

博士論文

Impacts of Trade Liberalization on Agricultural Trade,

Growth, and Poverty in Mongolia

(モンゴルにおける貿易自由化の農業貿易、成長および貧困への影響)

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ABSTRACT

This dissertation aims to assess the impacts of trade liberalization and related complementary policies on agricultural trade, growth, and poverty in Mongolia. As majority of the poor in Mongolia live in rural areas, engaging in livestock herding activities, agricultural development has great potential to reduce poverty. Moreover, agricultural trade accelerates agricultural development more than domestic markets by bringing cash income and creating jobs. Meanwhile, the contribution of agriculture in trade and GDP is declining over time although Mongolia has a comparative advantage in producing livestock products. Therefore, one of the biggest challenges that Mongolia faces is to improve living standards of rural poor while keeping up with the trade reform procedures at the international level.

To achieve its objective, the dissertation first assesses impacts of different types of trade liberalization on growth and poverty by adopting a macro-micro simulation approach that combines the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model with household survey data. The macro-micro approach has an advantage over a standard CGE model in studying distributional impact of trade liberalization, because it takes into account heterogeneities within household groups and improves the realism of modeling. The newly released GTAP database, version 8, which includes Mongolia as an independent region for the first time, and the Mongolian Household Socio-Economic Survey (HSES) 2007–2008 database allow the extension of evidence on impacts of trade liberalization on growth and poverty to Mongolia. In the macro-micro model, changes in household welfare are computed across 11,172 households sampled in HSES 2007–2008. Results demonstrate that impacts of trade liberalization vary depending on its type. In the case of Mongolia, bilateral trade liberalization with China and Russia increases growth and

reduces poverty, whereas multilateral reform is likely to have a negative impact. Moreover, household characteristics determine whether they gain or lose from the trade reform.

However, trade policy related distortions are not the only barriers to trade. Even if substantial trade liberalization removes all trade policy-related barriers, there still exist obstacles to trade such as transportation costs, information costs, and environmental costs. Therefore, the dissertation quantifies total trade costs for agricultural trade, and evaluates how the reduction in trade costs complement effects of trade liberalization using a combination of two approaches. First, an ad-valorem tariff equivalent of overall trade cost is analytically derived from the micro-founded gravity model. Then, the measure of trade costs is used to assess the impact of trade costs on agricultural trade and welfare in Mongolia, by modifying a multi-market, industry-oriented spatial partial equilibrium model. Results show that agricultural trade costs in Mongolia is decreasing over time, but they are still significant in size. The effect of total trade costs is much larger than just tariffs and a reduction in trade costs increases trade and improves welfare.

Finally, greater exposure to international trade could bring about agricultural productivity growth through improvements in technical efficiency and technology diffusion. This process could help Mongolia to exploit its comparative advantage in livestock products and increase exports of these products. Thus, to measure the current level of technical efficiency of the agricultural sector in Mongolia, and determine its sources, the stochastic production frontier approach was applied in the case of livestock sector in Mongolia. Using the results from the stochastic frontier analysis, changes in total factor productivity (TFP) and its components are computed. This study contributes to empirical literature on the relationship between trade openness and technical efficiency with evidence from the Mongolian livestock sector. Results show that trade openness is an important determinant of efficiency improvement in the livestock sector. TFP is increasing but at a declining rate.

Results of the dissertation provide some policy recommendations for Mongolia to achieve more equitable growth from trade liberalization. As trade reforms create both winners and losers, complementary policies that would help the poor to overcome the adverse effects of liberalization are necessary. For example, macroeconomic stability policies could mitigate short term adjustment costs. Moreover, trade facilitation policies and investment in infrastructure may accelerate benefits of trade liberalization by reducing trade costs. Finally, agricultural research and extension services would help to improve declining agricultural TFP growth.

DEDICATION

This dissertation is dedicated in memories of my beloved mother and grandmother who loved me unconditionally and inspired me to follow my dreams.

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TABLE OF CONTENTS

List of tables	xi
List of figures	xiv
List of abbreviations	xvi
1. Introduction	18
1.1. Background and rationale.....	18
1.2. Objectives and research questions.....	22
1.3. Overview of the dissertation.....	23
2. Recent trends of trade and poverty in Mongolia	27
2.1. Trade liberalization and trade policy in Mongolia	27
2.1.1. Trade policies and structural changes in agriculture	30
2.2. Evolution of trade	39
2.3. Why is the share of agricultural trade declining?	46
2.3.1. Trade costs.....	47
2.3.2. Agricultural productivity	50
2.4. Poverty.....	52

3. Impact of trade liberalization on growth and poverty: The case of Mongolia	54
3.1. Introduction	54
3.2. Literature review	55
3.3. Methodology and data	63
3.3.1. GTAP data and model scenarios.....	64
3.3.2. Household Socio-Economic Survey data	68
3.3.3. Microsimulation model	70
3.4. Results and discussions	74
3.5. Conclusion.....	82
Appendix to Chapter 3	85
4. Agricultural trade costs and their impact on trade and welfare in Mongolia	98
4.1. Introduction	98
4.2. Literature review	101
4.3. Methodology and data	105
4.3.1. Methodology	105
4.3.2. Data	111
4.4. Results and discussions	113
4.4.1. Main results	113

4.4.2. Sensitivity analysis	119
4.5. Conclusion.....	122
Appendix to Chapter 4	124
5. Efficiency and productivity of the Mongolian agricultural sector in an open economy: The case of the livestock sector	126
5.1. Introduction	126
5.2. Literature review	130
5.3. Methodology and data	135
5.3.1. Stochastic frontier analysis.....	135
5.3.2. Calculation and decomposition of TFP changes	136
5.3.3. Data	138
5.4. Hypothesis tests.....	139
5.5. Theoretical consistency of the estimated translog production frontier	142
5.6. Discussions.....	149
5.7. Conclusion.....	155
Appendix to Chapter 5	157
6. Conclusions	158
References	166

LIST OF TABLES

Table 2.1 Tariffs applied by Mongolia, %, 2011	29
Table 2.2 Decomposition of export growth, 1997–2007	46
Table 2.3 Duties faced in 2011: MFN average of traded tariff lines by major trade partners	49
Table 2.4 Efficiency of customs administration and import-export procedures	49
Table 2.5 Availability and quality of transport and communication infrastructure	50
Table 2.6 Poverty incidence, % of total population	53
Table 2.7 Poverty incidence by herding and non-herding, %	53
Table 3.1 Regions and sectors of the Mongolian GTAP model	64
Table 3.2 Summary statistics of variables from HSES 2007–2008	69
Table 3.3 Changes in GDP of Mongolia, percentage change from the base	75
Table 3.4 Welfare changes in Mongolia, million USD.....	75
Table 3.5 Regression of per capita gains/losses from unilateral and multilateral reforms	79
Table 3.6 Regression of per capita gains/losses from bilateral reforms	80

Table 3.7 Poverty incidence, change from the base in percentage points	82
Table A3.1 Regional classification used in the Mongolian GTAP model	85
Table A3.2 Sectoral classification used in the Mongolian GTAP model	86
Table A3.3 Import tariff rates applied by Mongolia, %	87
Table A3.4 Import tariff rates faced by Mongolia, %	88
Table A3.5 Export subsidies, by regions and countries, %	89
Table A3.6 Output subsidies, by regions and countries, %	90
Table A3.7 Changes in the real exchange rate in Mongolia	91
Table A3.8 Descriptions of categorical variables	91
Table A3.9 Market price changes in Mongolia, %	92
Table A3.10 Supply price changes in Mongolia, %	93
Table A3.11 Changes in wage rates in Mongolia, %	94
Table A3.12 Matching between GTAP sectors and household survey categories.....	95
Table A3.13 Studies that find negative impact of full multilateral trade liberalization .	96
Table A3.14 Changes in the world welfare from the multilateral liberalization, million USD.....	97
Table 4.1 Ad-valorem tariff equivalent of bilateral agricultural trade costs for Mongolia	114

Table 4.2 Regression of agricultural trade costs on trade cost proxies	115
Table 4.3 Changes in key indicators in Mongolia, percentage change from the base..	118
Table 4.4 Welfare changes in Mongolia, million USD.....	119
Table 4.5 Sensitivity of regression results of trade cost measure.....	122
Table A4.1 Scenario 1: Changes in trade, percentage change from the base	124
Table A4.2 Scenario 2: Changes in trade, percentage change from the base	125
Table A4.3 Scenario 3: Changes in trade, percentage change from the base	125
Table 5.1 Descriptive statistics of variables	138
Table 5.2 Hypothesis tests	140
Table 5.3 The stochastic production frontier estimation for Mongolian livestock sector (unrestricted)	145
Table 5.4 Restricted stochastic production frontier estimates for Mongolian livestock sector	148
Table 5.5 Technical inefficiency model.....	149
Table A5.1 Average percentage changes in TFP and its decomposition by province, 2002–2011	157

LIST OF FIGURES

Figure 2.1 The composition of GDP, %, 1996–2010	31
Figure 2.2 Employment by sector, %, of total employment, 1997–2009.....	31
Figure 2.3 Population trend, thousand people, 1970–2012.....	33
Figure 2.4 Trend in livestock numbers, thousand heads, 1970–2012	35
Figure 2.5 Main livestock production, thousand tons, 1990–2011	36
Figure 2.6 Exports of livestock commodities, thousand tons, 1990–2011.....	37
Figure 2.7 The share of trade in GDP, 1991–2011	40
Figure 2.8 Trade and trade balance, billion 2010 USD, 1995–2011	41
Figure 2.9 Trade in agricultural raw materials and food, million 2010 USD, 1995–2011	41
Figure 2.10 Product composition of exports, 1997 and 2007	42
Figure 2.11 Product composition of imports, 1997 and 2007	43
Figure 2.12 Main export destinations of Mongolia, the share in total exports, 1997 and 2010.....	44
Figure 2.13 Geographical orientation of Mongolia’s exports in 2007	45

Figure 2.14 Labor productivity of the livestock sector, thousand 2010 MNT per herder	51
Figure 3.1 Structure of the macro-micro simulation model	70
Figure 4.1 Sensitivity of agricultural trade costs to the choice of parameter values....	120
Figure 5.1 Annual percentage changes in TFP and its decomposition	154

LIST OF ABBREVIATIONS

CDE	Constant Difference Elasticity
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
CES	Constant Elasticity of Substitution
CGE	Computable General Equilibrium
DDA	Doha Development Agenda
EU	European Union
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
GAMS	General Algebraic Modeling System
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GSIM	Global Simulation Model
GSP	Generalized System of Preferences
GTAP	Global Trade Analysis Project
HIES	Household Income and Expenditure Survey
H-O	Hesckscher-Ohlin
HSES	Household Socio-Economic Survey

IMF	International Monetary Fund
LSMS	Living Standards Measurement Survey
MFN	Most Favored Nation
MNT	Mongolian Togrog
NSO	National Statistical Office (of Mongolia)
NTM	Non-Tariff Measure
PTA	Preferential Trade Agreement
RCA	Revealed Comparative Advantage
SFA	Stochastic Frontier Analysis
SITC	Standard International Trade Classification
SPS	Sanitary and Phytosanitary
TFP	Total Factor Productivity
TRAINS	Trade Analysis and Information System
TRQ	Tariff Rate Quota
USD	United States Dollar
WITS	World Integrated Trade Solution
WTO	World Trade Organization

1. INTRODUCTION

1.1. BACKGROUND AND RATIONALE

Both agricultural development and successful trade liberalization are equally important for developing countries to achieve economic growth and poverty reduction. While productive agricultural activities provide food, labor, and savings to the process of industrialization, and gradually eliminate poverty; trade openness broadens the variety of goods and services available to consumers, increases competition, lowers prices and allows producers to diversify risks and channel resources to where returns are highest. Attracted by possible benefits of openness, many developing countries have undergone considerable trade liberalization since the 1980s to boost growth and reduce poverty.

However, as trade liberalization is more intensified worldwide, the contribution of agriculture to global trade and gross domestic product (GDP) is declining. Although agricultural production in many developing countries is for home consumption and sale in domestic markets, growth in exports can accelerate agricultural development by increasing cash income, modernizing the agricultural sector, and creating more jobs (Aksoy, 2005). In

addition, agricultural growth is likely to have the greatest potential to alleviate poverty because majority of the poor in developing countries reside in rural areas, engaging in agricultural activities. Therefore, how to make agricultural trade liberalization work in favor of economic growth and poverty alleviation remains one of the most important issues in developing countries.

Like many developing countries, the share of agriculture in trade and GDP is declining over time in Mongolia. While the contribution of agriculture to GDP is declining, its share in total employment remains high. In 2009, approximately 40% of total labor force is in the agricultural sector (World Bank, 2013a).

The agricultural sector in Mongolia is dominated by livestock herding as the climate and the soil quality are not suitable for crop production. The sector has undergone major changes since Mongolia started its transition from a centrally planned to a market economy. The changes include the decollectivization of state farms, withdrawal of direct supports from the state, privatization of production assets, price liberalization, and openness to international trade. Shifting from collectives to private herding, herders gradually develop understanding of market forces and transform themselves into profit-oriented producers. At the same time, poverty is increasing in rural areas than in urban areas. According to the national poverty survey (National Statistical Office of Mongolia (NSO) and World Bank, 2009), rural poverty

increased from 33% in 1995 to 47% in 2008, whereas urban poverty is declining.

As Mongolia has a comparative advantage in producing livestock products due to a high number of livestock per capita and vast amounts of pastoral land, increasing exports of agriculture and trade liberalization of agricultural commodities are expected to affect the domestic agricultural sector significantly and reduce rural poverty. However, agricultural trade is still highly protected both in developing and developed countries. Indeed, agricultural trade liberalization issues have been long holding the Doha Development Agenda (DDA) to come into conclusion. Meanwhile, much research has been devoted to analyze the likely implications of the DDA on developing countries.

However, results of these studies are far from conclusive. Inconsistencies of the results of existing studies stem from the complexities of transmission mechanisms through which agricultural trade liberalization may affect poverty. Winters et al. (2004) define several channels that trade liberalization may affect poverty, including changes in prices, employment, government transfers, and incentives for investment and innovation, terms of trade shocks, remittances, and short run risk and adjustment costs. Research results differ depending on which transmission channels are considered.

In addition, most existing studies treat developing countries as a homogenous group whereas developing countries are, in fact, heterogeneous. Initial conditions and

country-specific factors have a great effect on whether a country benefit from trade liberalization. Thus, country-specific studies are more suitable to better understand the impacts of trade liberalization.

Moreover, trade liberalization requires a wide range of institutional reforms and complementary policies in order to deliver its benefits in full and remain sustainable (Rodrik, 2007). A lack of complementary policies and investments to facilitate trade may increase costs associated trading across borders. Indeed, one of the major obstacles to trade is trade costs, which tend to be large and variable over time and across sectors (Anderson and van Wincoop, 2004). Trade costs are particularly high in agriculture because most agricultural commodities tend to be bulky and perishable. In the case of Mongolia, trading across its borders is a costly operation due to landlockedness and poor infrastructure. Policy interventions to reduce such costs are particularly important to improve the positive effects of trade liberalization.

However, little has been known about the overall trade costs due to difficulties in measuring them. Broadly defined, trade costs include trade policy barriers and transportation costs, as well as all the other costs incurred in the exchange of goods across borders. Thus, it becomes difficult to measure the overall trade costs because many of the cost components are not observable. Nevertheless, existing literature emphasizes the importance of accounting for

the total trade costs rather than just a few observable components (Anderson and van Wincoop, 2004). Literature on trade costs in developing countries, where quality data are often lacking, is limited. Therefore, this dissertation aims to quantify the overall agricultural trade costs for Mongolia and extend the trade cost literature to Mongolia.

Another important complementary policy is related to capacity building and improving efficiency and productivity of domestic producers. Many agricultural producers in developing countries lack productive capacity and modern technology and equipment to compete in the world markets. The relationship between trade and technical efficiency is an empirical question because trade theories do not provide a clear explanation of this link (Rodrik, 1992). Researchers have studied the relationship between trade openness and technical efficiency at the industry or national level, whereas the case of the agricultural sector has rarely been studied with the exception of Shaik and Miljkovic (2011) and Miljkovic et al. (2013). Both studies find no empirical relationship between trade openness and technical efficiency of the agricultural sector. Therefore, this dissertation intends to contribute to the empirical literature of technical efficiency of the agricultural sector and trade openness.

1.2. OBJECTIVES AND RESEARCH QUESTIONS

This dissertation aims to study impacts of trade policies, including agricultural reforms at

both international and domestic levels on agricultural trade, growth, and poverty in Mongolia.

In particular, the following research questions will be addressed:

1. How different types of trade liberalization affect growth and poverty?
2. What is the impact of trade costs (both trade policy related and non-trade policy related) on agricultural trade and welfare?
3. What is the effect of trade openness on efficiency and productivity of the agricultural sector?

The research questions will be studied in the context of Mongolia with a specific focus on the livestock sector due to its predominance in the agricultural sector in Mongolia. The case of Mongolia is chosen for several reasons. First, Mongolia is different from many developing Asian countries in that it does not have comparative advantage in relatively cheap labor because of its small population size. Second, Mongolia has integral disadvantages namely low population density, landlockedness, and poor infrastructure which make international transaction of goods more costly. Third, harsh climate and infertile soil together with small population make its agricultural sector uncompetitive in the world market.

1.3. OVERVIEW OF THE DISSERTATION

This doctoral dissertation is divided into six chapters. Chapters 1 and 2 provide general

background on the research design and recent trend of trade and poverty in Mongolia. Chapters 3 to 5 comprise the core of the dissertation and address each of the research questions respectively. Finally, Chapter 6 concludes the dissertation.

Brief descriptions of the core chapters are as follows. Chapter 3 aims to answer the first research question. To study the impact of different types of trade policies on poverty, the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model is combined with household survey data through a microsimulation approach. The microsimulation approach has an advantage over a conventional CGE model because it allows an inclusion of “real” households from household surveys rather than “representative” households and improves realism by making it possible to capture differences within the same group of households. To link the household survey data with the CGE model, a microsimulation layered approach or top-down approach is applied. The data used in this study are GTAP database version 8, in which Mongolia is included as an independent region for the first time, and a nationally representative household survey, Household Socio-Economic Survey (HSES) 2007–2008 that covers 11,172 households. The results prove that trade reform types matter for growth and poverty. In the case of Mongolia, bilateral trade liberalization with China and Russia positively affects both GDP and welfare. Bilateral reforms are also more poverty alleviating than unilateral and multilateral liberalization,

particularly in rural herder households. Results also show that household characteristics determine whether they gain or lose from trade liberalization.

Chapter 4 addresses the second research question and derives a comprehensive measure of agricultural trade costs for Mongolia from the theoretical gravity model of Anderson and van Wincoop (2003). This measure is, then, used to quantify the impact of trade costs on agricultural trade and welfare in Mongolia by modifying an Armington-type partial equilibrium model by including total trade costs rather than just tariffs. The major data sources used are World Bank (2013b)'s World Integrated Trade Solutions (WITS) database for agricultural trade and the Food and Agriculture Organization of the United Nations (2013)'s Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) for agricultural production. The results show that agricultural trade costs in Mongolia are decreasing over time, although they are still high. A decline in the overall trade costs increases both trade and welfare in the country. Total trade costs have much greater impact than just tariffs.

Chapter 5 deals with the third research question. Taking into account major changes that took place in the livestock sector since Mongolia initiated a transition from a command to a market economy in the early 1990s, Chapter 5 measures technical efficiency and its sources—including trade openness—of the Mongolian livestock sector by using a stochastic

production frontier model on province-level panel data for the period 2001–2011. Furthermore, changes in total factor productivity (TFP) are decomposed by using the results from the stochastic frontier analysis and the Malmquist TFP index. The results suggest that trade openness is one of the most important determinants increasing efficiency of the sector, in addition to herd size. TFP increased during 2001–2011, but at a decreasing rate. The technical change is progressive, but its rate of growth is declining, suggesting a pressing need for technical improvements in the sector.

2. RECENT TRENDS OF TRADE AND POVERTY IN MONGOLIA

2.1. TRADE LIBERALIZATION AND TRADE POLICY IN MONGOLIA

In the early 1990s, trade liberalization was a critical reform conducted in Mongolia during its transition to a market-oriented system. With the main trade policy objectives of supporting sustainable development and economic growth and improving living standards, Mongolia started unilaterally liberalizing its trade regimes in the early transition years and gained access to the World Trade Organization (WTO) in 1997 after six years of an accession process (Ministry of Foreign Affairs and Trade in Mongolia and United Nations Development Programme, 2009).

Although WTO entry provides benefits in terms of an improved and more secure access to international markets, commitments that Mongolia accepted in its terms of accession to the WTO were relatively harsh at its level of development. After decades of the Council for Mutual Economic Assistance (COMECON) membership, Mongolia lacked knowledge and understanding about the multilateral trading system and the WTO, thus, failed to reserve rights and exceptions given to transitional and developing countries. For example, Mongolia

exercised neither the transitional period for its obligations nor the exemption from export subsidy prohibition typically granted to developing countries.

Moreover, there was little consultation with the domestic business community both before and after the accession, although the private sector grew rapidly to make up to 80% of GDP immediately after the entry to the WTO. The government of Mongolia generally took policies to bring national trade regulations in compliance with the WTO rather than searching ways to benefit from the WTO and expand market access for domestic producers. As a result, many private businesses still do not fully comprehend the WTO rules and how they can benefit from it. Instead, they fail to expand their business to international markets. A notable example of this is the livestock production sector, particularly meat industry that is suffering from a dependence on a single or a few buyers.

Since Mongolia entered the WTO, its trade has substantially liberalized. Liberalization has involved the tariff reduction and the removal of import licensing requirements. On accession, applied tariff rates of Mongolia were reduced to approximately 5%, with no significant difference between agricultural and non-agricultural goods, and all tariff lines were bound (on average at 20%) under the General Agreement on Tariffs and Trade (GATT) 1994. Currently, Mongolia applies an ad-valorem most-favored-nation (MFN) tariff rate of 5% to most of imported goods, with a few exceptions of zero and 10–25% rates (Table

2.1). Zero rates apply to live animals for breeding, horses, cows, pigs, sheep, goats, information dissemination equipment and its spare parts, other machines for information development, transistor diode and any similar transistors, and medical equipment (WTO, 2005). A seasonal rate of 10% is applied to flour and vegetables, and a rate of 25% is applied to alcoholic beverages and tobacco.

Table 2.1 Tariffs applied by Mongolia, %, 2011

Industry	Tariffs applied		
	Average	Minimum	Maximum
Agriculture and hunting	5%	0%	10%
Crops	5%	5%	10%
Livestock	4%	0%	5%
Hunting	5%	5%	5%
Forestry and Fishing	5%	5%	5%
Mining and quarrying	5%	5%	5%
Petroleum	5%	5%	5%
Food, beverages and tobacco	5%	5%	25%
Textiles, clothing and leather	5%	5%	5%
Wood and wood products	5%	5%	5%
Publishing, printing and reproduction of recorded media	5%	5%	5%
Coke, petroleum products and nuclear fuel	5%	5%	5%
Chemicals and chemical products	5%	5%	5%
Rubber and plastic products	5%	5%	5%
Non-metallic mineral products	5%	5%	5%
Metal and metal products	5%	5%	5%
Machinery and equipment	5%	5%	5%
Electrical and electronic equipment	5%	0%	5%
Precision instruments	5%	0%	5%
Motor vehicles and other transport equipment	5%	5%	5%
Other manufacturing	5%	5%	5%
Recycling	5%	5%	5%
Mixed goods (trade data)	5%	5%	5%

Source: International Trade Centre (2013)

Mongolia grants the MFN treatment to all WTO members. There are no preferential rates applied as Mongolia has not signed any regional or bilateral free-trade agreements. Mongolia has completed several bilateral trade-related arrangements, which do not include preferential treatment (WTO, 2005). Mongolia is currently a beneficiary of a number of preferential schemes under the Generalized System of Preferences (GSP), including that of Canada, the European Union, Japan and the United States (WTO, 2005).

