.063	+INF	.
---- VAR wIN	1.0000E-4	1.063	+INF	.
---- VAR wCN	1.0000E-4	1.092	+INF	.
---- VAR rNL	1.0000E-4	0.863	+INF	.
---- VAR rIN	1.0000E-4	0.863	+INF	.
---- VAR rCN	1.0000E-4	1.156	+INF	.
---- VAR zNL	1.0000E-4	1.227	+INF	.
---- VAR zIN	1.0000E-4	1.227	+INF	.
---- VAR zCN	1.0000E-4	0.958	+INF	.
---- VAR INL	.	307.662	+INF	.
---- VAR IIN	.	315.857	+INF	.
---- VAR ICN	.	317.612	+INF	.