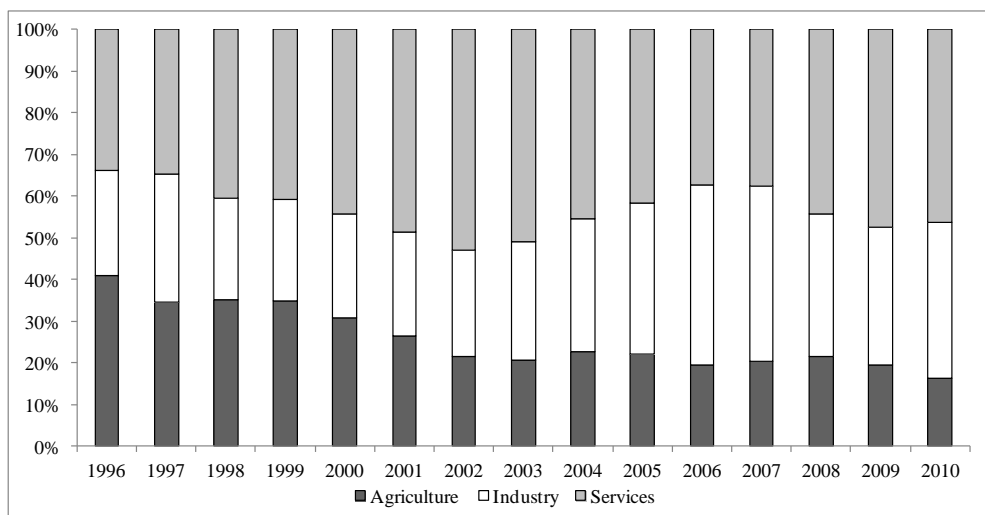
2.1.1. Trade policies and structural changes in agriculture

The contribution of different sectors to Mongolian GDP has changed significantly since the early 1990s. The share of agriculture has continuously declined and is displaced by services and industrial sectors (Figure 2.1). The contribution of agriculture fell from approximately 40% in 1996 to 16% in 2010, whereas services and industrial sectors grew to make up about 40% respectively. The compositional changes in GDP reflect major structural changes undertaken in Mongolia's transition from a centrally planned to a market economy (WTO, 2005).

Although its contribution to GDP has declined substantially, agriculture is still an important source of livelihoods, employing 40% of total labor force in 2009 (Figure 2.2). The agricultural sector, particularly the livestock herding, absorbed much of the urban

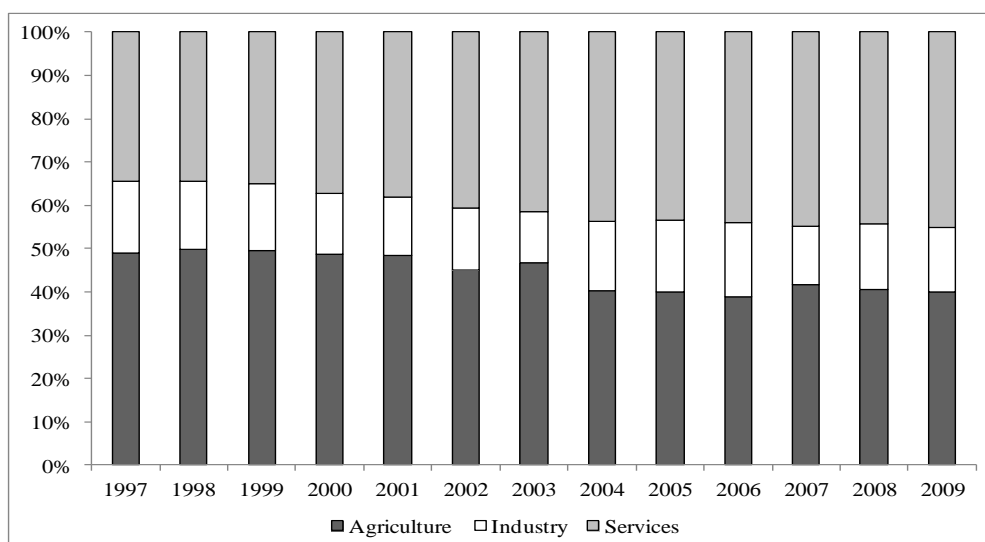
unemployed displaced from their jobs by the structural change reform from the socialist command economy to the market economy.

Figure 2.1 The composition of GDP, %, 1996–2010



Source: World Bank (2013a)

Figure 2.2 Employment by sector, %, of total employment, 1997–2009



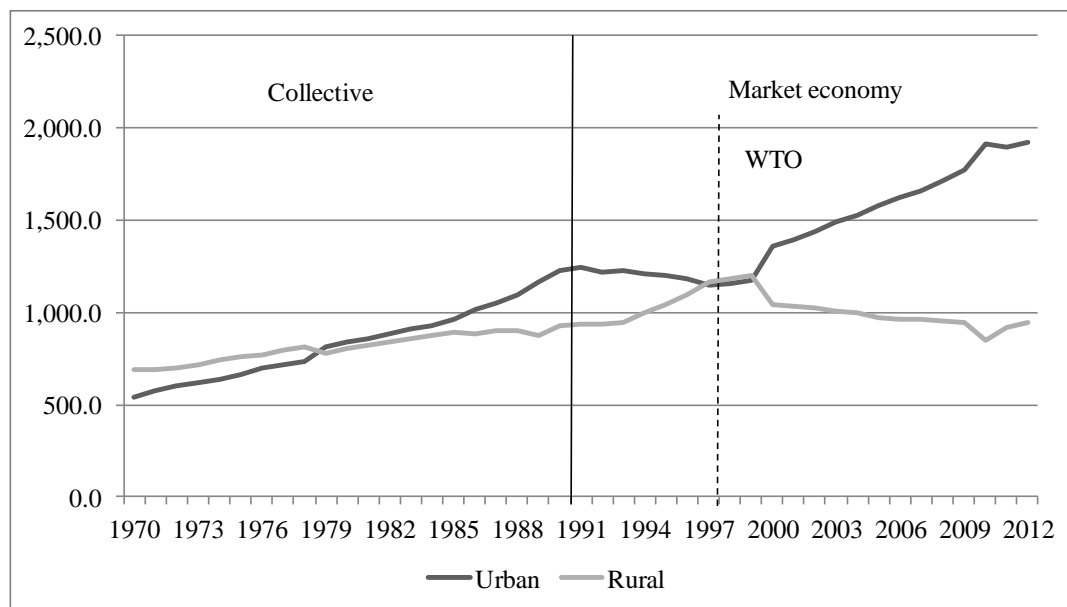
Source: World Bank (2013a)

There was a surge of urban-to-rural migration in the early transition period, owing to the fact that the urban unemployed from the breakdown of state owned enterprises returned to agriculture as a coping strategy (Figure 2.3). However, the migration trend reversed in the late 1990s and early 2000s due to consecutive natural disasters, which resulted in a loss of a large number of animals, causing many subsistence-based herders to fall into poverty. Majority of these herders who left the herding activity after the consecutive natural disasters of 1999–2003 had little or no herding experience prior to the transition (World Bank, 2010). Although this type of out-migration of marginal farmers/herders is relatively common in transitional economies, it can also be viewed as a way to strengthen the commercialized agricultural production system by reducing the subsistence-based farmers/herders.

While trade liberalization was one of the major reforms of the transition, it should not be considered in isolation in the case of the agricultural sector. The agricultural sector in Mongolia has undergone substantial changes due to major structural reform policies, including the decollectivization of state farms, retraction of direct support and involvement from the state, privatization of production assets, and price deregulation. Despite the fact that these reform policies were implemented to transform agricultural activities to a private sector, land and water sources are still owned and controlled by the state. Operating private

agricultural activities using public land and water resources has made the development of the Mongolian agricultural sector exclusive.

Figure 2.3 Population trend, thousand people, 1970–2012



Source: NSO (2013)

The agricultural sector in Mongolia is dominated by the livestock herding sub-sector, which contributes approximately 80–85% of the total agricultural output and employment (NSO, 2013). Owing to extreme continental climate and low fertility of soil, crop production has not developed in Mongolia. Consequently, the livestock sector has been playing an important role in Mongolian people's livelihoods.

With the breakdown of the rural collectives, physical and socio-economic support infrastructure to livestock production has deteriorated and eventually collapsed. As a result,

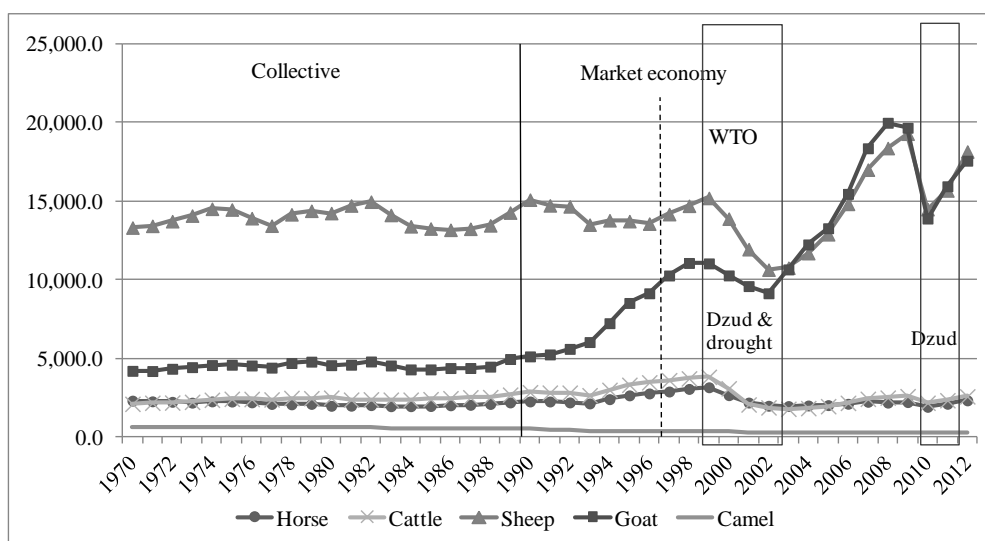
livestock production became more “traditional”, that is extensive livestock herding of five species of animals (cattle, camels, goats, horses, and sheep) on natural pastureland (World Bank, 2010). Furthermore, depreciation of irrigation systems and wells built during the socialist period due to lack of maintenance has made livestock herding more vulnerable to weather shocks and associated loss of animals.

Although resumption of more traditional livestock herding management may be viewed as a step backward from the relatively intensive livestock production management of the socialist period, the current form of livestock production is a rational response of herders to structural changes (World Bank, 2010). Currently, herders have no choice other than expanding the herd size to manage risks and increase outputs. Moreover, the fact that pastoral land and water resources are kept under the state ownership creates no incentive for herders to invest in improving land productivity.

The trend in livestock numbers and the composition of the national herd show significant changes during the transition from the collective to the market economy (Figure 2.4), reflecting social, economic and political changes occurred in Mongolia. During the collective period, all species of animals showed consistent trend, except for sheep numbers which varied more than the rest. Following the collapse of the collectives and state farms in 1990, the number of all types of livestock increased due to incentives created by the

privatization of livestock. However, the most significant increase was in goat numbers (Figure 2.4). The main contributing factor is the high prices paid for cashmere. In addition, herders gradually develop understanding of the market economy and the commercial aspects of livestock herding, and have incentives to breed cashmere goats.

Figure 2.4 Trend in livestock numbers, thousand heads, 1970–2012



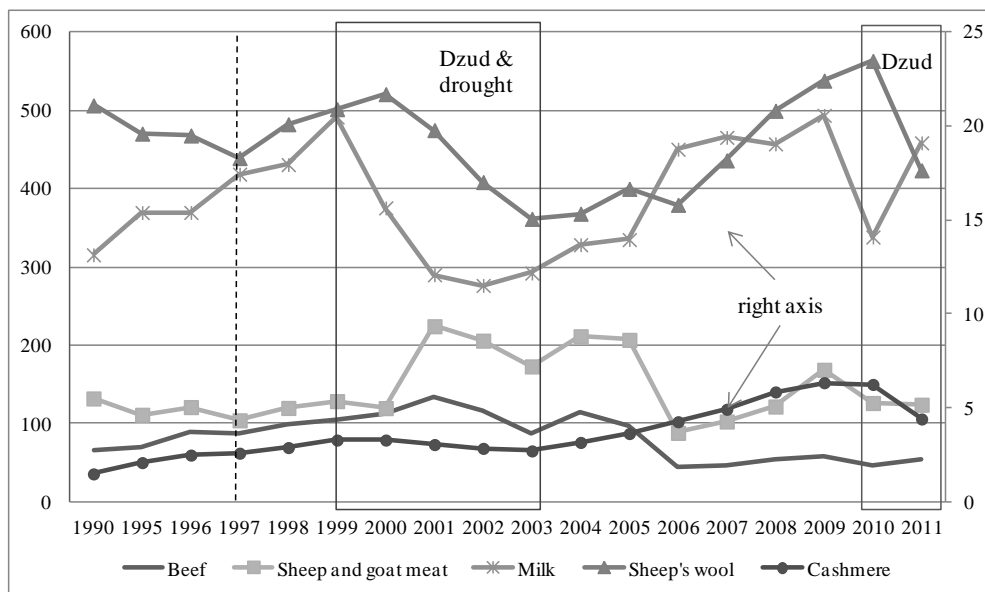
Source: NSO (2013)

Notes: *Dzud* is a Mongolian term for an extreme cold and snowy winter in which large numbers of animals die due to starvation and cold.

Although livestock numbers grew historically high in response to market factors by 1999, the widespread and multi-year drought and the *dzud* of 1999–2003 caused high livestock mortalities in the national livestock herd, reflecting the vulnerability of the sector to environmental risks. After the natural disasters of 1999–2003, sheep and goat numbers

increased even more rapidly than the growth before the disasters as herders find increasing the stock number as a risk management strategy against weather shocks when there are no other ways. However, stocks of large animals somewhat stayed at the post-disaster levels due to difficulties of breeding them in the short period. Again, harsh winters or the *dzud* hit the livestock sector in 2010–2011, killing more than 10 million heads of livestock and impoverishing many herder households. The sheep and goat herds show a quick recovery from the disaster, however, the number of large animals stay at the post-disaster levels.

Figure 2.5 Main livestock production, thousand tons, 1990–2011

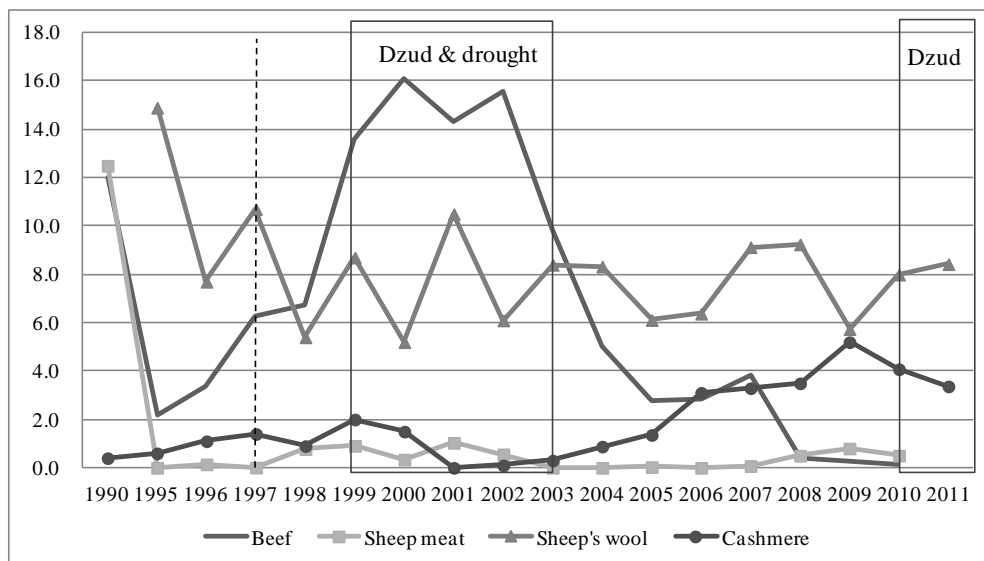


Source: NSO (2013)

The vulnerability of the sector to weather shocks is also reflected in the quantity of livestock production (Figure 2.5). During the disaster times, the livestock production

declines, with the exception of meat production. The increase in meat production may indicate that many subsistence-based herders are unable to survive the harsh winters and leave the herding activity by slaughtering their remaining livestock for meat. Although the livestock production fluctuates depending on weather and other stochastic shocks, the increase in cashmere production is notable. Between 1990 and 2011, the cashmere production almost tripled and reached 5,000 tons. Wool production has also shown an upward trend, however it is more variable than the cashmere production.

Figure 2.6 Exports of livestock commodities, thousand tons, 1990–2011



Source: NSO (2013)

The comparison of Figure 2.5 and Figure 2.6 demonstrates that most of the livestock production is for domestic consumption, except for cashmere and wool. As of 2011, more

than 3/4 of cashmere and about a half of wool was exported. Mongolia is currently the second largest cashmere producer behind China, providing approximately 25% of the world's cashmere (WTO, 2005). Mongolia exports mostly un-carded or de-haired cashmere. Although cashmere production has been increasing steadily, the industry suffers from a number of drawbacks worsened by inadequate public policies, adverse weather conditions, and external factors. The quality of cashmere is falling and proper marketing and distribution systems are lacking. The official recorded exports of cashmere have been stagnant in the recent years as an export tax is levied on raw cashmere exports in order to supply domestic producers with cheap cashmere. However, the measure appears to have failed to fill the domestic supply shortage, but it escalated the quantity of cashmere smuggled into China to avoid the export tax. It has been estimated that almost a half of the cashmere production is smuggled illegally (WTO, 2005).

The meat exports, which were dominant during the command economy and the early 1990s, dropped to almost nil. In 2010, less than 1% of meat was exported. Due to a lack of efforts to secure market access for meat exports, the meat production sector is suffering from several problems. First, herders lack modern technology, equipment, as well as experience and skills to operate on them. Hence, they fail to meet sanitary and phytosanitary (SPS) requirements of export markets. Second, Mongolian meat products lack

reputation in the world market. As Mongolian livestock are raised under natural pasturage conditions, their meat can be characterized as “organic”. If proper production techniques are used to ensure standards and quality of export markets, and legitimate certification is obtained, the level “organic” could increase its value-added in exports (Ministry of Foreign Affairs and Trade in Mongolia and United Nations Development Programme Mongolia, 2009). Third, it is necessary to negotiate improved access to export markets. Currently, the meat exports are suffering from a single market. More than 90% of meat exports go to Russia as Mongolia retained the permission to export meat to Russia even after the collapse of the Soviet Union. However, there are two difficulties in exporting meat to Russia: tariff rate quotas (TRQ), and veterinary and sanitary control. As Russia joined the WTO in 2012, its import restrictions are expected to be lowered to comply with the WTO rules.

2.2. EVOLUTION OF TRADE

Accession to the WTO significantly increased Mongolia’s foreign trade turnover. Figure 2.7 shows that the share of trade in GDP reached approximately 130% in 2011. Although total trade has been increasing, Mongolia has been suffering from acute trade deficits which have been financed by foreign direct investment, and workers’ remittances from abroad (Figure 2.8).

Since 1997, the trade balance has been always negative, with the exception of 2006 when world prices of Mongolia's major exports, including gold and copper increased. The trade deficits reached almost 2 billion USD in 2011. Trade deficits in agricultural raw materials and food products are more prominent, mainly resulting from net food imports (Figure 2.9).

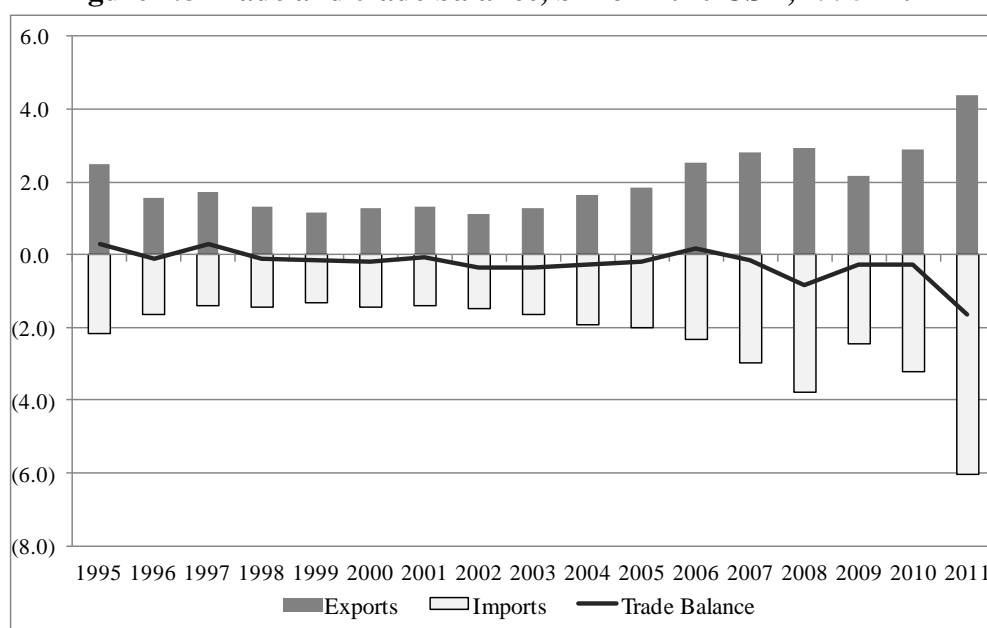
Figure 2.7 The share of trade in GDP, 1991–2011



Source: NSO (2013) and World Bank (2013a)

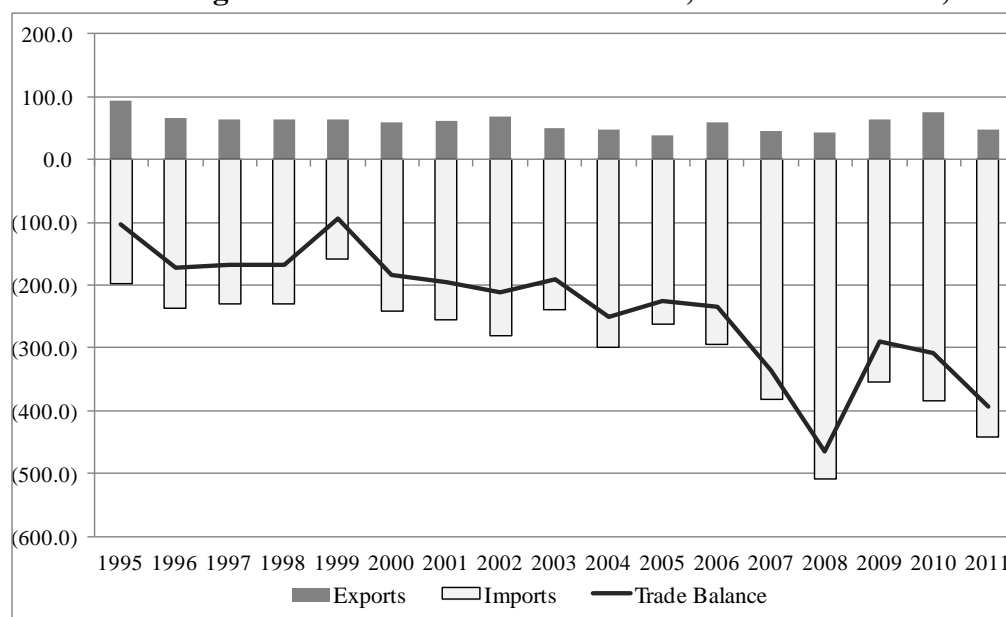
Moreover, export revenues have been extremely volatile, with annual export growth rates ranging approximately from –80% to 40% during 1991–2010 (NSO, 2012). Such volatility is because export commodities are mainly a few types of minerals and agricultural raw materials (Figure 2.10).

Figure 2.8 Trade and trade balance, billion 2010 USD, 1995–2011



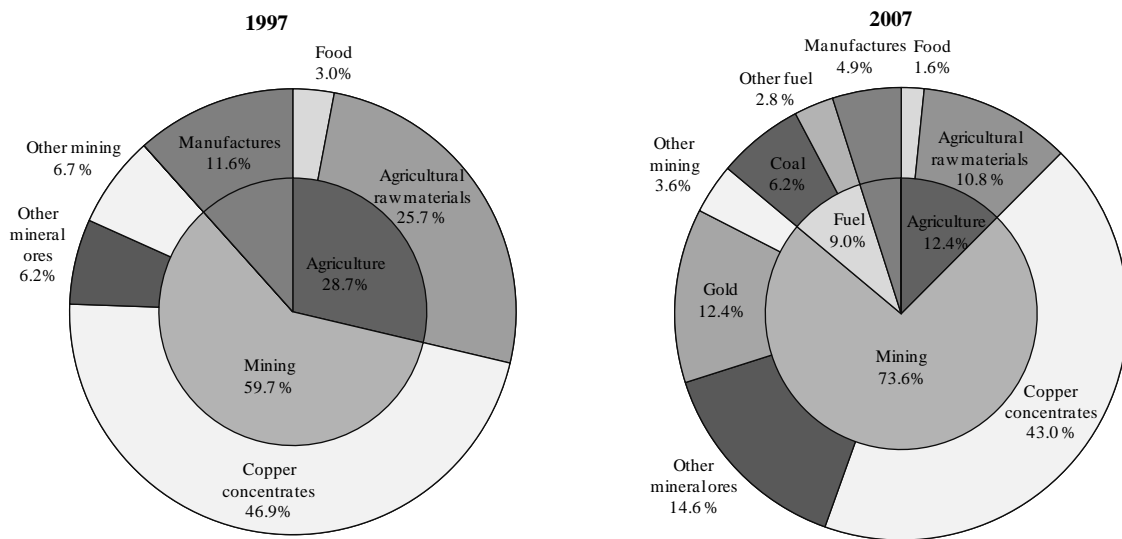
Source: NSO (2013) and International Monetary Fund (IMF) (2012)

Figure 2.9 Trade in agricultural raw materials and food, million 2010 USD, 1995–2011



Source: NSO (2013) and IMF (2012)

Figure 2.10 Product composition of exports, 1997 and 2007



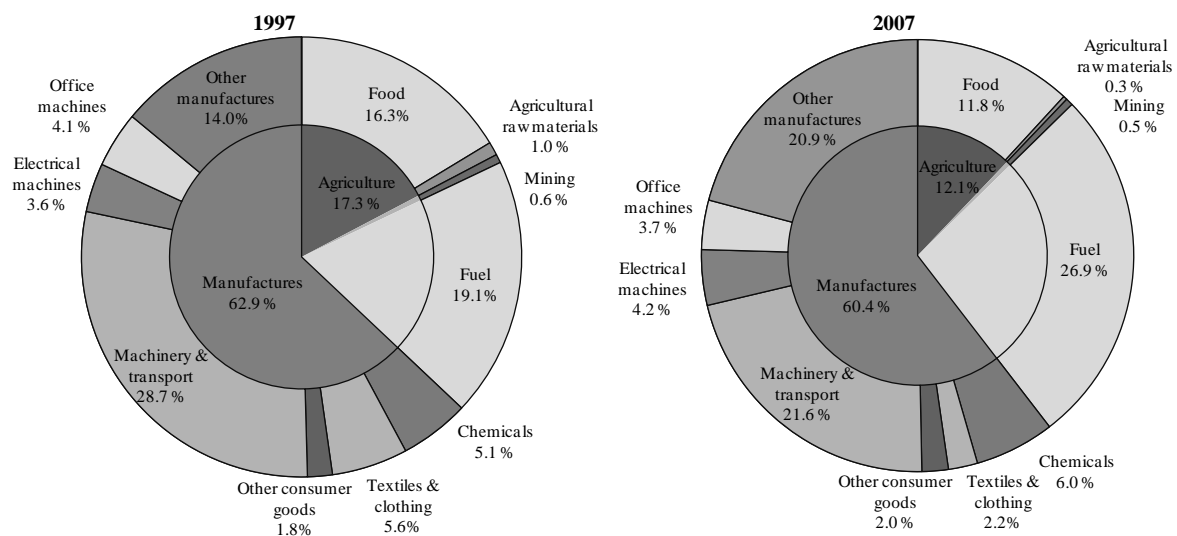
Source: Author's calculations based on data from World Bank (2013b)

In addition, the product composition of exports shows a significant change. The contribution of the mining sector to total exports continues to expand as new resource ores have been discovered in the recent years. Mongolia started to export gold and coal which make up almost 20% of the total exports, increasing the share of mining exports to 74%. Meanwhile, the contributions of agriculture and manufactures have been declining. Particularly, the share of agriculture in exports is more than halved between 1997 and 2007.

On the other hand, the product composition of imports has not changed as much as that of exports between years 1997 and 2007 (Figure 2.11). The share of fuel imports is increasing moderately, whereas the shares of agriculture and manufactures are declining slightly. The import commodities are dominated by manufactures which make up more than

60% of the total imports, of which 1/3 are in machinery and transport goods. Food imports constitute the major share of the agricultural imports. The share of food in total agricultural imports is increasing from 94% to 98% between 1997 and 2007.

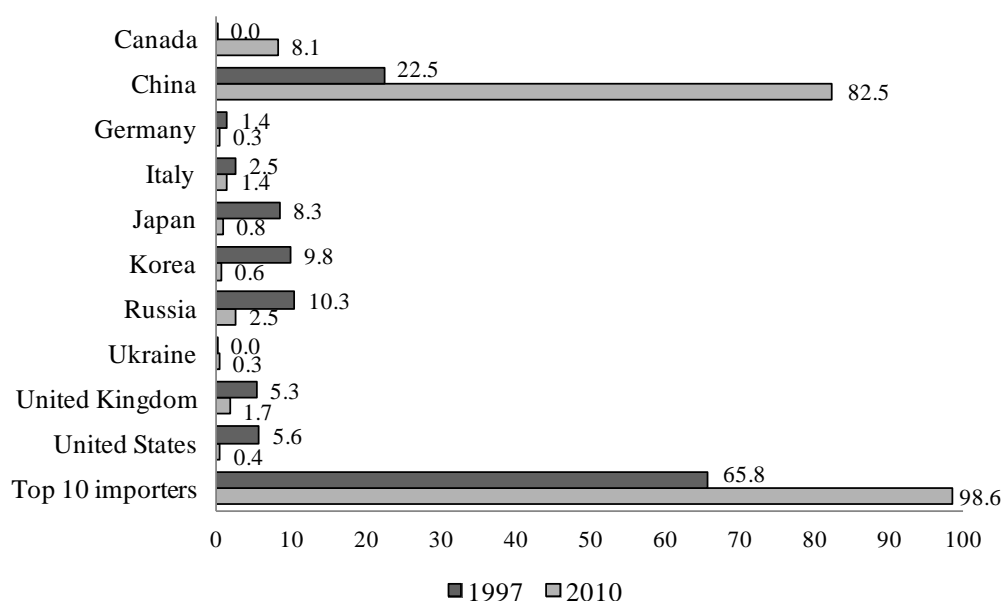
Figure 2.11 Product composition of imports, 1997 and 2007



Source: Author's calculations based on data from World Bank (2013b)

Furthermore, export destinations have comprised of a few countries, particularly China (Figure 2.12). The share of exports to China has increased significantly in recent years, reaching 82.5% in 2011. The export destinations have become more concentrated as the share of exports going to the top 10 importers rose from 65.8% in 1997 to 98.6% in 2010.

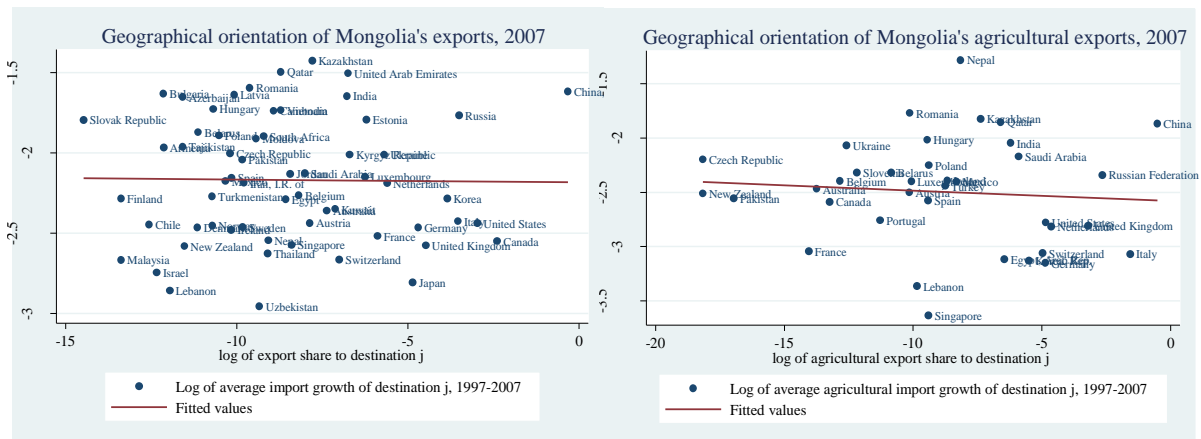
Figure 2.12 Main export destinations of Mongolia, the share in total exports, 1997 and 2010



Source: IMF (2011)

Although high concentration of export destinations may suggest a need to increase the number of export partners, diversification *per se* is not a trade policy objective if the existing trade relationship is favorable for growth. In order to assess the extent to which Mongolia's export orientation is favorable, in other words, to what extent it exports to partners that have experienced a faster import growth, one can construct a scatter plot of export shares against import growth, and draw a regression line. If the regression line slopes up (down), larger destinations have faster (slower) import growth; the orientation is favorable (unfavorable) (WTO and United Nations, 2012). Figure 2.13 shows the geographical orientation of Mongolia's total exports and agricultural exports.

Figure 2.13 Geographical orientation of Mongolia's exports in 2007



Source: Author's calculation based on data from IMF (2011) and World Bank (2013b)

In the case of total exports, the geographical orientation is neither favorable nor unfavorable. There may be a need for fostering growth at the extensive margin, that is, to increase the number of export destinations. In the case of agricultural exports, it is more prominent as the regression line slopes downward. It would be vital to negotiate improved access to export markets for agricultural exports.

This analysis can be complemented by a decomposition of export growth. There could be three possible ways for exports to grow: growth in the value of existing exports to the same destinations (intensive margin), growth in new export items and new destinations (extensive margin), and longer survival of export spells (death margin). It is possible to decompose export growth into the intensive, extensive, and death margin contributions using the following equation:

$$\Delta X = \sum_{K_0 \cap K_1} \Delta X + \sum_{K_1/K_0} X_k - \sum_{K_0/K_1} X_k \quad (2.1)$$

where X is exports, and K_0 and K_1 are sets of products exported in the base year and the reference year respectively. The first term is export variation at the intensive margin, the second is the new-product margin, and the third is the product death margin.

Table 2.2 shows Mongolian export growth decomposition for the total and agricultural trade. Consistent with the compositional change of exports between 1997 and 2007, export growth is dominated by the new product margin and the intensive margin is relatively small. While exports have grown more extensively, product death margin is quite high for agricultural trade. During 1997–2007, about 3% of previously exported agricultural commodities are no longer exported.

Table 2.2 Decomposition of export growth, 1997–2007

	Intensive margin	New product margin	Product death margin
Total trade	0.3485	0.6552	0.0037
Agricultural trade	0.2062	0.8242	0.0304

Source: Author's calculations based on data from World Bank (2013b)

2.3. WHY IS THE SHARE OF AGRICULTURAL TRADE DECLINING?

According to the revealed comparative advantage (RCA) index introduced by Balassa (1965),

Mongolia has a comparative advantage in producing meat and meat products, animal skins, hides, wool, and cashmere. However, Mongolia's export share of these livestock products in the world markets, with the exception of cashmere, is negligible. In addition, its share of agricultural exports in total exports has been declining, from a peak of 38% in 1999 to 4% in 2011, whereas its total trade has been increasing (World Bank, 2013b).

A variety of factors have contributed to Mongolia's declining agricultural export share, including its recent mining boom, traditional and backward agricultural production technology, and poor infrastructure. Of the various factors, high trade costs associated with agricultural trade and low productivity to compete in the international market are considered as the two most significant causes of the declining share of agricultural trade in Mongolia.

2.3.1. Trade costs

Even if substantial trade liberalization is set to remove all trade policy barriers, there still exist obstacles to trade. Broadly defined, trade costs include trade policy barriers and transportation costs, as well as all the other costs incurred in the exchange of goods across borders. According to Anderson and van Wincoop (2004), trade costs are roughly measured to be 170% ad-valorem tariff equivalent, of which approximately 8% are trade policy barriers in industrialized countries. Although data on trade costs for developing countries are

scarce because of data limitations and difficulties in measurement, these figures are expected to be higher in developing countries like Mongolia.

There are a few explanations as to why high trade costs are a significant barrier to agricultural trade in Mongolia. First, agriculture is a highly protected sector that many developed and developing countries impose strict import restrictions and high tariffs. The average tariffs for Mongolian agricultural exports are higher than those for non-agricultural exports (approximately 10.2% opposed to 9.2%). In particular, import tariffs imposed by its major trading partners, China (14.8% for agriculture and 7.3% for non-agriculture) and Russia (21.1% for agriculture and 20.6% for non-agriculture), are the highest (Table 2.3). Bilateral or multilateral efforts to reduce these would significantly affect the Mongolian economy. In addition to trade reforms vis-à-vis neighboring countries, Mongolia is also pursuing the reduction and elimination of tariffs on its exports under the WTO framework. Particularly, in the case of agriculture, tariffs are not the only policy barriers. As the recent efforts on regionalism and multilateralism around the world, tariffs have been reduced significantly. However, non-tariff barriers have become more important.

Second, since Mongolia is a landlocked country with poor infrastructure, trading across its borders is a costly operation. According to the World Economic Forum (2012), the cost to export one standard container is 2,265 USD for Mongolia, which ranks 118 out of 132

countries (Table 2.4). Moreover, the percentage of paved roads in the country is one of the lowest in the world, ranking 131 out of 132 countries (Table 2.5). Consequently, Mongolia lacks quality transport services for bulky and perishable agricultural commodities that require timely delivery.

Table 2.3 Duties faced in 2011: MFN average of traded tariff lines by major trade partners

Major markets	Simple average	Major markets	Simple average
<u>Agricultural products</u>		<u>Non-agricultural products</u>	
1. China	14.8	1. China	7.3
2. European Union	2.9	2. Canada	6.3
3. Russian Federation	21.1	3. European Union	6.3
4. United States	3.9	4. Russian Federation	20.6
5. Switzerland	8.1	5. Korea, Republic of	7.5

Source: WTO (2012)

Table 2.4 Efficiency of customs administration and import-export procedures

Indicators	Score	Rank out of 132
Burden of customs procedures, 1–7 (best)	3.3	115
Efficiency of the clearance process, 1–5 (best)	2	126
Number of days to import	47	122
Number of documents to import	8	74
Cost to import, USD per container	2,400	113
Number of days to export	46	125
Number of documents to export	8	95
Cost to export, USD per container	2,265	118
Irregular payments in exports and imports, 1–7 (best)	2.9	97
Corruption Perceptions Index, 0–10 (best)	2.7	100

Source: World Economic Forum (2012)

Table 2.5 Availability and quality of transport and communication infrastructure

Indicators	Score	Rank out of 132
Paved roads, % of total	3.5	131
Quality of air transport infrastructure, 1–7 (best)	3.2	120
Quality of railroad infrastructure, 1–7 (best)	2.6	67
Quality of roads, 1–7 (best)	1.8	129
Quality of port infrastructure, 1–7 (best)	2.8	118
Extent of business Internet use, 1–7 (best)	4.6	87
Mobile phone subscriptions/100 population	91.1	82
Broadband Internet subscriptions/100 population	2.6	79
Individuals using Internet, %	12.9	96

Source: World Economic Forum (2012)

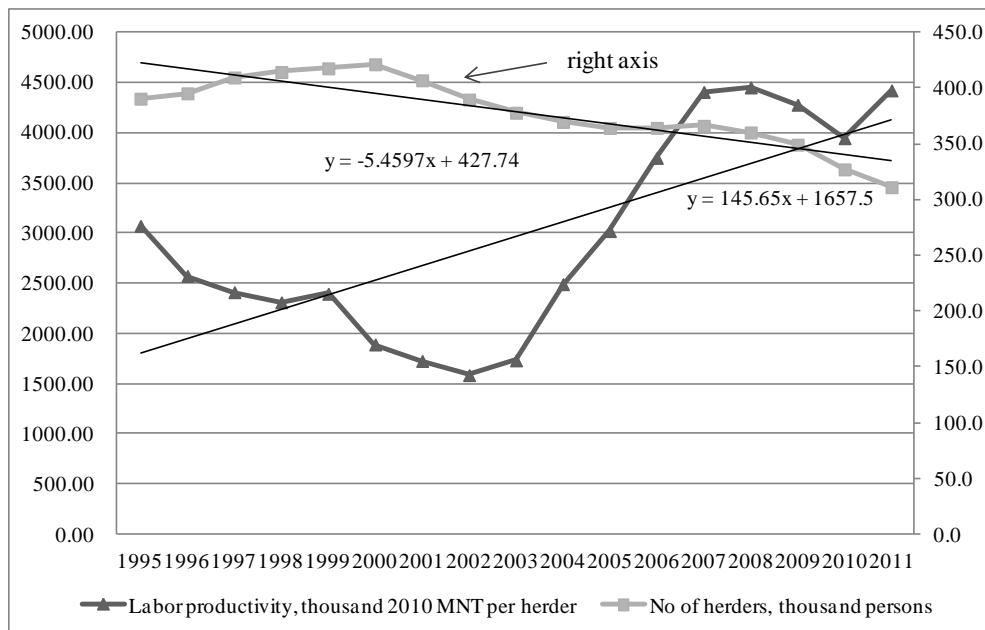
Third, many of Mongolia's food and agricultural commodities are subject to strict product standard requirements of export markets. Therefore, lack of standardization in Mongolia further impedes its agricultural trade potential.

2.3.2. Agricultural productivity

Another factor that impedes Mongolian agricultural trade is that Mongolian herders lack productive capacity to compete in the world market. Many of the livestock products are subject to sanitary and product standards of the export markets, while Mongolian herders lack technology and knowledge to comply with those standards. In order to transform to more commercialized production system and successfully participate in the world markets, the challenge facing the Mongolian livestock sector is to improve productivity and efficiency, and

invest in technology.

**Figure 2.14 Labor productivity of the livestock sector,
thousand 2010 MNT per herder**



Source: Author's calculations and estimations based on NSO (2013)

A partial measure of productivity of agriculture is labor productivity. Figure 2.14 shows labor productivity measured by the value of livestock production per herder and the number of herders. The dependence on nature is reflected in the pattern of labor productivity as it declines during the disasters of 1999–2003 and 2010–2011. The labor productivity declined during the 1990s as the number of unskilled herders due to the urban-to-rural migration of unemployed people displaced from their jobs by the transition policies. The productivity further declined as the widespread drought and the *dzud* of 1999–2003 wiped

out a large number of livestock and reduced production. As many unskilled and new herders were forced to leave the herding activity by the natural disasters, labor productivity started to improve. However, the *dzud* of 2010–2011 again hit the sector hard and reduced the labor productivity. Therefore, the vulnerability to weather shocks clearly indicates a necessity to improve the productive capacity of the sector and adopt modern technologies and equipment, which will also help herders to produce products that meet standards and requirements of international markets.

2.4. POVERTY

A painful transition process resulting from sharp liberalization marks a new phenomenon, poverty, in Mongolia. The 2007–2008 Household Socio-Economic Survey (HSES) estimated a poverty headcount rate of approximately 35% at the national level in 2008, showing little improvement from the 36% rate in 1995 (Table 2.6). Poverty incidence by the urban–rural divide shows, however, that rural poverty has since increased notably. The rural poverty headcount ratio reached 47% in 2008 from 33% in 1995. Because a majority of the rural population is engaged in traditional nomadic livestock herding, agricultural development can help alleviate poverty in Mongolia. Repeated and widespread natural disasters and inadequate

risk management impoverished many herding families (Table 2.7). In addition, trade liberalization of agricultural commodities and agricultural agreements are expected to affect the domestic agricultural sector significantly.

Table 2.6 Poverty incidence, % of total population

Year	National average	Urban	Rural
1995	36.3	38.5	33.1
2003	36.1	30.3	43.4
2008	35.2	26.9	46.6

Source: NSO (2013)

Given the persisting new phenomenon of rural poverty and the inevitability of more liberalized trade, a major challenge facing Mongolia is improving the living standards of the rural poor while meeting the international trade reform procedures.

Table 2.7 Poverty incidence by herding and non-herding, %

Year	National		Urban		Rural	
	Non-herders	Herders	Non-herders	Herders	Non-herders	Herders
2003	34.6	38.7	29.9	33.7	53.5	39.5
2008	29.6	44.8	26.4	31.7	46.2	46.7

Source: NSO (2013)

3. IMPACT OF TRADE LIBERALIZATION ON GROWTH AND POVERTY: THE CASE OF MONGOLIA

3.1. INTRODUCTION

Trade liberalization has been implemented globally in various forms, including domestic unilateral reforms, regional or bilateral free trade agreements, and multilateral liberalization agreements. In the case of Mongolia, trade liberalization has been mostly conducted unilaterally, except in relation to the country's entry into the WTO. Mongolia is currently the only WTO member country that has not concluded any regional free trade agreements.

In addition, further trade liberalization by way of bilateral and multilateral reforms is critical for connecting Mongolia to world markets. However, because of lack of data, little research has been conducted on the possible effects of trade liberalization on Mongolia's economy and poverty. The newly released GTAP, version 8 database (Narayanan et al., 2012), in which Mongolia is first included as an independent region, has created opportunities to conduct comprehensive studies on the effects of trade reforms on the Mongolian economy. However, this study, to the best of the author's knowledge, is the first of its kind on Mongolia.

This chapter aims to examine and compare effects of various trade reforms on Mongolia's economy and welfare using a macro–micro approach that links the GTAP model with a microsimulation one. Reform types considered are unilateral, bilateral with China and Russia, and multilateral. An important advantage of the macro–micro approach is that it allows for the estimation of welfare impacts of trade reforms at the household level and addresses household heterogeneities. This study estimates welfare effects across 11,172 sampled households in the Mongolian Household Socio-Economic Survey (HSES) for 2007–2008.

The rest of the chapter is organized as follows. Section 3.2 reviews literature relevant to trade liberalization, growth and poverty. Section 3.3 describes the data and methodology. Section 3.4 presents and discusses results. Section 3.5 concludes the chapter.

3.2. LITERATURE REVIEW

A failure to alleviate poverty in developing countries despite their being more open to international trade has led the proliferation of empirical analyses on the relationship between trade liberalization and poverty. This section reviews recent contributions, debates, methodologies and problems faced in the literature of trade liberalization and poverty.

The theoretical predictions on the relationship between trade openness and poverty are perceptive to the key assumptions made. In the Heckscher-Ohlin (H-O) model, free trade will increase the relative price of a good that a country has a comparative advantage and by the Stolper-Samuelson theorem, returns to relatively abundant factor which is intensively used will increase even larger. At the same time, trade will reduce the return to the scarce factor, by a smaller extent. In other words, when countries with different factor endowments and similar productivity levels trade freely, returns to factors will be equalized across countries. This implies that if poor countries abundantly endowed with unskilled labor, relaxing restrictions on foreign trade will increase wages of unskilled workers who are likely to be poor. However, some authors including Winters (2000) argue that the practical relevance of the Stolper-Samuelson theorem is negligible due to some of its restrict assumptions such as perfect labor mobility and the same level of technology across countries.

Empirical applications of the H-O model in developing countries have resulted in mixed conclusions. In the case of East Asian countries, the model predicted a rise in wages for low skilled labor and a consequent wage equalization following trade liberalization. For example, Wood (1994) finds that a decline in wage disparities in Republic of Korea, Taiwan, and Singapore after trade liberalization. Contrary, several authors including Harrison and Hanson (1999), and Feenstra and Hanson (1997) find that greater openness to trade and

foreign competition has resulted in higher wage inequality in Latin America. A possible explanation for the contradicting results of the application of the H-O model can be that Latin American countries may not have comparative advantage in low skilled labor intensive production. The Latin America may have comparative advantage in low skilled labor production relative to developing countries, however, the predictions of the H-O model blurs when a third country such as China who has more comparative advantage in low skilled labor production comes into picture.

The apparent contrasts and strict assumptions of the theory have turned the debate on the relationship between trade liberalization and poverty into an empirical question. The empirical literature on the poverty impacts of trade openness is vast and varies across many dimensions such as methodology, country coverage, hypothesis, time frame, and indicators of trade liberalization and poverty.

One of the common types of studies is a cross-country regression analysis. An important hypothesis tested in the cross-country regression analyses is that trade is good for growth, and growth reduces poverty. However, empirical studies investigating the impact of trade liberalization on poverty through its effects on growth is still inconclusive and hard to generalize due to methodologies and indicators used. The cross country regression analyses are subject to omitted variable and endogeneity problems which prevent from obtaining robust

results. Their findings depend on whether trade reforms improve growth, which is itself a questionable empirical problem as emphasized by Rodriguez and Rodrik (2001).

However, the general result in the cross-country regression analyses of poverty impacts of trade liberalization is that as countries become rich, income poverty declines. Dollar and Kraay (2004) provide evidence that the poor can benefit as much as an average person from growth resulted from trade. They use a cross-country regression approach with a group of 101 countries, of which developing countries are divided into globalizers and non-globalizers based on tariff reductions and trade volumes. Their findings suggest that the globalizers are catching up with rich countries, whereas non-globalizers are growing slower and left further behind. In addition, they find that growth achieved through expanded trade proportionally increased incomes of the poor and the globalizers attain poverty reduction.

On the other hand, some authors argue that the impact of trade openness on poverty depends on the extent to which economic growth reduces inequality. Deaton (2005) claims if the distribution of economic growth is unequal, poverty reduction depends on how the income of the poor grows relative to the average. Therefore, the findings of Dollar and Kraay (2004) are possible only when growth is equally distributed.

Besides the growth channel, trade liberalization may affect poverty directly. Winters (2000) identified potential direct links between trade reforms and poverty. These links

comprise availability of goods, consumer and factor prices, employment, changes in government transfers, incentives for investment and innovation, terms of trade shocks, remittances, and short run risk and adjustment costs. Most studies focus only one or two of these links. Of the various links, the consumption side of the trade-poverty linkage has been studied widely, while other linkages have not been considered extensively.

To take into account of the various linkages of the trade-poverty relationship, recent studies have used CGE modeling approaches. CGE models are more suitable to study impacts of a comprehensive trade reform that lowers many tariffs and removes many quantitative restrictions and is likely to have an economy wide effect. CGE models allow taking account of the inter-relationships among different sectors of the economy and the consequent effects that changes in one sector may have on other sectors through prices, output, employment and wages.

With regard to welfare implications of policy reforms, treatment of household sector is crucial. Most CGE models employ a relatively small number of representative household groups differentiated mainly by urban/rural, skilled/unskilled, and landed/landless. However, this approach has a serious limitation when studying poverty impacts of policy changes because it disregards important heterogeneity within household groups. To overcome this shortcoming, recent studies challenged to include “real” households from national household

surveys. Although the inclusion of “real” households adds to the complexity of modeling, it improves the realism and captures the heterogeneity within household groups.

In practice, “real” households can enter a CGE model in two different ways: CGE microsimulation layered approach and complete integration approach (Davies, 2009). In the latter, highly disaggregated data from household surveys are entered to a CGE model and labor market characteristics and consumers behaviors are defined at household level. An example of studies integrating CGE and household survey data is Cogneau and Robilliard (2007) who investigated the impact of growth shocks and poverty and income distribution in Madagascar by integrating household survey data with a CGE model. The authors fully embed a labor allocation model of 4,508 households within the CGE model. Their results confirmed that poverty impacts within the same household group are indeed very different and the representative household assumption could not capture the heterogeneity. The integrated approach was also applied by Cockburn (2002) for Nepal, Cororaton (2003) for the Philippines, and Boccanfuso and Savard (2007) for Mali.

Although the complete integration of microsimulation and CGE seems idealistic, it is computationally very expensive and sometimes not practical to inspect the impact of a simulation on each of several thousand households (Davies, 2009). On the other hand, microsimulation layered approach, which is considered to be more suitable methodology for

the proposed research, provides a simpler framework while keeping the realism. This approach is best characterized by its two-step nature. First, a general equilibrium model is solved to get commodity and factor price changes, exchange rates and other macro changes. Next, these changes are inputted into a microsimulation model that estimates the effects of trade liberalization policies on actual households. In the microsimulation model, a variety of poverty and other measures can be calculated using highly disaggregated data at the household level.

The most crucial part of the macro-micro layered simulation modeling is to satisfy the consistency between a CGE model and a microsimulation model. There are, in general, two different ways for macro-micro layered modeling: arithmetic microsimulation and behavioral microsimulation. The latter approach is based on a set of behavioral equations that estimate individuals' occupational choices and income generation process of households. An eminent example of behavioral macro-micro studies is Robilliard et al. (2008) who investigated the impact of the 1997 Indonesian crisis on poor households. In their model, labor income is categorized into wage earnings and household own business activity profits. The labor supply is modeled as a discrete choice between being inactive, self-employment, and waged employment. Their microsimulation model is based on 9,800 households with 33,000 individuals, while the CGE model distinguishes between formal and informal activities in

each sector. The CGE model is linked to the microsimulation model through wages, income from informal self employment, number of wage workers and self-employed, and consumption prices. Changes in these variables are obtained from the CGE model and inputted into the microsimulation model which is solved for each working age individual and household. To verify advantages of their approach, the authors modeled a representative household analysis to compare with their results. They claim that macro-microsimulation significantly improves the results and the representative household model systematically underestimates income and poverty impacts.

However, the approach of Robilliard et al (2008) is methodologically costly as it requires a great deal of estimation work at the household level (Hertel and Reimer, 2005). A somewhat simpler approach to link a CGE model with household survey data is the arithmetic microsimulation approach. This approach is more suitable for analyzing short run impacts of policy changes, because it does not take into account individuals' behavioral adjustments to macro policy changes. The assumption of unchanged behavior has frequently been criticized in literature. However, it is not as restrictive as it would appear and it can be consistent with behavioral responses under some conditions (Bourguignon and Spadaro, 2006). A recent application of macro-micro simulation through arithmetic microsimulation is Chen and Ravallion (2004) who analyzed welfare and poverty impact of China's accession to the WTO.

The arithmetic microsimulation is based on the duality characteristics of the consumer theory and is used to estimate the first-round effect of final welfare effect. The authors find a general gain to the economy as a whole, but rural poor households lose out.

Another application of arithmetic microsimulation approach to link with a CGE model is Hertel et al (2002). Their model is a multi-country, multi-region model based on the GTAP model of trade (Hertel, 1997). The authors studied the poverty impact of global trade liberalization in seven developing countries. The GTAP model is shocked to get factor and commodity price changes, which are then fed into microsimulation framework that characterizes households according to factor income and consumption profiles based on household surveys in seven countries respectively. A global AIDADS demand system is used to calculate demand responses to price changes and poverty level of utility for each region. To measure welfare changes, equivalent variation (EV) and first-order compensating variation (CV) measures are calculated for each individual. They find that full global trade liberalization will reduce poverty in four of the seven sampled countries and increase poverty in the rest.

3.3. METHODOLOGY AND DATA

In this chapter, a macro–micro simulation approach that combines the GTAP model based on the GTAP 8 database with the base year 2007 and a microsimulation model are applied.

3.3.1. GTAP data and model scenarios

Mongolia is included as a separate region in the GTAP database, version 8, for the first time. The original GTAP aggregation is modified to 6 regions and 24 sectors (Table 3.1). The complete lists of regional and sectoral aggregation are provided in Table A3.1 and Table A3.2 in Chapter 3 Appendix.

Table 3.1 Regions and sectors of the Mongolian GTAP model

Regions	Sectors		
	Agriculture and Food		Non-Agriculture
Mongolia	Rice	Other meat products	Mining of coal
China	Wheat	Dairy products	Mining of metal ores
Russia	Vegetables & fruits	Sugar	Other extraction
Developed	Other grain crops	Beverages & tobacco	Textiles and clothing
Developing	Live bovine animals	Other processed food	Light manufacturing
Least developed	Animal products	Fish	Heavy manufacturing
	Raw milk		Utility (electricity, gas, water)
	Raw animal products		Transport & communication
	used in textiles		Other services
	Meat of bovine animals		

Source: Author's aggregation based on GTAP 8 database

The factors of production are land, natural resources, capital, and skilled and unskilled labor. Land, natural resources, and capital are considered immobile factors, whereas labor is mobile. Capital is set as immobile to match the microsimulation model and to simulate short-term effects.

Trade liberalization is simulated through the removal of three types of distortions: domestic production subsidies/taxes, export subsidies/taxes, and import tariffs. The base data

for the distortions are presented in Table A3.3–Table A3.6 in Chapter 3 Appendix. Four scenarios (unilateral, bilateral with China, bilateral with Russia, and multilateral) are considered, each of which is subdivided into agricultural and non-agricultural policy reforms. Agricultural reforms are defined broadly to include agricultural raw materials and processed foods. For the unilateral and bilateral reform scenarios, removal of all three types of distortions is considered. For the multilateral reform scenario, full removal of distortions in the developed and developing countries, and no changes for the least-developed countries are considered.

The model applied to run the scenarios is the standard GTAP model (Hertel, 1997), which is a comparative static, multi-region, and multi-market CGE model, based on the neoclassical economic theory. From the demand side, each region in the standard GTAP model has a regional household that disposes of the total regional income to the three forms of final demand according to the Cobb-Douglas per-capita utility function for private household, government, and savings. Each of these three types of final demand represents a constant share of total regional income. The government and private household demands are composite goods that further allocated between domestically produced goods and imports. Imports are further differentiated by the origin according to the Armington substitution parameters. The private household demand is modeled in a Constant Difference Elasticity

(CDE) demand system, which captures price differences and income responsiveness across regions.

From the supply side, firms maximize profits based on the perfect competition and constant returns to scale technology assumptions. At the top level, the production technology follows the Leontief functional form and combines the Constant Elasticity of Substitution (CES) composite of value-added from primary factors, and the CES composite of domestically produced and imported intermediate inputs. The imported intermediate goods are again differentiated by their origin of region. In the standard GTAP model, international trade is modeled as a nested Armington structure, in which domestically produced goods are imperfect substitutes to imported goods, which are in turn differentiated by origins.

The general equilibrium in the standard GTAP model is achieved by satisfying both internal and external equilibrium conditions in the economy. The internal equilibrium ensures that primary factors are allocated across sectors to achieve the full employment condition. Therefore, excess factors released from one sector must be absorbed by another sector within the economy. Factor mobility across countries is not allowed in the standard GTAP model. Market prices adjust to maintain full employment.

External equilibrium manages the activities in the economy that involve interacting with the rest of the world. It maintains balance of payments equilibrium by ensuring any

trade deficit or surplus is offset by capital flows. In the external equilibrium, the real exchange rate balances net trade and capital flows. The real exchange rate in the standard GTAP model is defined as a ratio of domestic and foreign factor prices. Because primary factors are treated as the only non-tradable commodities in the GTAP model, the above definition of the real exchange rate also implies the ratio of prices of non-tradeables to tradeables. A decline (increase) in the real exchange rate variable acts as a real exchange rate depreciation (appreciation) in the model. Changes in the real exchange rate in Mongolia for each scenario are reported in Table A3.7 in the Appendix of Chapter 3. The changes show that for the unilateral and bilateral liberalization scenarios, domestic factor prices increase relative to the international factor prices, leading to a real appreciation; whereas the opposite happen for the multilateral liberalization scenario. The removal of the three types of policy distortions simultaneously makes it difficult to interpret its impact on the exchange rate as different types of distortions work in opposite directions. Nonetheless, the real appreciation in the unilateral and bilateral scenarios may indicate an increase in consumption of both tradables and non-tradeables, while the real depreciation in the multilateral scenario may show an increase in the demand for importables and a decline in the demand for non-tradeables.

Given the general equilibrium conditions discussed above, the standard GTAP

model closure is neoclassical, that is, all markets are in equilibrium, all firms earn zero profits, and the regional household maximizes utility within its budget constraint. The global investment is assumed to be responsive to changes in the relative rates of return across regions. However, changes in investment do not affect the productive capital, thus, reflecting short-run. Conversely, the investment affects saving and the current account balance in each region. For unilateral liberalization simulations, a small-country assumption, in which domestic policies do not affect the world prices, is applied. The model is solved using the GEMPACK software.

3.3.2. Household Socio-Economic Survey data

Mongolia has been conducting the Household Income and Expenditure Survey (HIES) every year and combining it with the Living Standards Measurement Survey (LSMS) every 3–4 years since 1995. In 2007, the NSO updated the HIES by including several modules from the LSMS, calling the amalgamated version the Household Socio-Economic Survey (HSES). The updated survey will be carried out annually (NSO and World Bank, 2009).

The HSES 2007–2008 is a nationally representative household survey. The main objectives of the HSES are to evaluate and monitor the income and expenditure of households, to update the basket and the weights for the consumer price index, and to offer inputs to the national accounts. The survey interview was conducted from July 2007 to June 2008, visiting

11,232 households sampled around the country. However, 60 households did not have complete information (NSO and World Bank, 2009), and the survey database prepared by the NSO does not include them. Thus, this study covers a total of 11,172 households.

Table 3.2 Summary statistics of variables from HSES 2007–2008

Variable	No. of Obs	Mean	Std. Dev.	Min	Max
Poor	11,172	dummy variable		0	1
Household size	11,172	3.9	1.7	1	17
Share of kids	11,172	26.5	22.7	0	100
Savings	11,172	dummy variable		0	1
Share of wage earners	11,172	19.6	25.0	0	100
Share of herders	11,172	10.3	21.1	0	100
Share of farmers	11,172	0.8	5.7	0	100
Share of own business runners	11,172	5.5	13.8	0	100
Remittance receiver	11,172	dummy variable		0	1
Urban	11,172	dummy variable		0	1
Age of head	11,172	44.8	14.1	13	98
Male head	11,172	dummy variable		0	1
Marital status of head	11,172	categorical variable		1	4
Education of head	11,172	categorical variable		1	6
Employment status of head	11,172	categorical variable		1	8
Migration status of head	11,172	dummy variable		0	1

Source: NSO and World Bank (2009)

Notes: The dummy variable “poor” is 1 if a household’s consumption level is below the national poverty line of 62,494 MNT per month per person, estimated by NSO and World Bank (2009). Detailed descriptions of the categorical variables are in Table A3.8 in Appendix to Chapter 3.

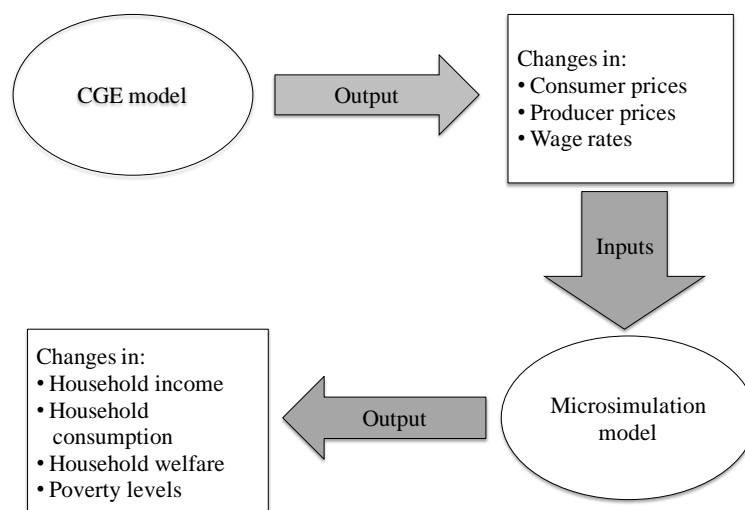
The survey contains 16 modules that cover basic socio-economic information about the members of the household, education, health, reproductive health, migration,

employment, wage jobs, job search, agriculture and herding, non-farm family business, other income, savings and loans, housing and energy, durable goods, food consumption, and non-food expenditures. Table 3.2 shows summary statistics of variables used in this study.

3.3.3. Microsimulation model

The CGE model results produce changes in consumer, producer, and factor prices. Changes in prices are reported in Table A3.9–Table A3.11 in Chapter 3 Appendix. These sets of price changes are then entered into the microsimulation model to measure welfare and poverty indicators at the household level. The structure of the microsimulation model is illustrated in Figure 3.1.

Figure 3.1 Structure of the macro-micro simulation model



Source: Author's illustration

This study's methodology closely follows that of Chen and Ravallion (2004). In this model, each household maximizes its utility by choosing consumption, q_i^d , and work effort, L_i , subject to its budget constraint. The utility function is expressed by $u_i(q_i^d, L_i)$ and the indirect utility function of household i can be written as

$$v_i[p_i^d, w_i, \pi_i] = \max_{(q_i^d, L_i)} u_i(q_i^d, L_i)$$

$$\text{subject to } p_i^d q_i^d = w_i L_i + \pi_i \quad (3.1)$$

where p_i^d are consumer prices, w_i are wage rates, and π_i is the profit from household own business activities, which is given by

$$\pi_i = (p_i^s, p_i^d, w_i) = \max_{(z_i, L_i^o)} (p_i^s q_i^s - p_i^d z_i - w_i L_i^o) \quad (3.2)$$

$$\text{subject to } q_{ij}^s \leq f_{ij}(z_{ij}, L_{ij}^o)$$

$$j = 1, \dots, m; \sum_j z_{ij} \leq z_i, \sum_j L_{ij}^o \leq L_i^o$$

where p_i^s are supply prices, q_i^s are quantities supplied, L_i^o is the labor input to own-production activities, and the z_i are production inputs. f_{ij} is the household-specific production function for good j . L_{ij}^o and z_{ij} are labor and inputs, respectively, used in producing good j . By solving the maximization problem and applying the Envelope theorem, we can calculate a first-order approximation to the welfare impact in a neighborhood of the household optimum. Then, the monetary value of the change in utility, g_i , for a household i is given by

$$g_i = \sum_{j=1}^m \left[p_{ij}^s q_{ij}^s \frac{dp_{ij}^s}{p_{ij}^s} - p_{ij}^d (q_{ij}^d + z_{ij}) \frac{dp_{ij}^d}{p_{ij}^d} \right] + \sum_{k=1}^n \left(w_k L_{ik}^s \frac{dw_k}{w_k} \right) \quad (3.3)$$

where L_{ik}^s represents the household labor supply of activity k outside its own business. The subscript j refers to sectors. Equation (3.3) yields the household-level welfare impacts for changes in prices and wages resulting from trade reforms.

The utility and profit functions are assumed to vary with observed household characteristics to capture heterogeneities across households. Then, the indirect utility function becomes

$$v_i(p_i^d, w_i, \pi_i) = v(p_i^d, w_i, \pi_i, x_{1i}) \quad (3.4)$$

$$\text{where } \pi_i = \pi(p_i^s, p_i^d, w_i, x_{2i}) \quad (3.5)$$

and x_{1i} and x_{2i} are household characteristics that shift the utility functions in (3.1) and profit functions in (3.2).

The welfare gain/loss from trade reform in equation (3.3) depends on household consumption, labor supply, and production choices, which, in turn, depend on prices and household characteristics, that is, on x_{1i} and x_{2i} , respectively. Therefore, the welfare change can be written as

$$g_i = g(p_i^d, p_i^s, w_i, x_{1i}, x_{2i}) \quad (3.6)$$

$$= \sum_{j=1}^m \left[p_{ij}^s q^s(p_i^d, p_i^s, w_i, x_{2i}) \frac{dp_{ij}^s}{p_{ij}^s} - p_{ij}^d [q^d(p_i^d, w_i, \pi_i, x_{1i}) + z_{ij}(p_i^d, p_i^s, w_i, x_{2i})] \frac{dp_{ij}^d}{p_{ij}^d} \right]$$

$$+ \sum_{k=1}^n w_k [L_{ik}(p_i^d, w_i, \pi_i, x_{1i}) - L_{ik}^o(p_i^d, p_i^s, w_i, x_{2i})] \frac{dw_k}{w_k}$$

Assuming that price differences are captured using a complete set of regional dummy variables, linearly transforming equation (3.6) with an additive error term yields the following regression model for the gains/losses:

$$g_i = \beta_1 x_{1i} + \beta_2 x_{2i} + \sum_k \gamma_k D_{ki} + \varepsilon_i \quad (3.7)$$

where $D_{ki} = 1$ if household i lives in region k and 0 otherwise and ε_i is the error term.

The characteristics may include age of household head, education, demographic characteristics, and occupation.

Matching between the GTAP model and the household survey is the most crucial part of the macro–micro approach. The GTAP model sectors are matched with the closest category of the household survey. The detailed description of concordances of the GTAP sectors in the household survey categories is provided in Table A3.12 in Chapter 3 Appendix. Once the GTAP sectors and household survey categories are matched, changes in consumption and production for each household can be calculated.

The GTAP model defines two types of labor: skilled and unskilled. In the household survey data, this study uses educational level to define individuals' skill levels. People who completed vocational education or higher are defined as skilled, whereas those with a qualification lower than vocational education are considered unskilled. Then, changes in the

wage rates are used to calculate changes in wage income for each type of labor.

Land price changes from the GTAP model do not affect the household sector in this model. In Mongolia, the land privatization process is still ongoing. Currently, citizens can only own land for residential purposes. Pastoral land belongs to the government, and herders can use the land free of charge. Therefore, the household survey has no information on land ownership.

In assessing the impacts of trade reforms on poverty, household consumption is calculated as a welfare measure for changes in prices. The poverty ratio is determined as the share of the population whose consumption is below the national poverty line (i.e., 62,494 MNT per month per person) estimated by NSO and World Bank (2009).

3.4. RESULTS AND DISCUSSIONS

The GTAP model results show that the impact of trade liberalization in Mongolia varies depending on the reform type (Table 3.3 and Table 3.4). In general, the impact of the unilateral trade reform is smaller compared to other types. Bilateral trade liberalization with China and Russia shows more positive effects, of which most gains are from non-agricultural reforms. By contrast, multilateral trade liberalization scenarios yield declines in GDP and welfare owing to several reasons, which are discussed later.

Table 3.3 Changes in GDP of Mongolia, percentage change from the base

	Private consumption	Investment	Government expenditure	Exports	Imports	GDP
Base, mln USD	1,984.0	1,474.8	518.2	2,391.9	-2,439.3	3,929.6
Unilateral	-0.8	-0.3	-0.5	0.2	0.2	-0.6
Agricultural	-0.1	-0.1	-0.1	0.1	0.1	-0.1
Non-agricultural	-0.5	-0.8	-0.5	2.3	2.3	-0.6
Bilateral with China	2.0	3.9	2.2	0.5	1.9	1.9
Agricultural	0.0	0.1	0.1	0.1	0.1	0.1
Non-agricultural	2.0	3.9	2.1	0.3	1.8	1.8
Bilateral with Russia	4.6	6.1	4.8	-0.1	1.6	4.2
Agricultural	0.4	0.7	0.4	0.2	0.4	0.4
Non-agricultural	4.3	5.4	4.4	-0.3	1.2	3.8
Multilateral	-10.3	-10.6	-10.2	-7.8	-8.3	-10.1
Agricultural	-0.5	0.1	-0.1	0.0	0.1	-0.3
Non-agricultural	-9.7	-10.7	-9.9	-7.7	-8.4	-9.7

Source: Author's simulations

Table 3.4 Welfare changes in Mongolia, million USD

	Total	Allocative efficiency	ToT in goods and services	ToT in savings- investment
Unilateral	-6.9	5.5	-11.8	-0.7
Agricultural	0.2	1.3	-1.0	0.0
Non-agricultural	-7.3	4.2	-10.8	-0.6
Bilateral with China	43.3	0.3	42.8	0.2
Agricultural	1.5	0.2	1.3	0.1
Non-agricultural	41.8	0.2	41.6	0.1
Bilateral with Russia	110.2	3.5	106.5	0.3
Agricultural	5.0	1.0	3.9	0.1
Non-agricultural	105.8	2.7	103.1	0.1
Multilateral	-83.2	4.8	-85.4	-2.7
Agricultural	10.0	2.6	7.3	0.1
Non-agricultural	-91.5	2.3	-91.0	-2.8

Source: Author's simulations

Notes: ToT - terms of trade. The equivalent variation is used to measure changes in welfare.

Generally, the welfare change from trade liberalization can be decomposed into

allocative efficiency and the terms of trade effects. The allocative efficiency gained from trade is usually positive because productive factors are allocated more efficiently when trade policy barriers are removed during liberalization. Conversely, the terms of trade effects can be either positive or negative, depending on the trade structure. The net effect on welfare is the sum of the allocative efficiency gain and the changes in terms of trade. In the case of Mongolia, allocative efficiency is positive in all types of trade reforms. However, the adverse effects of the terms of trade dominate in the unilateral and multilateral reforms, resulting in welfare reduction.

Although the negative welfare impact of trade liberalization, particularly the multilateral reform, seems odd, it is not uncommon. A number of studies using CGE model find negative impacts of multilateral liberalization for a country or a group of country in their sample. Examples of such studies are listed in Table A.13 in Appendix 3. However, it should be noted that those studies are not directly comparable to this study due to differences in types of CGE modeling, theoretical assumptions, behavioral parameters, scenarios, time frames, and countries in their sample.

Trade reforms improve overall world welfare, but an individual country may suffer (Bouet, 2006). This finding also holds for the multilateral simulation in this study, because the result for the world welfare is positive (239 billion USD), whereas that for Mongolia is

negative (Table A.14).

A number of reasons exist for the possible negative growth and welfare implications of trade liberalization. First, as the welfare decomposition suggests, the effects of adverse terms of trade outweigh the allocative efficiency gain because either import prices increase or export prices decrease owing to increased competition in the export markets. Because Mongolia mainly exports a few types of primary commodities that have low income elasticities of demand and volatile prices, it is subject to deterioration in terms of trade. Second, preferential access to certain developed countries' markets could be eroded. Currently, Mongolia is granted nonreciprocal preferential access under the United States Generalized System of Preferences (GSP) and the European Union's (EU's) GSP Plus. In particular, cashmere exporters have been benefiting from the EU GSP Plus scheme. If tariff cuts were to be granted to all WTO members under the multilateral liberalization scenario, the relative advantage of existing preferential access would be reduced. In some cases, costs associated with the erosion of preferences may exceed the benefits derived from multilateral trade liberalization, resulting in a net loss. Third, Mongolia may face short-run adjustment costs when government revenues from tariffs are reduced. This is particularly true for simulations in this study because short-run impacts are considered in order to match the GTAP model with the household survey. A dynamic CGE model that considers the increase in factors of

production, technical progress, and factor productivity is required to evaluate the long-term impacts of trade liberalization. Finally, this study does not consider several other types of distortions included in the GTAP database, such as taxes on primary factors, private import consumption taxes, government import purchase taxes, and taxes on firms' imported intermediate inputs that may distort trade and reduce welfare. Therefore, the multilateral liberalization in this study does not refer to frictionless trade.

In contrast, Mongolia is likely to gain from bilateral trade agreements with China and Russia. The complementary trade structure between Mongolia and its two major trading partners may improve Mongolia's terms of trade by increasing the demand for its exports. Moreover, physical proximity positively affects trade relations with the two countries.

Although the welfare change at the national level is a useful indicator, it conceals information on the trade reform winners and losers. It is expected that household gains/losses from trade liberalization depend on household-specific characteristics. Table 3.5 and Table 3.6 show estimated results of the regression model (3.7). Equation (3.7) is estimated using a robust regression technique to remedy outliers that persist even after appropriate data cleaning procedures. By applying the robust regression technique, it becomes possible to consider all valuable data collected and still get consistent and unbiased estimates.

Table 3.5 Regression of per capita gains/losses from unilateral and multilateral reforms

	Unilateral			Multilateral		
	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural
<i>Characteristics of household</i>						
Poor	-2,780.8 *** (-9.12)	-3,300.1 *** (-39.21)	1,968.1 *** (7.20)	-31,242.4 *** (-53.32)	-2,906.5 *** (-24.48)	-27,556.6 *** (-50.91)
Household size	-578.9 *** (-6.53)	-785.2 *** (-32.13)	406.2 *** (5.12)	-2,739.5 *** (-16.10)	-505.4 *** (-14.66)	-2,272.5 *** (-14.46)
Share of kids	10.2 (1.41)	-2.3 (-1.18)	10.7 * (1.65)	-81.9 *** (-5.90)	9.1 *** (3.22)	-84.6 *** (-6.60)
Savings	3,031.7 *** (9.88)	341.8 *** (4.04)	2,159.3 *** (7.85)	5,273.4 *** (8.95)	705.9 *** (5.91)	3,740.2 *** (6.87)
Share of wage earners	652.7 *** (86.54)	-1.9 (-0.92)	655.7 *** (97.01)	177.8 *** (12.27)	91.7 *** (31.23)	110.8 *** (8.28)
Share of herders	17.2 * (1.76)	3.6 (1.33)	14.7 * (1.68)	-47.6 ** (-2.54)	4.6 (1.22)	-46.5 *** (-2.69)
Share of farmers	15.7 (0.53)	-27.4 *** (-3.36)	64.4 ** (2.43)	-229.0 *** (-4.04)	4.6 (0.40)	-229.6 *** (-4.38)
Share of own business runners	232.8 *** (20.19)	4.1 (1.27)	229.3 *** (22.19)	-131.5 *** (-5.94)	-48.6 *** (-10.82)	-129.8 *** (-6.34)
Remittance receiver	-2,457.0 *** (-7.64)	263.4 *** (2.97)	-2,929.6 *** (-10.17)	3,501.4 *** (5.67)	-265.6 ** (-2.12)	3,646.6 *** (6.39)
Urban	547.0 (1.49)	-101.2 (-1.00)	372.3 (1.13)	4,440.8 *** (6.30)	518.8 *** (3.63)	3,625.3 *** (5.57)
<i>Characteristics of household head</i>						
Age	-23.6 * (-1.80)	10.7 *** (2.96)	-47.0 *** (-3.99)	12.2 (0.48)	-6.7 (-1.30)	22.9 (0.98)
Male	1,891.3 *** (4.32)	303.6 *** (2.51)	1,691.6 *** (4.31)	-1,608.6 * (-1.91)	797.0 *** (4.67)	-2,236.1 (-2.88) **
Married	840.6 ** (2.54)	55.3 (0.61)	586.4 ** (1.98)	1,737.2 *** (2.73)	214.9 * (1.67)	1,257.1 ** (2.14)
Divorced	-18.0 (-0.03)	-13.2 (-0.09)	194.8 (0.39)	-1,806.7 * (-1.68)	-153.3 (-0.70)	-1,481.0 (-1.49)
Never married	-1,141.6 *** (-2.70)	18.7 (0.16)	-909.6 ** (-2.40)	596.0 (0.73)	-167.2 (-1.02)	947.2 (1.26)
No education	-1,903.3 *** (-3.32)	-278.7 * (-1.76)	-1,174.6 ** (-2.29)	-9,717.9 *** (-8.83)	-959.8 *** (-4.31)	-8,318.0 *** (-8.19)
Primary education	-1,598.6 *** (-3.66)	-204.1 * (-1.70)	-941.8 ** (-2.41)	-8,094.6 *** (-9.66)	-713.0 *** (-4.20)	-6,857.1 *** (-8.86)
Secondary education	-827.6 *** (-2.42)	-70.4 (-0.75)	-841.8 *** (-2.74)	-4,096.4 *** (-6.23)	-388.6 *** (-2.92)	-3,303.6 *** (-5.44)
Vocational education	-1,677.5 *** (-3.98)	-332.8 *** (-2.86)	-1,531.0 *** (-4.06)	-4,312.4 *** (-5.33)	-669.1 *** (-4.08)	-3,222.1 *** (-4.31)
College education	2,657.4 *** (6.48)	311.4 *** (2.75)	2,028.6 *** (5.52)	3,010.3 *** (3.82)	693.1 *** (4.34)	3,072.5 *** (4.22)
Herder	1,128.7 *** (2.41)	322.4 *** (2.49)	614.9 (1.46)	-258.6 (-0.29)	1,163.0 *** (6.38)	-1,589.7 * (-1.91)
Farmer	-3,333.9 *** (-2.76)	-270.9 (-0.81)	-2,810.3 *** (-2.59)	-549.7 (-0.24)	1,211.2 *** (2.57)	-1,345.7 (-0.63)
Works in private company	-925.5 *** (-2.69)	-91.4 (-0.96)	-1,030.4 *** (-3.34)	-507.8 (-0.77)	-1,076.0 *** (-8.04)	483.3 (0.79)
Works in public organization	2,638.2 *** (6.06)	-256.3 ** (-2.14)	2,176.1 *** (5.58)	-325.5 (-0.39)	-512.6 *** (-3.03)	-78.5 (-0.10)
Works in state owned enterprise	7,180.6 *** (10.61)	414.6 ** (2.22)	6,526.3 *** (10.76)	4,956.8 *** (3.81)	1,068.8 *** (4.06)	3,917.0 *** (3.26)
Pensioner	-1,990.7 *** (-4.49)	294.4 ** (2.41)	-1,826.7 *** (-4.60)	884.2 (1.04)	-485.1 *** (-2.81)	1,406.4 * (1.79)
Unemployed	-2,432.4 *** (-4.09)	-424.6 *** (-2.59)	-1,712.5 *** (-3.22)	-2,431.3 ** (-2.13)	-897.6 *** (-3.88)	-1,599.8 (-1.52)
Migration status	-773.1 *** (-2.74)	205.5 *** (2.64)	-1,013.7 *** (-4.01)	1,193.0 ** (2.20)	-24.6 (-0.22)	1,091.5 ** (2.18)
Constant	8,042.0 *** (8.93)	11,973.9 *** (48.21)	-6,604.7 *** (-8.19)	78,379.7 *** (45.33)	8,384.4 *** (23.93)	68,513.6 *** (42.89)
Observations	11,172	11,172	11,172	11,172	11,172	11,172
R-square	0.36	0.25	0.36	0.31	0.24	0.28

Source: Author's estimations

Note: t-statistics are in parentheses. *, **, and *** represent the 1%, 5%, and 10% statistical significance level, respectively. The dependent variable is the per capita gains/losses in MNT.

Table 3.6 Regression of per capita gains/losses from bilateral reforms

	Bilateral with China			Bilateral with Russia		
	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural
<i>Characteristics of household</i>						
Poor	7,000.9 *** (24.01)	459.8 *** (14.63)	7,074.5 *** (26.76)	11,958.4 *** (20.97)	2,817.4 *** (18.57)	9,406.6 *** (20.57)
Household size	659.8 *** (7.79)	79.0 *** (8.66)	604.9 *** (7.88)	2,424.3 *** (14.64)	1,314.2 *** (29.83)	1,012.9 *** (7.63)
Share of kids	23.7 *** (3.43)	1.0 (1.34)	25.5 *** (4.08)	77.0 *** (5.70)	25.7 *** (7.14)	51.4 *** (4.74)
Savings	520.6 * (1.78)	101.6 *** (3.22)	210.4 (0.79)	1,952.9 *** (3.40)	54.2 (0.36)	1,370.3 *** (2.98)
Share of wage earners	507.9 *** (70.48)	14.2 *** (18.24)	480.1 *** (73.46)	1,048.8 *** (74.38)	95.6 *** (25.50)	936.1 *** (82.78)
Share of herders	17.9 * (1.92)	2.0 ** (2.03)	14.6 * (1.73)	46.9 *** (2.57)	3.3 (0.67)	37.5 *** (2.57)
Share of farmers	121.6 *** (4.31)	6.3 ** (2.07)	81.6 *** (3.19)	190.7 *** (3.45)	40.8 *** (2.77)	137.3 *** (3.10)
Share of own business runners	-2.0 (-0.18)	0.1 (0.07)	23.4 ** (2.34)	71.1 *** (3.30)	-3.9 (-0.68)	68.4 *** (3.96)
Remittance receiver	-2,885.1 *** (-9.39)	-271.9 *** (-8.21)	-2,565.0 *** (-9.21)	-6,252.9 *** (-10.40)	-1,185.4 *** (-7.42)	-5,151.0 *** (-10.69)
Urban	-1,793.3 *** (-5.12)	-348.1 *** (-9.21)	-1,261.8 *** (-3.97)	-267.1 (-0.39)	1,369.9 *** (7.51)	-1,712.2 *** (-3.11)
<i>Characteristics of household head</i>						
Age	-40.8 *** (-3.25)	-5.0 *** (-3.72)	-35.1 *** (-3.08)	-134.1 *** (-5.45)	-40.1 *** (-6.12)	-82.0 *** (-4.16)
Male	2,148.9 *** (5.13)	265.8 *** (5.89)	1,816.8 *** (4.79)	3,088.8 *** (3.77)	-77.3 (-0.36)	3,229.2 *** (4.92)
Married	274.2 (0.87)	-18.2 (-0.53)	222.0 (0.77)	1,334.2 ** (2.15)	451.7 *** (2.74)	574.0 (1.16)
Divorced	381.9 (0.71)	62.0 (1.08)	375.0 (0.77)	-250.1 (-0.24)	-183.9 (-0.66)	-175.1 (-0.21)
Never married	-912.8 ** (-2.26)	-86.7 ** (-1.99)	-827.5 ** (-2.26)	-1,855.2 ** (-2.34)	-683.1 *** (-3.24)	-1,011.0 (-1.59)
No education	-323.8 (-0.59)	249.9 *** (4.23)	-362.3 (-0.73)	-2,571.4 ** (-2.40)	863.9 *** (3.03)	-2,138.8 *** (-2.49)
Primary education	-358.9 (-0.86)	315.9 *** (7.03)	-591.0 (-1.56)	-2,454.6 *** (-3.01)	162.6 (0.75)	-2,201.5 *** (-3.37)
Secondary education	-1,010.1 *** (-3.09)	300.6 *** (8.52)	-1,271.5 *** (-4.29)	-3,914.5 *** (-6.11)	-395.1 ** (-2.32)	-3,089.8 *** (-6.02)
Vocational education	-1,733.4 *** (-4.31)	-40.1 (-0.92)	-1,660.8 *** (-4.55)	-3,569.3 *** (-4.53)	-549.3 *** (-2.62)	-3,219.1 *** (-5.10)
College education	396.8 (1.01)	-292.3 *** (-6.92)	584.8 * (1.65)	2,912.3 *** (3.80)	-107.2 (-0.53)	2,451.7 *** (3.99)
Herder	2,890.7 *** (6.46)	968.2 *** (20.06)	1,737.6 *** (4.28)	4,809.4 *** (5.49)	320.7 (1.38)	3,474.6 *** (4.95)
Farmer	-1,104.9 (-0.96)	88.3 (0.71)	-1,593.2 (-1.52)	-3,296.5 (-1.46)	-24.0 (-0.04)	-2,581.1 (-1.42)
Works in private company	-2,344.5 *** (-7.14)	-209.4 *** (-5.91)	-2,071.7 *** (-6.95)	-4,732.8 *** (-7.36)	-330.1 ** (-1.93)	-3,826.3 *** (-7.42)
Works in public organization	1,261.2 *** (3.03)	-53.3 (-1.19)	1,462.4 *** (3.88)	2,754.9 *** (3.39)	53.3 (0.25)	2,744.5 *** (4.21)
Works in state owned enterprise	3,753.8 *** (5.80)	-39.0 (-0.56)	3,632.2 *** (6.19)	7,407.8 *** (5.85)	1,038.8 *** (3.09)	5,859.1 *** (5.77)
Pensioner	-1,547.1 *** (-3.65)	-253.1 *** (-5.54)	-1,129.2 *** (-2.94)	-2,841.7 *** (-3.43)	-1,056.5 *** (-4.79)	-1,909.4 *** (-2.87)
Unemployed	-1,182.6 ** (-2.08)	-198.1 *** (-3.24)	-862.4 * (-1.68)	-1,494.0 (-1.35)	137.8 (0.47)	-1,573.0 * (-1.77)
Migration status	-1,146.6 *** (-4.25)	-76.1 *** (-2.62)	-1,022.4 *** (-4.18)	-2,054.3 *** (-3.89)	-11.4 (-0.08)	-1,983.7 *** (-4.69)
Constant	-15,631.6 *** (-18.17)	-1,145.0 *** (-12.35)	-15,698.9 *** (-20.13)	-38,374.2 *** (-22.80)	-17,141.7 *** (-38.29)	-22,111.3 *** (-16.38)
Observations	11,172	11,172	11,172	11,172	11,172	11,172
R-squared	0.26	0.18	0.27	0.30	0.18	0.29

Source: Author's estimations

Note: t-statistics are in parentheses. *, **, and *** represent the 1%, 5%, and 10% statistical significance level, respectively. The dependent variable is the per capita gains/losses in MNT.

The estimated coefficients on most variables are highly statistically significant; however, their signs vary for the different trade reforms. Because there are no *a priori* expected signs for the estimated coefficients, it indicates that various types of trade reforms have different impacts on household welfare. The results demonstrate that poor households and those with many children are likely to lose in unilateral and multilateral reforms, with the exception of a unilateral non-agricultural reform.

By contrast, the same households tend to gain in all bilateral reforms. Households with savings gain in all reforms, and those with young, male, and married household heads are likely to gain in most unilateral and bilateral reforms. Conversely, the age of household head is not an important factor affecting whether the household gains from multilateral reforms. The educational level of the household head is more important in non-agricultural reforms. Whereas the less educated are able to gain in bilateral agricultural reforms, the college-educated gain from most trade reforms. Herders are likely to gain in all bilateral and agricultural reforms, whereas they lose from multilateral non-agricultural reforms. In general, bilateral trade reforms are more poverty alleviating, whereas the poor tend to lose in unilateral and multilateral reforms.

Table 3.7 summarizes poverty impacts of different trade reform scenarios in Mongolia. Consistent with the regression results, bilateral reforms reduce poverty, whereas

multilateral reforms likely increase poverty. The magnitude of the changes is larger in non-agricultural reforms. The poor tend to be engaged in activities that are adversely affected by increased competition from multilateral liberalization, whereas the complementary trade structures of China and Russia increase the demand for Mongolia's exports and reduce poverty.

Table 3.7 Poverty incidence, change from the base in percentage points

	Urban	Rural	Total
Base	26.9	46.6	35.2
Unilateral	0.05	0.12	0.08
Agricultural	0.39	0.54	0.45
Non-agricultural	-0.51	-0.86	-0.66
Bilateral with China	-1.04	-1.27	-1.14
Agricultural	-0.16	-0.12	-0.15
Non-agricultural	-1.03	-1.27	-1.13
Bilateral with Russia	-1.71	-2.60	-2.09
Agricultural	-0.82	-1.17	-0.97
Non-agricultural	-1.38	-1.61	-1.48
Multilateral	3.63	3.36	3.52
Agricultural	0.26	0.25	0.25
Non-agricultural	3.21	3.11	3.16

Source: NSO and World Bank (2009) and own computation

Notes: The baseline poverty rate is for 2008.

3.5. CONCLUSION

This chapter attempted to analyze the effects of various trade reforms on economic growth and poverty in Mongolia using a macro–micro simulation approach. The results prove that trade

reform types matter for growth and poverty. In the case of Mongolia, bilateral trade liberalization with China and Russia positively affects both GDP and welfare. Bilateral reforms are also more poverty alleviating than unilateral and multilateral liberalization, particularly in rural herder households. In contrast, multilateral liberalization is likely to result in a decline in growth and an increase in poverty. Several reasons could explain why trade liberalization causes a negative outcome, including terms of trade deterioration, erosion of preferences, and short-run adjustment costs.

It is found that household characteristics determine whether the household gains from trade liberalization. Poor households and those with many children are likely to lose in most unilateral and multilateral reforms, whereas they tend to gain in bilateral reforms. This may indicate that the poor are likely to be engaged in activities that are adversely affected by the increased competition from multilateral liberalization. Thus, complementary policies that help the poor overcome the adverse effects of multilateral liberalization should be implemented. For example, investment in human capital may alleviate poverty, as the low educated tend to lose in trade liberalization. Moreover, macroeconomic stability policies should be implemented to reduce short-term shocks of trade reforms.

Although the advantages of the model used in this study for evaluating welfare changes at the household level are evident, it is not free of limitations. First, dynamic gains

resulting from technical progress and productivity growth may exist that are not being captured by the model. Such dynamic gains can be captured by applying a dynamic CGE model and household survey panel data. Second, owing to data limitations, several types of distortions are not considered in the model, such as rules of origin, technical barriers, and sanitary and phytosanitary regulations. These types of distortions have often been applied because the relative importance of tariffs and export subsidies has declined considerably owing to worldwide trade liberalization agreements. Although these limitations are acknowledged, it is believed that the results of this study provide evidence regarding the short-run distributional impact of trade liberalization in Mongolia.

APPENDIX TO CHAPTER 3

Table A3.1 Regional classification used in the Mongolian GTAP model

Mongolian GTAP model regions	Comprising regions
Mongolia	Mongolia.
China	China.
Russia	Russia.
Developed	Australia; New Zealand; Japan; Canada; United States of America; Austria; Belgium; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Slovakia; Slovenia; Spain; Sweden; United Kingdom; Switzerland; Norway.
Developing	Rest of Oceania; Hong Kong; Korea; Taiwan; Rest of East Asia; Cambodia; Indonesia; Malaysia; Philippines; Singapore; Thailand; Viet Nam; Rest of Southeast Asia; India; Pakistan; Sri Lanka; Mexico; Rest of North America; Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Paraguay; Peru; Uruguay; Venezuela; Rest of South America; Costa Rica; Guatemala; Honduras; Nicaragua; Panama; El Salvador; Rest of Central America; Caribbean; Rest of EFTA; Albania; Bulgaria; Belarus; Croatia; Romania; Ukraine; Rest of Eastern Europe; Rest of Europe; Kazakhstan; Kyrgyzstan; Rest of Former Soviet Union; Armenia; Azerbaijan; Georgia; Bahrain; Iran Islamic Republic of; Israel; Kuwait; Oman; Qatar; Saudi Arabia; Turkey; United Arab Emirates; Egypt; Morocco; Tunisia; Rest of North Africa; South Africa.
Least Developed	Lao People's Democratic Republ; Bangladesh; Nepal; Rest of South Asia; Rest of Western Asia; Cameroon; Cote d'Ivoire; Ghana; Nigeria; Senegal; Rest of Western Africa; Central Africa; South Central Africa; Ethiopia; Kenya; Madagascar; Malawi; Mauritius; Mozambique; Tanzania; Uganda; Zambia; Zimbabwe; Rest of Eastern Africa; Botswana; Namibia; Rest of South African Customs ; Rest of the World.

Source: Author's classification based on GTAP 8 database

Table A3.2 Sectoral classification used in the Mongolian GTAP model

No.	Mongolian GTAP model sectors	Comprising sectors
1	Rice	Paddy rice; Processed rice.
2	Wheat	Wheat.
3	Vegetables & fruits	Vegetables, fruit, nuts.
4	Other grain crops	Cereal grains not elsewhere classified; Oil seeds; Sugar cane, sugar beet; Plant-based fibers; Crops not elsewhere classified.
5	Live bovine animals	Cattle, sheep, goats, horses.
6	Animal products	Other Animal Products: swine, poultry and other live animals; eggs, in shell (fresh or cooked), natural honey, snails (fresh or preserved) except sea snails; frogs' legs, edible products of animal origin not elsewhere classified, hides, skins and furskins, raw , insect waxes and spermaceti, whether or not refined or coloured
7	Raw milk	Raw milk.
8	Raw animal products used in textiles	Wool, silk-worm cocoons.
9	Meat of bovine animals	Meat of cattle, sheep, goats, and horse.
10	Other meat products	Pig meat and offal. preserves and preparations of meat, meat offal or blood, flours, meals and pellets of meat or inedible meat offal; greaves; animal products not elsewhere classified.
11	Dairy products	Dairy products.
12	Sugar	Sugar.
13	Beverages & tobacco	Beverages and tobacco products.
14	Other processed food	Vegetable oils and fats; Food products not elsewhere classified.
15	Fish	Fishing.
16	Mining of coal	Coal.
17	Mining of metal ores	Mining of metal ores, uranium, gems. other mining and quarrying, minerals not elsewhere classified.
18	Other extraction	Forestry; Oil; Gas.
19	Textiles and clothing	Textiles; Wearing apparel.
20	Light manufacturing	Leather products; Wood products; Paper products, publishing; Metal products; Motor vehicles and parts; Transport equipment not elsewhere classified; Manufactures not elsewhere classified.
21	Heavy manufacturing	Petroleum, coal products; Chemical, rubber, plastic prods; Mineral products not elsewhere classified; Ferrous metals; Metals not elsewhere classified; Electronic equipment; Machinery and equipment not elsewhere classified.
22	Utility (electricity, gas, water)	Electricity; Gas manufacture, distribution; Water; Construction.
23	Transport & communication	Trade; Transport not elsewhere classified; Sea transport; Air transport; Communication.
24	Other services	Financial services not elsewhere classified; Insurance; Business services not elsewhere classified; Recreation and other services; Public administration, Defence, Health, Education; Dwellings.

Source: Author's classification based on GTAP 8 database

Table A3.3 Import tariff rates applied by Mongolia, %

	China	Russia	Developed	Developing	Least developed
Rice	5.0	0.0	4.6	2.3	0.0
Wheat	5.0	5.0	4.9	5.0	0.0
Vegetables & fruits	7.4	5.5	4.1	2.2	0.0
Other grain crops	5.0	5.0	4.8	4.2	0.0
Live bovine animals	0.2	1.8	3.6	0.4	0.0
Animal products	5.0	5.0	4.9	2.5	0.0
Raw milk	0.0	0.0	0.0	0.0	0.0
Raw animal products used in textiles	0.0	5.0	5.0	0.0	0.0
Meat of bovine animals	5.0	0.0	1.2	0.8	0.0
Other meat products	5.0	5.0	4.5	1.5	0.0
Dairy products	5.0	5.0	4.4	3.0	0.0
Sugar	5.0	5.0	4.2	4.9	0.0
Beverages & tobacco	5.2	9.2	7.6	8.7	0.0
Other processed food	5.5	7.0	5.0	5.4	2.2
Fish	0.0	0.0	0.8	1.8	0.0
Mining of coal	5.0	0.0	0.0	0.0	0.0
Mining of metal ores	5.0	5.0	4.6	4.8	0.0
Other extraction	5.0	5.0	0.0	2.4	0.0
Textiles and clothing	5.0	5.0	4.7	4.5	4.3
Light manufacturing	5.0	5.0	5.0	4.9	1.0
Heavy manufacturing	4.9	5.0	4.8	4.6	2.9
Utility (electricity, gas, water)	1.1	4.1	0.0	0.0	0.0
Transport & communication	0.0	0.0	0.0	0.0	0.0
Other services	0.0	0.0	0.0	0.0	0.0

Source: GTAP 8 database

Table A3.4 Import tariff rates faced by Mongolia, %

	China	Russia	Developed	Developing	Least developed
Rice	0.0	0.0	0.0	0.0	0.0
Wheat	0.0	0.0	0.0	0.0	0.0
Vegetables & fruits	16.5	0.0	1.3	0.0	0.0
Other grain crops	4.8	0.0	1.1	2.9	0.0
Live bovine animals	0.0	0.0	0.0	0.7	0.0
Animal products	8.3	0.0	2.3	4.4	0.0
Raw milk	0.0	0.0	0.0	0.0	0.0
Raw animal products used in textiles	9.1	10.3	0.1	5.4	0.0
Meat of bovine animals	0.0	14.1	0.1	11.5	0.0
Other meat products	0.0	15.0	2.1	37.7	0.0
Dairy products	0.0	0.0	9.8	0.0	12.1
Sugar	0.0	0.0	0.0	0.0	0.0
Beverages & tobacco	19.8	0.0	0.4	45.9	0.0
Other processed food	10.4	11.2	5.3	10.4	21.8
Fish	7.2	0.0	0.0	0.0	0.0
Mining of coal	4.5	5.0	0.0	0.0	0.0
Mining of metal ores	0.0	13.4	0.0	1.3	0.0
Other extraction	0.0	3.9	0.0	0.1	0.0
Textiles and clothing	10.7	16.0	8.3	17.3	4.4
Light manufacturing	6.5	12.4	0.4	17.7	10.1
Heavy manufacturing	1.5	7.1	0.0	4.0	2.0
Utility (electricity, gas, water)	0.0	0.0	0.0	0.0	0.0
Transport & communication	0.0	0.0	0.0	0.0	0.0
Other services	0.0	0.0	0.0	0.0	0.0

Source: GTAP 8 database

Table A3.5 Export subsidies, by regions and countries, %

	Mongolia	China	Russia	Developed	Developing	Least developed
Rice	0.0	0.0	0.0	0.0	0.0	0.0
Wheat	0.0	0.0	0.0	0.0	0.2	0.0
Vegetables & fruits	0.0	0.0	0.0	0.2	0.2	0.0
Other grain crops	0.0	0.0	0.0	0.0	0.0	0.0
Live bovine animals	0.0	0.0	0.0	2.5	0.1	0.0
Animal products	0.0	0.0	0.0	0.0	0.0	0.0
Raw milk	-0.7	0.0	-5.8	-0.2	-0.5	-0.2
Raw animal products used in textiles	0.0	0.0	0.0	0.0	0.0	0.0
Meat of bovine animals	0.0	0.0	0.0	0.8	0.0	0.0
Other meat products	0.0	0.0	0.0	0.8	0.0	0.0
Dairy products	0.0	0.0	0.0	6.3	0.0	0.0
Sugar	0.0	0.0	0.0	38.7	0.0	0.0
Beverages & tobacco	0.0	0.0	0.0	0.2	0.1	0.0
Other processed food	0.0	0.0	0.0	0.1	0.0	0.0
Fish	0.0	0.0	0.0	0.0	0.0	2.3
Mining of coal	-1.7	-7.4	-1.0	0.2	-0.5	-0.2
Mining of metal ores	-1.2	-6.1	-5.8	0.0	-0.7	-0.6
Other extraction	-0.6	-4.6	-28.0	0.2	-0.1	-0.5
Textiles and clothing	-2.3	-7.1	-6.9	0.0	-0.7	0.1
Light manufacturing	-13.2	-3.7	-8.8	0.0	-1.1	-3.4
Heavy manufacturing	-8.5	-3.7	-10.0	-0.1	-1.5	-2.3
Utility (electricity, gas, water)	0.0	0.0	0.0	0.0	0.0	0.0
Transport & communication	0.0	0.0	0.0	0.0	0.0	0.0
Other services	0.0	0.0	0.0	0.0	0.0	0.0

Source: GTAP 8 database

Notes: Negative values indicate taxes.

Table A3.6 Output subsidies, by regions and countries, %

	Mongolia	China	Russia	Developed	Developing	Least developed
Rice	-0.7	0.0	0.0	5.1	1.7	-0.2
Wheat	-0.2	0.0	0.0	0.5	7.7	-3.4
Vegetables & fruits	-0.2	0.0	3.4	0.4	-0.1	-0.2
Other grain crops	-0.2	0.0	0.1	0.4	1.8	-0.2
Live bovine animals	-0.2	0.0	0.3	0.1	-1.0	-0.7
Animal products	-0.2	0.0	0.8	0.0	-0.6	-1.1
Raw milk	-0.2	0.0	1.7	0.8	-0.2	-0.8
Raw animal products used in textiles	-0.2	0.0	0.0	0.8	-1.1	-1.4
Meat of bovine animals	-3.0	0.0	0.0	-1.9	-1.1	-1.8
Other meat products	-3.0	0.0	0.0	-1.6	-1.0	-1.7
Dairy products	-0.2	0.0	0.0	-1.2	-0.9	-5.2
Sugar	-3.0	0.0	0.0	-7.7	-2.5	-0.7
Beverages & tobacco	-0.9	0.0	0.0	-12.3	-7.8	-2.5
Other processed food	-3.0	0.0	0.0	-2.2	-1.5	-0.9
Fish	-0.1	0.0	0.0	-3.0	-0.6	-1.0
Mining of coal	-3.1	0.0	0.0	-0.4	0.5	1.2
Mining of metal ores	-3.9	0.0	0.0	-8.6	-1.0	-0.7
Other extraction	-0.5	0.0	0.0	-3.2	-4.3	-2.1
Textiles and clothing	-4.3	0.0	0.0	-4.4	-0.9	1.4
Light manufacturing	-0.7	0.0	0.0	-2.1	-1.0	-1.7
Heavy manufacturing	-0.7	0.0	0.0	-4.1	-1.4	-4.9
Utility (electricity, gas, water)	-1.6	0.0	0.0	-2.0	-0.4	-1.8
Transport & communication	-1.7	0.0	0.0	-1.5	-1.2	-1.3
Other services	-0.4	0.0	0.0	-2.1	-1.4	-0.8

Source: GTAP 8 database

Notes: Negative values indicate taxes.

Table A3.7 Changes in the real exchange rate in Mongolia

	Exchange rate
Base	1.00
Unilateral	1.07
Bilateral with China	1.04
Bilateral with Russia	1.06
Multilateral	0.98

Source: Author's simulations

Note: An increase (decrease) in the real exchange rate is a real appreciation (depreciation)

Table A3.8 Descriptions of categorical variables

Variable name	Categorical code	Description
<i>Characteristics of household head</i>		
Marital status		
	1	Married
	2	Divorced
	3	Never married
	4	Other (separated, and widowed)
Employment status		
	1	Herder
	2	Farmer
	3	Works in private sector
	4	Works in public sector
	5	Works in state owned enterprise
	6	Pensioner
	7	Unemployed
	8	Other (student, etc)
Educational level		
	1	None
	2	Primary
	3	Secondary
	4	Vocational
	5	College (undergraduate degree)
	6	Master's degree and higher

Source: NSO and World Bank (2009)

Table A3.9 Market price changes in Mongolia, %

	Unilateral			Bilateral with China			Bilateral with Russia			Multilateral		
	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural
Rice	0.8	-2.3	3.1	2.7	0.5	2.3	3.9	-0.1	4.0	-3.2	-2.0	-1.3
Wheat	-1.6	-2.3	0.6	1.1	0.2	0.9	0.6	-0.8	1.5	-6.0	-0.4	-5.5
Vegetables & fruits	-0.2	-1.1	0.9	3.6	2.4	1.3	2.4	0.4	2.1	-2.8	1.2	-4.0
Other grain crops	1.8	-1.1	3.0	3.3	1.2	2.2	4.0	0.1	3.9	-2.3	-0.9	-1.4
Live bovine animals, horses, camels, sheeps, goats	3.1	-0.1	3.2	5.5	0.6	4.9	10.2	1.4	8.7	-1.5	1.1	-2.6
Other animals	1.6	-0.8	2.4	4.2	0.7	3.6	6.7	0.5	6.2	-2.4	0.4	-2.7
Raw milk	3.5	-0.7	4.2	4.0	1.0	3.0	5.6	0.3	5.3	0.4	0.2	0.2
Raw animal products used in textiles	0.6	-0.1	0.7	1.7	0.9	0.8	1.5	0.2	1.3	1.4	0.9	0.4
Meat of cattle, horse, sheep, goat, and camel	-0.7	-1.1	0.5	1.2	-0.1	1.3	10.8	8.8	2.5	-5.1	1.1	-6.2
Other meat products	-1.9	-2.8	0.9	1.5	0.0	1.5	5.2	2.8	2.8	-8.0	-3.7	-4.2
Dairy products	-0.9	-2.0	1.1	0.9	0.0	1.0	0.6	-0.9	1.5	-6.5	-1.4	-5.2
Sugar	-4.7	-3.4	1.5	0.5	-0.7	1.1	0.9	-1.0	2.0	-9.6	-6.5	-3.2
Beverages & tobacco	-3.3	-2.2	-0.4	0.1	-0.2	0.3	-0.3	-0.2	0.0	-12.1	-4.5	-7.6
Other processed food	-4.1	-3.5	0.6	0.3	-0.3	0.7	-0.5	-1.6	1.2	-10.8	-5.7	-5.1
Fish	-0.2	-0.6	0.5	3.3	3.4	-0.1	0.2	-0.1	0.2	-2.4	1.0	-2.4
Mining of coal	1.8	0.0	1.8	6.7	0.0	6.7	0.6	0.0	0.6	-2.0	-0.3	-1.7
Mining of metal ores	1.2	0.0	1.1	1.2	0.0	1.2	0.7	0.0	0.7	-17.4	-0.2	-17.1
Other extraction	0.9	0.0	0.9	0.9	0.0	0.9	0.0	0.0	0.0	-17.2	0.0	-17.1
Textiles and clothing	0.7	0.0	0.7	1.6	0.1	1.6	0.8	0.1	0.8	-5.0	-0.2	-4.8
Light manufacturing	0.5	-0.1	0.6	1.2	0.1	1.1	1.5	0.2	1.3	-7.1	0.1	-7.2
Heavy manufacturing	1.0	0.0	1.0	-0.3	0.0	-0.3	-1.3	0.0	-1.4	-10.1	-0.1	-10.0
Utility (electricity, gas, water)	-0.4	-0.1	-0.3	1.9	0.1	1.9	2.6	0.3	2.3	-7.8	0.2	-8.0
Transport & communication	-0.2	-0.1	-0.2	1.0	0.1	1.0	1.7	0.2	1.5	-6.1	0.1	-6.2
Other services	1.1	-0.1	1.2	2.1	0.1	2.1	4.2	0.4	3.9	-5.3	0.2	-5.4

Source: Author's simulations

Table A3.10 Supply price changes in Mongolia, %

	Unilateral			Bilateral with China			Bilateral with Russia			Multilateral		
	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural	Total	Agricultural	Non-agricultural
Rice	1.5	-1.6	3.1	2.7	0.5	2.3	3.9	-0.1	4.0	-2.5	-1.2	-1.3
Wheat	-1.4	-2.1	0.6	1.1	0.2	0.9	0.6	-0.8	1.5	-5.8	-0.2	-5.5
Vegetables & fruits	0.0	-0.9	0.9	3.6	2.4	1.3	2.4	0.4	2.1	-2.6	1.4	-4.0
Other grain crops	2.1	-0.9	3.0	3.3	1.2	2.2	4.0	0.1	3.9	-2.1	-0.7	-1.4
Live bovine animals, horses, camels, sheeps, goats	3.3	0.0	3.2	5.5	0.6	4.9	10.2	1.4	8.7	-1.4	1.3	-2.6
Other animals	1.7	-0.7	2.4	4.2	0.7	3.6	6.7	0.5	6.2	-2.2	0.5	-2.7
Raw milk	3.7	-0.5	4.2	4.0	1.0	3.0	5.6	0.3	5.3	0.5	0.4	0.2
Raw animal products used in textiles	0.8	0.1	0.7	1.7	0.9	0.8	1.5	0.2	1.3	1.5	1.1	0.4
Meat of cattle, horse, sheep, goat, and camel	2.4	1.9	0.5	1.2	-0.1	1.3	10.8	8.8	2.5	-2.0	4.2	-6.2
Other meat products	1.2	0.2	0.9	1.5	0.0	1.5	5.2	2.8	2.8	-4.9	-0.6	-4.2
Dairy products	-0.6	-1.8	1.1	0.9	0.0	1.0	0.6	-0.9	1.5	-6.3	-1.2	-5.2
Sugar	-1.7	-3.4	1.5	0.5	-0.7	1.1	0.9	-1.0	2.0	-6.5	-3.4	-3.2
Beverages & tobacco	-2.4	-2.2	-0.4	0.1	-0.2	0.3	-0.3	-0.2	0.0	-11.2	-3.6	-7.6
Other processed food	-1.1	-3.5	0.6	0.3	-0.3	0.7	-0.5	-1.6	1.2	-7.7	-2.6	-5.1
Fish	0.0	-0.6	0.5	3.3	3.4	-0.1	0.2	-0.1	0.2	-2.2	1.1	-2.4
Mining of coal	5.1	0.0	5.1	6.7	0.0	6.7	0.6	0.0	0.6	1.2	-0.3	1.5
Mining of metal ores	5.3	0.0	5.3	1.2	0.0	1.2	0.7	0.0	0.7	-13.3	-0.2	-13.0
Other extraction	1.3	0.0	1.3	0.9	0.0	0.9	0.0	0.0	0.0	-16.7	0.0	-16.7
Textiles and clothing	5.3	0.0	5.3	1.6	0.1	1.6	0.8	0.1	0.8	-0.5	-0.2	-0.3
Light manufacturing	1.2	-0.1	1.3	1.2	0.1	1.1	1.5	0.2	1.3	-6.4	0.1	-6.5
Heavy manufacturing	1.6	0.0	1.7	-0.3	0.0	-0.3	-1.3	0.0	-1.4	-9.4	-0.1	-9.3
Utility (electricity, gas, water)	1.3	-0.1	1.3	1.9	0.1	1.9	2.6	0.3	2.3	-6.2	0.2	-6.3
Transport & communication	1.5	-0.1	1.5	1.0	0.1	1.0	1.7	0.2	1.5	-4.4	0.1	-4.4
Other services	1.5	-0.1	1.6	2.1	0.1	2.1	4.2	0.4	3.9	-4.9	0.2	-5.0

Source: Author's simulations

Table A3.11 Changes in wage rates in Mongolia, %

	Unskilled labor	Skilled labor
Unilateral	5.7	4.8
Agricultural	0.0	-0.1
Non-agricultural	5.6	4.8
Bilateral with China	4.3	4.1
Agricultural	0.2	0.1
Non-agricultural	4.0	4.0
Bilateral with Russia	8.0	8.3
Agricultural	0.7	0.6
Non-agricultural	7.4	7.7
Multilateral	0.9	-0.8
Agricultural	0.6	0.5
Non-agricultural	0.4	-1.2

Source: Author's simulations

Table A3.12 Matching between GTAP sectors and household survey categories

GTAP sectors	Household survey categories
Rice	Rice
Wheat	Wheat flour (grades high, 1, and 2) and, other flour
Vegetables and fruits	Apples, mandarins, other fresh fruits, raisins, wild fruits, dried fruits, wild nuts, other nuts, watermelons, potatoes, cabbages, carrots, turnips, onions, garlics, tomatoes, cucumbers, green and red peppers, mushrooms, and other vegetables
Other grain crops	Millet, farina, barley, oats, grain, and seeds
Live animals	Cattles, horses, camels, sheep, and goats
Animal products	Pigs, and poultry
Raw milk	Milk
Raw animal products used in textiles	Wool, raw cashmere, animal hair, animal skin, and hides
Meat of cattle, sheep, horses, goat, etc	Mutton, beef, goat meat, horse meat, camel meat, and dried meat (traditional home dried "borts")
Other meat products	Chicken, pork, bacon, game meat, other poultry meat, animal interior, and eggs
Dairy products	Yogurt, dried curts, airag (fermented horse milk), cheese, coffee milk, condensed milk, sour cream, butter, margarin, cream, and melted butter
Sugar	Sugar, and lump sugar
Beverages and tobacco	Domestic vodka, imported vodka, domestic and imported beer, wine, other alcoholic beverages, domestic and imported cigarretes, and tobacco
Other processed food	Bread, noodles, biscuits, cakes, fish (dried, smoked, and canned), vegetable oil, other oil, pickled vegetables, canned vegetable salad, sugar substitutes, candies, chocolates, jams, ice cream, syrup, marmalades, venegar, ketchup, mayonnaise, baking soda, baby food or formula, tea, coffee, cocoa, soft drinks, fruit juice, vegetable juice, bottled water, etc
Fish	Fish, and seafood
Mining of coal	Mining of coal
Mining of metal ores	Mining of metal ores
Other extraction	Forestry and logging, quarrying of stone, sand and clay, and other mining
Textiles and clothing	Clothing and footwear, and manufacture of textiles and wearing apparel
Light manufacturing	Durable goods such as furnitures, home appliances, household transportation goods, fertilizers, agricultural tools and equiment, animal feed, manufacture of leather and related products, manufacture of wood and wood products, printing and reproduction of recorded media, manufacture of basic metals, fabricated metal products, motor vehicles, furniture, etc
Heavy manufacturing	Chemical insecticides, pesticides, drugs for animals, manufacture of coke and refined petroleum products, chemicals and chemical products, pharmaceutical products and pharmaceutical preparations, rubber and plastics products, non-metallic mineral products, computer, electronic and optical products, electrical equipment, and machinery and equipment
Utility and construction	Heating, electricity, water, gas, other utilities, construction building, and steam and air conditioning supply
Transport, communication, and trade	Transportation and communication, warehousing, postal and courier activities, and wholesale and retail trade
Other services	Education, health, rent, other services, taxes, veterinary costs, maintenance of fences and equiment, insurance, financial intermediation, insurance, recreation activities, sewerage, waste collection, computer programming, consulting, real estate activities, professional, scientific and technical activities, administrative and support service activities, education, human health and social work activities, arts, entertainment, and other service activities

Source: Author's aggregation

Table A3.13 Studies that find negative impact of full multilateral trade liberalization

Reference	Model type	Experiment	Dynamic/Static	Year of Data	Regions/Sectors	Potential losers
Dee and Hanslow (2000)	Foreign Direct Investment Trade Analysis Project (FTAP)	Full liberalization	Dynamic	1995	19 x 3	Canada, Mexico
Diao et al (2001)	Agricultural US Department of Agriculture–Economic Research Service model	Full liberalization	Static/dynamic	1997	12 x 9	Mexico, Rest of the World
Cline (2004)	Harrison, Rutherford, and Tarr model	Full liberalization	Static/dynamic	1997	25 x 22	Malaysia, Mexico, China, Malaysia
Anderson et al (2006)	LINKAGE	DDA	Dynamic	2001	27 x 25	Hong Kong, Singapore, Bangladesh, China, Vietnam, Russia, Mexico
Bchir et al (2005)	MIRAGE	DDA industry	Static	2001	22 x 20	Canada, Brazil, China, India, Mexico, Rest of Latin America
Bouet et al (2005a)	MIRAGE	Full liberalization	Dynamic	2001	21 x 18	Argentina, Bangladesh, Canada, China, EU, Mexico, Mozambique, Southern African Customs Union, Venezuela, Zambia
Bouet et al (2005b)	MIRAGE	DDA agriculture	Static	1997	11 x 30	Mediterranean countries, Sub-Saharan Africa
Francois et al (2005)	GTAP	Full liberalization	Dynamic	1997	16 x 17	China, India, South America
Hertel and Keeney (2005)	GTAP-Agr	Full liberalization	Static	2001	30 x 3	Bangladesh, Mozambique, Philippines, Rest of Latin America, Rest of Sub-Saharan Africa

Source: Author's compilation from Bouet (2008)

Table A3.14 Changes in the world welfare from the multilateral liberalization
million USD

	World welfare
Total	239204.3
Agricultural	58010.0
Non-agricultural	182155.2

Source: Author's simulations

4. AGRICULTURAL TRADE COSTS AND THEIR IMPACT ON TRADE AND WELFARE IN MONGOLIA

4.1. INTRODUCTION

A high number of livestock per capita and vast amounts of pastoral land give Mongolia a comparative advantage in producing livestock products. According to the revealed comparative advantage (RCA) index introduced by Balassa (1965), Mongolia has a comparative advantage in producing meat and meat products, animal skins, hides, wool, and cashmere. However, Mongolia's export share of these livestock products in the world markets, with the exception of cashmere, is negligible. In addition, its share of agricultural exports in total exports has been declining, from a peak of 38% in 1999 to 4% in 2011, whereas its total trade has been increasing.

A variety of factors have contributed to Mongolia's declining agricultural export share, including its recent mining boom, traditional and backward agricultural production technology, and poor infrastructure. Of the many factors, this chapter focuses on trade costs as a major obstacle to agricultural trade. The objective of the chapter is to quantify the

overall agricultural trade costs and measure their impact on both trade and welfare in Mongolia.

There are a few explanations as to why high trade costs are a significant barrier to agricultural trade in Mongolia. First, agriculture is more protected than non-agriculture. Second, since Mongolia is a landlocked country with poor infrastructure, trading across its borders is a costly operation. According to the World Economic Forum (2012), the cost to export one standard container is 2,265 USD for Mongolia, which ranks 118 out of 132 countries. Moreover, the percentage of paved roads in the country is one of the lowest in the world, ranking 131 out of 132 countries. Consequently, Mongolia lacks quality transport services for bulky and perishable agricultural commodities that require timely delivery. Third, many of Mongolia's food and agricultural commodities are subject to strict product standard requirements of export markets. Therefore, lack of standardization in Mongolia further impedes its agricultural trade potential. Finally, understanding the magnitude of trade costs is important when formulating policy interventions to reduce such costs and improve the positive effects of trade liberalization.

Broadly defined, trade costs include trade policy barriers and transportation costs, as well as all the other costs incurred in the exchange of goods across borders. Thus, it becomes difficult to measure the overall trade costs because many of the cost components

are not observable. Nevertheless, existing literature emphasizes the importance of accounting for the total trade costs rather than just a few observable components (Anderson and van Wincoop, 2004).

Therefore, this chapter attempts to quantify the overall agricultural trade costs for Mongolia with its major trading partners, namely, China, Italy, Japan, Korea, Russia, Switzerland, the United Kingdom, and the United States. These countries jointly accounted for 97% of Mongolia's agricultural exports in 2007. To measure the overall trade costs, an approach developed by Novy (2013) is applied, which has remedied two particular limitations of previous studies: the partial coverage of trade costs and the arbitrary trade cost functional form. In addition, the approach uses readily observable trade data, which provides an opportunity to extend the trade cost literature to developing countries like Mongolia, where quality data are lacking.

In addition, this chapter aims to measure the impact of trade costs on both trade and welfare by using the measure of overall trade costs. For this, an Armington-type partial equilibrium model motivated by Francois and Hall (1997, 2003) is applied. However, the model is modified in this study to capture the total trade costs rather than just tariffs.

The structure of the chapter is as follows. Section 4.2 briefly reviews the literature on trade costs. Section 4.3 describes the methodologies and data used. Section 4.4 presents

and discusses the results, and Section 4.5 concludes the chapter.

4.2. LITERATURE REVIEW

A significant amount of research has been dedicated to measuring trade costs. Yet, a comprehensive measure, covering many countries over a long period, is still lacking. The main reason for this lack is that trade costs are difficult to measure because many of the components are not observable. In addition, even for those components that can be directly measured, availability is often scarce and the quality is debatable.

Trade costs are usually inferred from trade flows by using the gravity model. Frequently used variables for trade costs in the gravity model literature include distance, a common border, a common language, and tariffs, largely because these data are more available than other measures such as non-tariff barriers, transportation costs, infrastructure quality, and administrative burdens at borders.

Trade policy related barriers such as tariffs have been of particular interest to policy researchers. With the increasing availability of tariff data for both developed and developing countries, the gravity model has been applied to estimate the effects of trade policy on trade flows. The effects of tariff liberalization have been studied by including two types of policy

variables: membership of a preferential trade agreement (PTA) and applied tariff rates. Most of such studies find a significantly negative impact of tariffs and a positive effect of PTAs on bilateral trade.

However, the relative importance of tariffs has been decreasing on account of trade liberalization efforts in both bilateral and World Trade Organization (WTO) frameworks. Simultaneously, the use of non-tariff measures (NTMs) is increasing (World Bank and International Monetary Fund, 2008). Hoekman and Nicita (2011) demonstrated that the more developed countries use NTMs to regulate trade. NTMs also tend to be more concentrated in a few major industries that are relatively significant to the trade of developing countries, such as food, agriculture, and textiles (Anderson and van Wincoop, 2004). Owing to the scarcity of reliable data and difficulty of modeling endogenous NTMs, empirical evidence on the impact of product standards and technical regulations on trade is scarce. In one of the few papers on the subject, Otsuki et al. (2001) estimate that a 10% rise in restrictiveness could reduce trade by 11% in the case of European standards on African groundnut exports. Moreover, Disdier et al. (2008) find that standards and technical regulations decrease trade between developing and developed countries.

Consistent with the fact that trade policy barriers, particularly tariffs, have decreased worldwide, empirical studies have proven that non-trade policy related costs

have become more important. Even if all the trade policy barriers are removed, there would still be trade costs associated with the environment. The most commonly used variable to account for such trade barriers in the gravity model literature is the physical distance between importing and exporting countries. This distance is considered to be a good proxy for transportation costs. Empirical estimates of the gravity model often yield a significant and negative coefficient for the distance variable, ranging from -0.7 to -1.2 (Disdier and Head, 2008). The significance of the distance is also persistent over time (Brun et al., 2005). However, the main drawback of the distance variable is that it is time-invariant while transport costs vary across time and commodities.

Furthermore, transport costs differ by geography and quality of infrastructure. For instance, a main mode of transportation in landlocked countries is road transport, which is more expensive than ocean transport. Conversely, maritime transportation is more important for coastal countries. Recently, more studies are focusing on transport infrastructure. For instance, Coulibaly and Fontagné (2006), Buys et al. (2006), and Shepherd and Wilson (2007) show that road quality significantly increases the gains from trade. Studies by De (2005, 2006) find that port efficiency and infrastructure quality determine the magnitude of trade costs.

Other types of trade costs include information costs, bureaucratic procedures when

crossing borders, corruption, poor governance, and transparency. Technological progress in telecommunication, which has resulted in decreased communication costs, boosted world trade in the last quarter of the 20th century (Fink et al., 2002). Anderson and Marcouiller (2002) claim that weak institutions serve as a barrier to trade by rendering trading across borders extremely risky because of imperfect contract enforceability. Furthermore, Francois and Manchin (2007) indicate that strong institutions in terms of size of government, freedom of trade, protection of property rights, and business regulation increase trade at both extensive and intensive margins.

The major disadvantage of these studies is that they consider only a few directly measurable components of trade costs, leaving many other components unmeasured. Therefore, trade costs inferred from the gravity model are only a partial indicator of true trade costs. In addition, existing studies assume an arbitrary functional form for trade costs, which could yield misleading results for trade costs (Anderson and van Wincoop, 2004).

In order to overcome these problems—incompleteness and arbitrariness—with direct measures of trade costs, Novy (2013) proposes an analytical method to derive the total bilateral trade costs by using a theoretical gravity model. His analytical solution relies on the intuition that trade costs affect not only international trade but also intra-national trade. Novy (2013) empirically tests his method by using trade data from the United States

and its major trading partners during the period 1970–2000 and finds that US bilateral trade costs with its two major trading partners (Canada and Mexico) decreased during this period. In addition, he finds that much of the US trade growth can be attributed to the decrease in trade costs.

While the benefits of Novy's (2013) method are attractive, it is not free from drawbacks. The method is prone to data quality and measurement errors, as trade costs are solved analytically rather than estimated. However, the measurement error problem can be overcome by checking the validity of the derived trade cost variable by linking it to observable trade cost components.

4.3. METHODOLOGY AND DATA

4.3.1. Methodology

Two approaches are used in this study. First, a tariff-equivalent measure of trade costs is derived based on the Anderson and van Wincoop's (2003) micro-founded gravity model. The methodology to derive the measure of trade costs closely follows the analytical method developed by Novy (2013). Second, using the derived measure of trade costs, the impact of trade costs on trade and welfare are simulated within a partial equilibrium framework. The

partial equilibrium simulation model used in this chapter is based on the spatial partial equilibrium model developed by Francois and Hall (1997). However, the model of Francois and Hall is modified to capture the total trade costs rather than just tariffs.

4.3.1.1. The micro-founded measure of trade costs

Anderson and van Wincoop (2003) develop a multi-country general equilibrium model of international trade, and derive the following micro-founded gravity equation with trade costs:

$$x_{ij} = \frac{y_i y_j}{y^W} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma} \quad (4.1)$$

where x_{ij} is the nominal exports from country i to country j , y (indexed over countries) is the nominal income of countries i and j , and y^W is the world income, defined as $y^W \equiv \sum_j y_j$. The elasticity of substitution across goods, σ , is assumed to be greater than 1. t_{ij} represents the bilateral trade costs, and Π_i and P_j are the outward and inward multilateral resistance terms, respectively.

The multilateral resistance terms are not observable. Therefore, the estimation of trade costs requires additional assumptions, such as symmetric trade costs and a certain functional form of trade costs. These additional assumptions can be easily violated. To overcome these drawbacks, Novy (2013) proposes an analytical solution for multilateral

resistance terms without imposing trade cost symmetry or any particular functional form of trade costs.

Novy's (2013) analytical method assumes that bilateral trade costs affect both international trade and domestic trade. If country i 's trade costs with all other countries decrease, some of the goods domestically produced and traded will be shipped to foreign countries. With this assumption, equation (4.1) is rewritten for domestic trade and solved for the product of multilateral resistance terms as follows:

$$\Pi_i P_i = \left(\frac{x_{ii}/y_i}{y_i/y^W} \right)^{\frac{1}{(\sigma-1)}} t_{ii} \quad (4.2)$$

which implies that for any given value of t_{ii} , the multilateral resistance terms can be inferred from readily observable trade data.

To solve for explicit bilateral trade costs, equation (4.1) is multiplied by the gravity equation for trade flows in the opposite direction, x_{ji} . This gives us the bidirectional gravity equation, which contains the inward and outward multilateral resistance variables for both countries:

$$x_{ij} x_{ji} = \left(\frac{y_i y_j}{y^W} \right)^2 \left(\frac{t_{ij} t_{ji}}{\Pi_i P_j \Pi_j P_i} \right)^{1-\sigma} \quad (4.3)$$

Substituting equation (4.2) for $\Pi_i P_i$ and $\Pi_j P_j$ and then rearranging yields

$$\frac{t_{ij} t_{ji}}{t_{ii} t_{jj}} = \left(\frac{x_{ii} x_{jj}}{x_{ij} x_{ji}} \right)^{\frac{1}{\sigma-1}} \quad (4.4)$$

Equation (4.4) does not impose any symmetry on trade costs. Taking the geometric mean of

trade costs in both directions and subtracting 1 yields an expression for the tariff equivalent of trade costs:

$$\tau_{ij} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}} \right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}} \right)^{\frac{1}{2(\sigma-1)}} - 1 \quad (4.5)$$

where τ_{ij} denotes the tariff equivalent of bilateral trade costs relative to domestic trade costs. Equation (4.5) implies that if the bilateral trade flows, $x_{ij}x_{ji}$, have increased relative to domestic trade flows, $x_{ii}x_{jj}$, then either trading internationally must have become easier or trade costs must have fallen. Therefore, equation (4.5) captures the trade costs indirectly from observable domestic and international trade data.

Once the measure of trade costs is derived, it is possible to check the relationship between the computed trade costs and the common trade cost proxies from the gravity literature. To do so, the following gravity-type model of trade costs is estimated:

$$\tau_{ijt} = d_{ij}^{\delta_0} e^{(\delta_1 border_{ij} + \delta_2 landlock_{ij} + \delta_3 island_{ij} + \delta_4 language_{ij})} tariff_{ijt}^{\delta_5} infra_{jt}^{\delta_6} \quad (4.6)$$

where d_{ij} is the distance between countries i and j , $border_{ij}$ and $language_{ij}$ are dummy variables indicating whether the countries share a common border and a common official language, respectively; $landlock_{ij}$ and $island_{ij}$ are the dummy variables indicating whether either partner is a landlocked or an island country, respectively; $tariff_{ijt}$ is the ad valorem tariff rate imposed by country j on country i 's goods at time t ; and $infra_{jt}$ is the importing country's infrastructure index.

4.3.1.2. *The partial equilibrium model of trade costs*

From the analytically derived measure of bilateral trade costs, the impact of trade costs on trade and welfare can be simulated. The model applied in this chapter is motivated by a spatial partial equilibrium model formulated by Francois and Hall (1997) and further developed as a global simulation model (GSIM). The GSIM is an industry-focused, multiple-market, partial equilibrium model of tariff liberalization, and is modified here by including total bilateral trade costs rather than just tariffs.

Let us assume the Armington-type preferences, where each country is endowed with n goods differentiated by their country of origin. These n goods are imperfect substitutes with a constant elasticity of substitution (CES). The elasticities of demand and supply are assumed to be constant. The Armington composite good in country i is defined as a CES composite of domestic goods and imports:

$$q_i = \left[\sum_{j=1}^n \alpha_{ij} X_{ij}^\rho \right]^{1/\rho} \quad (4.7)$$

where i and j are the indexes of the goods (countries); α_{ij} is the CES weight, or the share of country j 's imports in country i 's total trade; and $\rho = 1 - 1/\sigma$, where σ is the elasticity of substitution between the goods. The price index of the composite good, q_i , is

$$CP_i = \left[\sum_{j=1}^n \alpha_{ij}^\sigma P_{ij}^{1-\sigma} \right]^{1-\frac{1}{\rho}} \quad (4.8)$$

where P_{ij} is the price of good j in country i .

From the first-order conditions, the demand for good j in country i is

$$\begin{aligned} X_{ij}^D &= \left(\frac{\alpha_{ij}}{P_{ij}} \right)^\sigma \left[\sum_{i=1}^n \alpha_{ij} C P_i^{1-\sigma} \right]^{-1} Y_i \\ &= \left(\frac{\alpha_{ij}}{P_{ij}} \right)^\sigma C P_i^{\sigma-1} Y_i \end{aligned} \quad (4.9)$$

where Y_i is the expenditure on composite good q_i , defined as $C P_i q_i$. The combination of equation (4.9) and the supply equation defines a non-linear system for the focus market in terms of prices. The supply equation can be specified with a constant supply elasticity

$$X_j^S = k_{Sj} P_j^{*\varepsilon_j} \quad (4.10)$$

where k_{Sj} is the supply function constant term, P_j^* is the world price, and ε_j is the supply elasticity.

In the presence of trade barriers, the relationship between the domestic and world prices is given by

$$P_{ij} = P_j^* (1 + tr_{ij} + w_{ij}) \quad (4.11)$$

where P_j^* is the world price of good j , tr_{ij} is the ad valorem tariff rate on good j imposed by country i , and w_{ij} is the trade costs other than the tariffs between i and j . Here, w_{ij} is defined as the analytically derived trade costs, τ_{ij} minus tr_i .

The market clearing condition for the model ensures that there is no excess demand in each product market, so it is defined as

$$\sum_{i=1}^n \left[\left(\frac{\alpha_{ij}}{P_{ij}} \right)^\sigma C P_i^{\sigma-1} Y_i \right] = k_{Sj} \left(\frac{P_{ij}}{1 + tr_{ij} + w_{ij}} \right)^{\varepsilon_j} \quad (4.12)$$

The partial equilibrium model is closed by defining the demand for the composite good and the zero excess demand condition for the composite good as follows:

$$q_i = ka_i \cdot CP_i^{\sigma A} \quad (4.13)$$

$$ka_i \cdot CP_i^{\sigma A} - Y_i = 0 \quad (4.14)$$

The system of equations (4.7)–(4.14) is solved for prices using General Algebraic Modeling System (GAMS) software. This solution for prices is then used to solve for quantities and welfare changes.

4.3.2. Data

The trade cost measure is constructed for Mongolia's agricultural trade with its eight major trade partners, namely, China, Italy, Japan, Korea, Russia, Switzerland, the United Kingdom, and the United States. The construction of the trade cost measure requires data on international and domestic trade of agricultural commodities. Agricultural exports data are obtained from the World Bank's WITS database. Agricultural exports include all commodities classified as agriculture according to the Standard International Trade Classification (SITC) Revision 3 nomenclature standard product group. Domestic trade is calculated as the difference between the total domestic production of agricultural commodities and agricultural exports. The agricultural production data are taken from the

FAOSTAT.

To link the derived trade cost measure with the common trade cost proxies, a broader sample of countries is considered. Here, data cover Mongolia and its 57 trading partners for the period 1996–2007 (the list is provided in Appendix to Chapter 4). Owing to missing values, the panel is unbalanced. Tariff data are obtained from the Trade Analysis and Information System (TRAINS) database within WITS. Trade cost proxies, such as distance, border, and access to sea, are obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) website. The infrastructure index for the importing country is constructed as an average of the density of the road network, paved road network, rail network, and number of telephone lines per person, following Limao and Venables (2001). The infrastructure variables are taken from the World Bank's World Development Indicators online database.

The computation of the trade cost measure and the partial equilibrium model depend on the following behavioral parameters: the elasticity of substitution, demand elasticity, and supply elasticity. As indicated by Anderson and van Wincoop (2004), the elasticity of substitution commonly takes a value between 5 and 10, and they use the intermediary value of 8 in their estimates. Other authors, including Novy (2013), follow Anderson and van Wincoop (2004), also using the value 8 for σ . Therefore, the computation

and simulation in this chapter also apply the value 8 for σ . The upper and lower bounds are used to check the sensitivity of the results. For the demand and supply elasticities, the GTAP elasticities are used.

4.4. RESULTS AND DISCUSSIONS

4.4.1. Main results

The measure of trade costs for Mongolia's agricultural trade with its eight major trading partners is computed for the period 1996–2007 (Table 4.1). Mongolia's bilateral agricultural trade costs with its major trading partners show a downward trend. Nevertheless, the decline in its bilateral agricultural trade costs exhibits considerable heterogeneity across countries. The costs of trading with Italy show the largest decline (59%), followed by Korea (41%), Russia (32%), and Japan (30%). One reason for the decrease in Mongolia's trade costs was its accession to the WTO in 1997, which provided guaranteed and safe access to foreign markets. The entry to the WTO also bound the tariff rates that Mongolia's exports face. In addition to the WTO schemes, the European Union's (EU) GSP Plus has granted Mongolia tariff-free access to the EU market since 2006. The EU GSP Plus covers about 7,200 products from the developing countries, of which cashmere and its related commodities

have provided the most benefit to Mongolia.

Table 4.1 Ad-valorem tariff equivalent of bilateral agricultural trade costs for Mongolia

Partner countries	Tariff equivalent, %		Percentage change
	1996	2007	
China	117.3	107.5	-8.4
Italy	320.0	130.5	-59.2
Japan	283.6	199.6	-29.6
Korea	262.1	155.8	-40.5
Russia	138.8	94.5	-32.0
Switzerland	238.7	190.1	-20.4
United Kingdom	130.8	111.4	-14.9
United States	201.4	198.1	-1.6

Source: Author's calculation

Currently, Mongolia is the second largest raw cashmere exporter in the world, after China, with most of the exports to the EU, particularly Italy. The cashmere and wool trade from Mongolia to Italy has increased dramatically since Mongolia's accession to the WTO in 1997 and has soared further since the GSP Plus. At the domestic level, the production of cashmere has grown significantly with the incentives created by the privatization of livestock during the 1990s and the high returns from cashmere production. Consequently, cashmere has become the third largest export commodity, in terms of value, after copper and gold. The country's exports of cashmere to Japan and Korea have also increased since 1997.

The trade cost measure captures both cost components that can be observed and

those that cannot be observed. To check how the trade cost measure is related to the common trade cost proxies, the regression model of Equation (4.6) is estimated in the log-linear form. As the trade cost measure is created by embodying multilateral trade resistance, it is not necessary to include country-fixed effects in our regression model. Instead, regression (4.6) is estimated using a random-effects model based on the Hausman test. The regression model is applied to the unbalanced panel data for Mongolia and its 57 partner countries for the period 1996–2007 (Table 4.2).

Table 4.2 Regression of agricultural trade costs on trade cost proxies

	Coefficient	t-stat
Common border dummy	-0.26 ***	-8.91
Common official language dummy	-0.17 ***	-6.77
Log of distance	0.13 ***	18.83
Landlockedness dummy	0.20 ***	14.96
Island dummy	-0.13 ***	-8.36
Log of infrastructure quality of importer	-0.05 ***	-4.00
Log of applied tariffs by importer	0.04 ***	29.97
Constant	-0.26 ***	-4.40
Number of observations	16,368	
R-squared	0.33	

Source: Author's estimation

Notes: Panel data random effects estimates. The dependent variable is the log of the tariff equivalent of the trade cost measure.

*** indicates statistical significance at the 1% level.

The results show that all the independent variables are highly statistically

significant and of expected signs. Adjacency and a common official language are associated with lower trade costs. In addition, island countries tend to have lower trade costs as a result of their direct access to the sea and cheaper maritime transport costs. In contrast, being landlocked is positively related to trade costs. The distance between trading partners is correlated with higher trade costs. The effect of distance is much higher than the effect of tariffs. The results imply that a 1% increase in the distance between any two trading partners raises trade costs by 13%, as compared to a 4% increase imposed by tariffs. The quality of infrastructure of the importing country decreases trade costs. Trade costs are likely to decrease by 5% if the infrastructure quality improves by 1%.

Although agricultural trade costs are declining, they are still much higher than the costs of trading manufactured goods. For instance, Novy (2013) computes the trade costs for aggregate trade by combining both agricultural and manufactured goods and finds that the average trade costs from 1970 to 2000 were between 94% and 144%.

High agricultural trade costs have large welfare implications in Mongolia. In the absence of data for NTMs and other cost components that are not observable, the computed trade cost measure provides a good insight into the changes in welfare due to a reduction in trade costs. Therefore, by utilizing the computed trade cost measure, a partial equilibrium analysis of Mongolia with its eight major trading partners is used to evaluate impacts of

trade costs.

The partial equilibrium model is calibrated to the base year 2007 data, and the elasticity of substitution between the domestic and imported goods is set at 8, to be consistent with the measure of trade costs. The following three scenarios are established to simulate the effects of trade costs:

- ✧ Scenario 1: a 100% tariff cut in agricultural commodities in all countries
- ✧ Scenario 2: a 50% tariff cut and 50% cut in trade costs in all countries
- ✧ Scenario 3: a 100% tariff cut and 50% cut in trade costs in all countries

The model results are presented in Table 4.3. Tariff reduction alone has a relatively small impact, whereas a tariff reduction coupled with a decrease in trade costs yields a greater impact on prices and trade. In addition, removing tariffs without reducing trade costs may have a trade diversion effect for Mongolia's agricultural trade. Since the model used in this study takes into account the substitution effect between imported goods from different countries, a uniform tariff removal in all countries of interest results in switching from more costly to less costly trading partners. The detailed trade effects for partner countries are shown in Table A4.1–Table A4.3 in Chapter 4 Appendix.

In contrast, removing tariffs and reducing the trade costs increase both exports and imports with all the trade partners. The effect of trade costs is much more visible than that of

tariffs alone. As exports rise by a greater magnitude, the domestic sales of domestic goods fall in all three scenarios.

Table 4.3 Changes in key indicators in Mongolia, percentage change from the base

	Base	Scenario 1	Scenario 2	Scenario 3
Composite good price	1.0	-2.2	-21.3	-22.9
Composite good	477.9	0.5	4.9	5.3
Domestic sales	317.2	-1.4	-13.6	-14.7
Total exports	224.4	1.9	19.2	20.8
Of which: Exports to				
China	140.9	2.9	19.4	21.7
Italy	48.9	0.6	21.1	21.5
Japan	4.1	0.4	27.1	27.4
Korea	1.0	8.1	22.7	29.6
Russia	16.7	2.3	16.2	17.9
Switzerland	1.6	-4.0	8.4	5.8
United Kingdom	9.5	-4.7	9.3	5.8
United States	1.8	-0.3	24.7	24.4
Total imports	160.7	0.1	3.9	3.6
Of which: Imports from				
China	46.0	0.1	3.7	3.4
Italy	1.2	0.0	5.8	5.5
Japan	1.2	-0.4	10.6	10.0
Korea	20.2	-0.2	7.8	7.4
Russia	84.8	0.2	2.3	2.1
Switzerland	0.03	-0.3	10.1	9.5
United Kingdom	0.5	0.1	4.1	3.8
United States	6.7	-0.4	10.5	10.0

Source: Author's simulation

Notes: Base year trade data are in million USD.

The price of the composite good falls in all the three scenarios. The change in prices resulting from the reduction in tariffs and trade costs has a welfare implication for

producers, consumers, and the government (Table 4.4). The decrease in prices results in consumer surplus gain and producer surplus loss. The tariff reduction results in forgone tax revenues. The total welfare change is the sum of the changes in the consumer and producer surpluses and tax revenues. If the tariffs alone are reduced, the consumer surplus gain is offset by the forgone tax revenues, and the total welfare is negative. However, if the tariff cut is combined with a reduction in trade costs, the total welfare is positive.

Table 4.4 Welfare changes in Mongolia, million USD

	Scenario 1	Scenario 2	Scenario 3
Total welfare	-0.8	75.9	79.3
Of which:			
Producer surplus	-3.5	-24.5	-25.2
Consumer surplus	10.8	104.3	112.5
Tariff revenue	-8.0	-3.9	-8.0

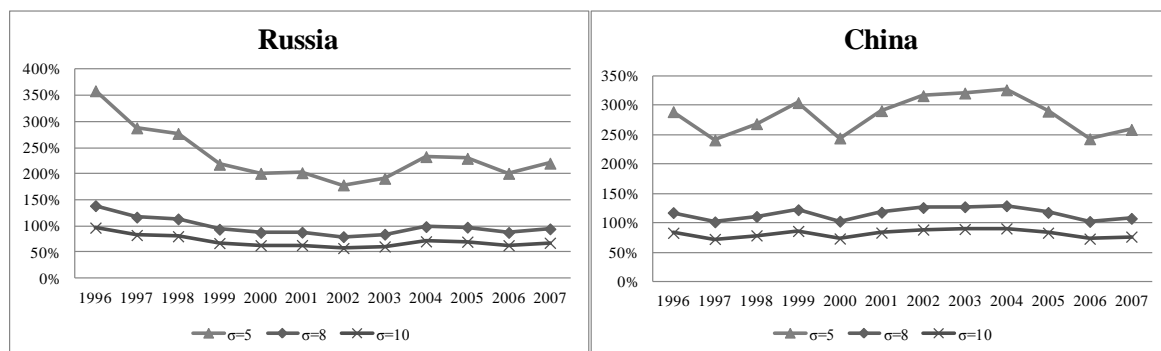
Source: Author's simulation

4.4.2. Sensitivity analysis

Computation of the trade cost measure relies on the choice of value for the elasticity of substitution, σ . The main results are derived by assuming that $\sigma = 8$. However, the elasticity of substitution value may vary across commodities and countries. According to Anderson and van Wincoop (2004), the elasticity of substitution generally takes a value between 5 and

10, and they assume an intermediate value of $\sigma = 8$ in their analysis. Novy (2013) follows Anderson and van Wincoop and also assumes a value of 8. Nonetheless, it is useful to see how sensitive the results are to the chosen value of the elasticity of substitution. This study uses the lower and upper bounds of the elasticity of substitution to check the sensitivity of the results.

Figure 4.1 Sensitivity of agricultural trade costs to the choice of parameter values



Source: Author's calculation

The measure of agricultural trade costs is re-calculated using different elasticity of substitution values for the largest two trading partners, China and Russia, for the period 1996–2007 (Figure 4.1). The results show that the levels of trade cost measure are slightly sensitive to the value chosen for the elasticity of substitution. In particular, lower values yield higher levels of trade costs. However, as the value of the parameter increases, the degree of sensitivity decreases. There is a smaller difference between trade costs computed

with $\sigma = 8$ and $\sigma = 10$. Anderson and van Wincoop (2004) and Novy (2013) observe the sensitivity of the trade cost measure to the value of σ and note that it is typical in various approaches.

Although the levels of trade cost measure are somewhat sensitive to the values of σ , the changes in trade costs over time are almost not affected. For $\sigma = 5$, Mongolia's bilateral agricultural trade costs with Russia decreased by 38% between 1996 and 2007. The same costs decreased by 32% and 30% when assuming $\sigma = 8$ and $\sigma = 10$, respectively. Similarly, the bilateral agricultural trade costs with China decreased by 10.4%, 8.3%, and 7.8%, respectively, for the values $\sigma = 5$, $\sigma = 8$, and $\sigma = 10$. Therefore, the changes in trade costs over time are reasonably robust.

Furthermore, the regression results are not qualitatively affected by the elasticity of substitution values (Table 4.5). The parameter value does not affect the t-statistics of the estimates or the R^2 of the regression. The estimated coefficients show some changes; however, their signs and magnitudes are hardly affected. All the independent variables have the expected signs and are statistically significant at the 1% level. The results look less sensitive for higher elasticity of substitution values. For example, a 1% increase in tariffs raises the trade costs by 4% and 3%, respectively, when assuming $\sigma = 8$ and $\sigma = 10$. Also, the distance elasticity of trade costs is 13% and 10% for $\sigma = 8$ and $\sigma = 10$, respectively. In

general, it seems that continuous variables are less sensitive to the parameter value than the dummy variables. The sensitivity of the dummy variables is consistent with the sensitivity of the levels of trade costs, as the interpretation of the dummy variables is based on the mean value of trade costs.

Table 4.5 Sensitivity of regression results of trade cost measure

Trade costs	$\sigma=5$	$\sigma=8$	$\sigma=10$	t-stat
	Coefficient	Coefficient	Coefficient	
Common border dummy	-0.45 ***	-0.26 ***	-0.20 ***	-8.91
Common official language dummy	-0.30 ***	-0.17 ***	-0.13 ***	-6.77
Log of distance	0.23 ***	0.13 ***	0.10 ***	18.83
Landlockedness dummy	0.35 ***	0.20 ***	0.15 ***	14.96
Island dummy	-0.22 ***	-0.13 ***	-0.10 ***	-8.36
Log of infrastructure quality of importer	-0.10 ***	-0.05 ***	-0.04 ***	-4.00
Log of applied tariffs by importer	0.08 ***	0.04 ***	0.03 ***	29.97
Constant	-0.45 ***	-0.26 ***	-0.20 ***	-4.40
Number of observations	16,368			
R-squared	0.33			

Source: Author's estimation

Notes: Panel data random effects estimation. The dependent variable is the log of the tariff equivalent of trade cost measure.

*** indicates statistical significance at the 1% level.

4.5. CONCLUSION

An important factor that impedes agricultural trade in Mongolia is high trade costs.

Therefore, this chapter aimed to quantify agricultural trade costs and their impact on trade

and welfare in Mongolia. The combination of an innovative new approach proposed by Novy (2013) and the Armington-type partial equilibrium model motivated by Francois and Hall (1997, 2003) allowed the extension of the trade cost literature to Mongolia, where components of trade costs are difficult to measure. It is believed that the overall agricultural trade costs measure can serve as a good proxy for policy formulation when direct measures of trade costs are lacking.

The results demonstrate that agricultural trade costs are decreasing over time in Mongolia, although they are still considerable. While a reduction in tariffs alone has mixed results because of substitution effects between imported goods from different countries, a decrease in overall trade costs increases both trade and welfare in Mongolia.

The computation of the trade cost measure relies on the choice of value for the elasticity of substitution. In general, the results show that the sensitivity of the trade cost measure fades away as the elasticity of substitution value increases. Although the levels of trade costs are sensitive to smaller elasticity of substitution values, the changes in trade costs over time are hardly affected. The direction of the relationship between the trade cost measure and observable cost components is not influenced by the parameter value. In addition, for higher elasticity of substitution values, the magnitude of the relationship is even less sensitive.

APPENDIX TO CHAPTER 4

List of countries in the regression analysis

Australia	Greece	Luxembourg	Saudi Arabia
Austria	Hungary	Malaysia	Singapore
Belarus	India	Mexico	Slovak Republic
Belgium	Indonesia	Mongolia	Slovenia
Canada	Iran	Nepal	South Africa
China	Ireland	Netherlands	Spain
Colombia	Israel	New Zealand	Switzerland
Cyprus	Italy	Norway	Thailand
Czech Republic	Japan	Pakistan	Turkey
Denmark	Jordan	Panama	Ukraine
Egypt	Kazakhstan	Poland	United Kingdom
Finland	Korea	Portugal	United States
France	Kyrgyz Republic	Qatar	Yemen
Georgia	Lebanon	Romania	
Germany	Lithuania	Russia	

Table A4.1 Scenario 1: Changes in trade, percentage change from the base

Importer \ Exporter	China	Italy	Japan	Korea	Mongolia	Russia	Switzerland	United Kingdom	United States
China	-0.1	4.1	5.1	4.5	2.9	3.3	3.8	5.7	5.3
Italy	1.7	0.6	2.6	2.5	0.6	1.9	2.7	0.6	2.9
Japan	1.9	2.4	-0.3	2.6	0.4	0.8	2.9	2.3	2.4
Korea	14.1	7.1	12.4	-0.3	8.1	8.3	4.4	13.9	14.1
Mongolia	0.1	0.0	-0.4	-0.2	-1.4	0.2	-0.3	0.1	-0.4
Russia	2.4	3.1	2.5	2.8	2.3	-0.3	3.2	3.5	2.6
Switzerland	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0
United Kingdom	-3.2	-4.7	-2.2	-2.1	-4.7	-3.1	-2.4	-4.7	-1.7
United States	0.5	1.0	0.2	0.5	-0.3	-0.7	1.8	1.6	-0.9

Source: Author's simulation

Table A4.2 Scenario 2: Changes in trade, percentage change from the base

Importer \ Exporter	China	Italy	Japan	Korea	Mongolia	Russia	Switzerland	United Kingdom	United States
China	-0.5	21.5	15.3	16.1	19.4	16.8	24.5	12.6	14.4
Italy	20.8	-1.1	19.4	20.5	21.1	15.9	3.8	1.4	12.4
Japan	15.0	19.9	-0.7	14.9	27.1	21.3	20.7	14.1	13.3
Korea	14.7	19.8	13.7	-1.7	22.7	17.6	24.0	12.0	13.3
Mongolia	3.7	5.8	10.6	7.8	-13.6	2.3	10.1	4.1	10.5
Russia	15.2	15.0	19.7	17.5	16.2	-1.9	14.4	9.8	19.1
Switzerland	6.5	-10.5	3.5	7.3	8.4	-0.8	-14.9	-13.2	-3.4
United Kingdom	2.8	-6.9	4.2	3.4	9.3	1.5	-7.4	-9.3	-3.3
United States	12.0	10.7	11.2	12.3	24.7	18.3	10.4	3.9	-2.6

Source: Author's simulation

Table A4.3 Scenario 3: Changes in trade, percentage change from the base

Importer \ Exporter	China	Italy	Japan	Korea	Mongolia	Russia	Switzerland	United Kingdom	United States
China	-0.6	24.9	18.9	19.4	21.7	19.3	27.9	16.4	18.1
Italy	22.1	-0.8	21.5	22.5	21.5	17.3	5.3	1.8	14.3
Japan	16.4	21.9	-0.9	16.8	27.4	22.0	23.0	15.8	15.0
Korea	24.4	25.5	22.1	-2.0	29.6	23.9	27.9	21.0	22.6
Mongolia	3.4	5.5	10.0	7.4	-14.7	2.1	9.5	3.8	10.0
Russia	16.9	17.3	21.8	19.6	17.9	-2.1	16.7	12.0	21.2
Switzerland	4.0	-12.7	1.0	4.7	5.8	-3.2	-17.0	-15.3	-5.8
United Kingdom	0.5	-9.9	2.6	1.8	5.8	-0.7	-9.3	-12.2	-4.8
United States	12.2	11.3	11.2	12.5	24.4	17.7	11.5	4.6	-3.2

Source: Author's simulation

5. EFFICIENCY AND PRODUCTIVITY OF THE MONGOLIAN AGRICULTURAL SECTOR IN AN OPEN ECONOMY: THE CASE OF THE LIVESTOCK SECTOR

5.1. INTRODUCTION

The Mongolian livestock sector has undergone considerable changes since Mongolia's transition from a command to an open market economy in 1990. With the privatization of livestock, state collectives were broken down into small household farms, which were mostly subsistence-based. Moreover, in the early transition period many newly unemployed from the collapse of state owned enterprises moved to rural areas to earn a livelihood from herding. The urban-rural migration was reversed in the early 2000s, as many herders with a small herd size were unable to survive the consecutive harsh winters of 1999–2002 and the drought in 2003. At the same time, households with large herd sizes were increasing, indicating their successful transition towards a more commercialized livestock production.

One of the major changes in the livestock sector was the withdrawal of direct support from the government. As the physical infrastructure and socio-economic support by

the rural collectives collapsed, livestock production became more “traditional,” that is, extensively managed livestock production depended almost entirely on natural forage (World Bank, 2010). Furthermore, due to lack of maintenance the depreciation of irrigation systems and wells, built during the socialist period, has made livestock herding more vulnerable to weather shocks and associated loss of animals.

Although resumption of the more traditional livestock herding management may be viewed as a step backward from the relatively intensive livestock production management of the socialist period, the current form of livestock production is a rational response of herders to structural changes (World Bank, 2010). Currently, herders have no choice other than expanding the herd size to manage risks and increase output. Moreover, the fact that pastoral land and water resources are kept under state ownership creates no incentive for herders to invest in improving land productivity.

While operating private herding on public land and being subject to environmental risks, Mongolian herders gradually converted into profit-oriented commercial producers in the open market economy. Rapidly increasing the number of livestock, overcrowding pastureland close to markets, and changing herd composition are indications of transition to the commercialization of the sector. Since privatization, most species of livestock have increased with the most significant increase in goat numbers. Understanding the

commercial aspects of the livestock production, as Mongolia opened up for international trade, herders increase goat numbers in response to greater demand for cashmere from China and some EU countries.

However, exports of other livestock products are still negligible, although Mongolia has a comparative advantage in producing livestock products. There are a number of reasons for this, one of which is the low productivity of the sector trying to compete in world markets. Many of the livestock products are subject to sanitary and product standards in the export market, while Mongolian herders lack technology and knowledge to comply with these standards.

In order to transform to a more commercialized production system and successfully participate in the world markets by exploiting comparative advantage in livestock products, the challenge facing the Mongolian livestock sector is to improve productivity and efficiency, and invest in technology. Greater exposure to international trade could bring about agricultural productivity growth through improvements in technical efficiency and technology, and therefore increase exports of livestock products. Agricultural development resulting from greater agricultural productivity and increasing exports could, in turn, reduce rural poverty. For this reason, it is important to study the current level of productivity and efficiency of the sector in relation to market changes and

openness to trade. The relationship between trade and technical efficiency is an empirical question because trade theories do not provide a clear explanation of this link (Rodrik, 1992). Researchers have studied the relationship between trade openness and technical efficiency at the industry or national level, whereas the case of the agricultural sector has rarely been studied with the exception of Shaik and Miljkovic (2011) and Miljkovic et al. (2013). Both studies find no empirical relationship between trade openness and technical efficiency of the agricultural sector. Therefore, this study intends to contribute to the empirical literature of technical efficiency of the agricultural sector and trade openness. In addition, productivity and efficiency analysis in Mongolia is limited to partial indicators of productivity. Moreover, the relationship between trade openness and technical efficiency of the agricultural sector, to the best of the author's knowledge, has not been studied before in the case of Mongolia. Thus, the current study aims to fill these gaps in the literature regarding Mongolia.

The objective of the chapter is to measure technical efficiency and its sources, including trade openness measured by the share of trade in GDP, of the Mongolian livestock sector. A stochastic production frontier analysis and its associated inefficiency model are applied on province-level panel data for the period 2001–2011. Additionally, this study further aims to measure and decompose changes in TFP using the results from the stochastic

frontier analysis (SFA) and the Malmquist TFP index.

The rest of the chapter is organized as follows. Section 5.2 surveys literature on the relationship between trade openness and technical efficiency. Section 5.3 describes the data and methodology. Section 5.4 conducts the hypothesis tests and chooses the empirical model. Section 5.5 derives theoretical consistent results from the estimated stochastic production frontier by imposing monotonicity restrictions on the production function. Section 5.6 discusses the results and section 5.7 concludes.

5.2. LITERATURE REVIEW

The relationship between the trade liberalization and technical efficiency has been studied extensively in both theoretical and empirical literature. According to the neo-classical trade theory, trade protection encourages domestic firms to engage in monopolistic competition and enjoy excess profits. As a result, firms fail to achieve minimum costs, thus, technical efficiency. Furthermore, imperfect competition brings about a waste of scarce resources through rent-seeking activities. The exposure to foreign competition through free trade makes an industry to be less subjective to such symptoms, because the competitive pressure forces firms to minimize costs. Domestic producers could also take

advantage of free trade by exploiting economies of scale and greater elasticity of demand for their products.

The endogenous growth theory provides another possible channel through which trade openness affect efficiency. In the endogenous growth model, domestic innovation and international technology diffusion lead to accumulation of technology. The rate of growth of the domestic innovation depends, in turn, on the level of human capital and the initial technology stock, whereas trade openness brings about international technology diffusion. Openness may generate not only technology diffusion, but also managerial skills and know-how which could affect the growth rate of innovation or the rate of technology adoption. This process, in turn, could boost productivity and efficiency of domestic producers.

However, Rodrik (1992) argues that economic theories do not systematically explain the relationship between openness and efficiency. He claims that protection does not always weaken the incentive for increasing productivity and efficiency. If trade protection provides a larger market share to a firm, it will likely to invest more on technological improvements. Furthermore, Rodrik asserts that the argument of economies of scale is perhaps the strongest reason for productivity improvement; however, it relies on frictionless entry into and exit from industries.

The theoretical uncertainties about the efficiency effects of trade openness necessitate empirical evidence to come up with a conscience. Yet, evidence so far has been conflicting. There are numerous empirical studies that link openness to productivity and/or technical efficiency. Most of these studies are conducted for the manufacturing sector or the aggregate economy level. For example, Karunaratne (2001) finds technical efficiency improves in the Australian manufacturing sector over time with trade reforms, by using a stochastic production frontier model. Chu and Kalirajan (2011) analyze the impact of trade policy measures namely effective rates of protection, nominal rates of protection, and import ratio on the manufacturing firm (in)efficiency level, by using the Battese and Coelli (1995) type of the stochastic frontier approach and detailed firm-level panel data for the Vietnamese manufacturing sector. The authors find that trade liberalization is associated with better firm performance and greater technical efficiency. Hossain and Karunaratne (2004) also find that trade openness measured by export orientation and capital deepening reduces technical inefficiency in the Bangladesh manufacturing sector. However, when dividing manufacturing sectors into export-oriented and import-substituting, the authors find that export-oriented industries experience no change or little increase in efficiency whereas import-substituting industries show a significant increase in their efficiency. Sasidaran and Shanmugam (2008) analyze effects of export intensity, raw material import

intensity, and structural changes for phasing out of quotas on technical efficiency in the Indian textile industry. They find that export intensity improves firm efficiency while imported raw materials reduce efficiency. The impact of the removal of quotas is found to be negative on the overall efficiency of the firms in their paper.

In the case of the agricultural sector, agricultural productivity and efficiency has been a subject to extensive research, however, its direct relationship to trade openness has been rarely studied. An example of studies that link trade openness to technical efficiency of the agricultural sector is Hassine and Kandil (2009) who analyze impacts of trade liberalization on agricultural productivity and poverty in 14 Mediterranean countries. To take account for country heterogeneity, Hassine and Kandil use a latent class stochastic frontier model and find that trade openness improves farm efficiency significantly. For measuring the degree of trade openness, the authors use three variables – total agricultural trade, agricultural trade barriers, and agricultural equipment imports. They further find that efficiency and productivity gain resulted from trade openness is a major source for poverty alleviation.

Conversely, Shaik and Miljkovic (2011) and Miljkovic et al. (2013) find that trade openness has no impact on technical efficiency in the agricultural sector. Shaik and Miljkovic (2011) use aggregate agricultural sector panel data for the United States,

whereas Miljkovic et al. (2013) use data for Brazil. Both studies use the Battese and Coelli (1992) type of stochastic production frontier model with a Cobb-Douglas production function.

While the above studies contribute to the literature of agricultural productivity and efficiency, they have some severe drawbacks that may affect the results they derived. For instance, Shaik and Miljkovic (2011) and Miljkovic et al. (2013), in spite of using the stochastic frontier approach, did not formally test the appropriate functional form for the production technology and the distributional form for the inefficiency term. The choice for the functional and distributional forms could affect significantly the estimated results since there is no *a priori* justification for these forms used in the stochastic frontier models. Moreover, both papers did not check the theoretical consistency of their estimated production function. Theoretically, any production function must be monotonically increasing and quasiconcave in all inputs. Without fulfilling these properties of the production function, estimates using stochastic frontier approach cannot meaningfully interpreted.

Therefore, this study aims to contribute to the limited literature on the relationship between the efficiency and openness in agriculture, by investigating the case of Mongolian livestock sector and formally testing functional and distributional forms, as

well as checking theoretical consistency. In addition, this study will add to the little evidence on the agricultural efficiency in Mongolia. To date, perhaps the only research done on Mongolia's agricultural productivity and efficiency is Bayarsaihan and Coelli (2003) who measure total factor productivity changes in Mongolian grain and potato farming during 1976–1989. Therefore, this study, to the best of the author's knowledge, is the first attempt to analyze productivity and efficiency of the Mongolian livestock sector.

5.3. METHODOLOGY AND DATA

5.3.1. Stochastic frontier analysis

Following Battese and Coelli (1995), the stochastic production frontier and its associated inefficiency model is expressed as equations (5.1) and (5.2).

$$y_{it} = x_{it}\beta + v_{it} - u_{it} \quad (5.1)$$

where y_{it} is the value of gross livestock production in province i at time t , x_{it} are factors of production in province i at time t , β are parameters to be estimated, v_{it} are random error components which are assumed to be independently and identically distributed as $N(0, \sigma_v^2)$, and independent of u_{it} , which are non-negative random variables that account for technical inefficiency in production. u_{it} is assumed to be independently distributed as truncations at

zero of $N(\mu_{it}, \sigma_u^2)$, with

$$\mu_{it} = z_{it}\delta \quad (5.2)$$

where z_{it} are variables that may explain inefficiency, and δ are unknown parameters to be estimated.

The technical efficiency (TE) of herding in each province can be predicted from the estimated production frontier as

$$TE_{it} = \frac{E(y_{it}|u_{it}, x_{it})}{E(y_{it}|u_{it}=0, x_{it})} \quad (5.3)$$

where E is the expectations operator and $TE_{it} \in [0,1]$. It measures the output of livestock production in province i relative to that of the fully efficient province given the same input vector.

5.3.2. Calculation and decomposition of TFP changes

Using the SFA results, the Malmquist TFP index can be constructed to measure TFP change between two periods. The traditional Malmquist TFP index does not capture scale changes.

If an industry of interest is subject to variable returns to scale, the traditional Malmquist index may produce biased results. The problem can be solved by imposing constant returns to scale upon the production technology. However, for sectors such as agriculture where constant returns to scale do not usually hold, it is preferable to include a scale change

component. In this case, the Malmquist TFP index can be composed as

$$TFP_{it} = TEC_{it} \times TC_{it} \times SC_{it} \quad (5.4)$$

where TEC_{it} , TC_{it} , and SC_{it} are the technical efficiency change, technical change, and scale change for i -th province at t -th time respectively, which are computed using the SFA results in equations (5.5), (5.6), and (5.7).

$$TEC_{it} = \frac{TE_{it}}{TE_{i,t-1}} \quad (5.5)$$

To compute the technical change index, we can take the partial derivatives of the production function with respect to time and evaluate at periods t and $t-1$ for each province. Then, the technical change index between two periods is calculated as the geometric mean of these two partial derivatives. For the production function in the log form, the technical change index is the exponential of the arithmetic mean of the log derivatives:

$$TC_{it} = \exp \left\{ \frac{1}{2} \left[\frac{\partial \ln y_{i,t-1}}{\partial (t-1)} + \frac{\partial \ln y_{it}}{\partial t} \right] \right\} \quad (5.6)$$

Following, the scale change index can be expressed as

$$SC_{it} = \exp \left\{ \frac{1}{2} \sum_{n=1}^N [\varepsilon_{ni,t-1} SF_{i,t-1} + \varepsilon_{nit} SF_{it}] \ln(x_{nit}/x_{ni,t-1}) \right\} \quad (5.7)$$

where $SF_{i,t-1} = (\varepsilon_{i,t-1} - 1)/\varepsilon_{i,t-1}$, $\varepsilon_{i,t-1} = \sum_{n=1}^N \varepsilon_{ni,t-1}$ and $\varepsilon_{ni,t-1} = \frac{\partial \ln y_{i,t-1}}{\partial \ln x_{ni,t-1}}$. The subscript n indexes the factors of production.

5.3.3. Data

The data used in this study are obtained from the annual livestock census data collected by the NSO. The data is a panel at the province level consisting of 21 provinces and the capital city (a total of 22 regions) for the period 2001–2011. The descriptive statistics of the variables used are explained in Table 5.1.

Table 5.1 Descriptive statistics of variables

Variable	Measurement	Mean	Std. Dev.	Min	Max
<u>Frontier Production Function</u>					
Livestock production	million 2010 MNT	38,360.3	25,200.7	916.0	114,297.6
Number of herders	thousand persons	16.5	10.1	0.8	40.2
Pasture land	thousand hectare	5,254.9	3,411.0	39.1	14,597.7
Number of total livestock	thousand <i>bod</i> ¹ heads	401.4	229.1	17.1	1,085.4
Fodder	fodder unit ² , ton	23,299.6	20,150.1	276.4	103,535.9
<u>Technical inefficiency model</u>					
Farm size per household	<i>bod</i>	56.2	18.0	22.9	102.2
Share of households with electricity	%	53.7	29.8	2.8	100.0
Share of households with auto vehicles	%	19.9	10.3	3.1	58.5
Share of households with livestock fences	%	69.3	17.1	24.7	100.0
Fodder per livestock	Kg/ <i>bod</i>	76.8	90.4	1.7	482.7
Exposure to trade	%	4.4	11.5	0.2	84.5
Number of observations		242			

Source: Author's computations based on NSO (2013)

Notes: ¹ The total number of five species of livestock is added up on the basis of the *bod* unit, a traditional stock unit used in Mongolia. The transformation coefficients for *bod* units are 1 cattle-1 *bod*, 1 horse-1 *bod*, 1 camel-1.5 *bods*, 6 sheep-1 *bod*, and 8 goats-1 *bod*.

² The NSO measures total amount of fodder by adding up different types of fodder by conversion coefficients. More details can be found at www.nso.mn and www.1212.mn.

The value of livestock production is converted to constant 2010 MNT using the

annual inflation rate data from the World Economic Outlook database (IMF, 2013).

Assuming that each province is exposed to trade proportional to its share in national GDP, the variable “exposure to trade” is constructed as $\text{Trade/GDP} \times \text{province GDP/GDP} \div 100$.

5.4. HYPOTHESIS TESTS

The SFA has several advantages over other methods of inefficiency, including the data envelopment analysis and the deterministic frontier model. The SFA takes account of measurement and other random errors upon the frontier, and allows the estimation of standard errors and hypothesis tests using maximum-likelihood methods, which were not possible with different approaches (Coelli et al., 2005). However, the SFA is also subject to criticisms that there is generally no *a priori* justification for selection of any particular functional form for the production function and distributional form for the inefficiency term. Various functional forms have been used in the literature from Cobb-Douglas to the less restrictive translog production function. Likewise, various distributional forms have been used in the literature from normal distribution to the more general truncated-normal distribution.

Therefore, several formal hypothesis tests are conducted to determine the preferred functional form for the production frontier and the distributional form for the inefficiency term. The results of the hypothesis tests using likelihood ratio tests are presented in Table 5.2.

Table 5.2 Hypothesis tests

Null hypothesis	Log-likelihood	χ^2 statistic	Critical $\chi^2_{v, 0.95}$	Decision
Unrestricted model	184.70			
Cobb-Douglas	140.55	88.29	$\chi^2_{14, 0.95} = 23.68$	Reject H0
No technical inefficiency	112.20	144.99	Mixed $\chi^2_{28, 0.95} = 40.76$	Reject H0
No time trend	81.54	206.32	$\chi^2_{6, 0.95} = 12.59$	Reject H0
Half normal distribution	138.62	92.15	$\chi^2_{28, 0.95} = 41.34$	Reject H0

Source: Author's estimations

Notes: The critical value for the mixed chi-square distribution is taken from Kodde and Palm (1986).

The first null hypothesis that the Cobb-Douglas production function of the following form:

$$y_{it} = \beta_0 + \sum_{j=1}^4 \beta_j x_{jit} + \beta_t t + \beta_d D_d + v_{it} - u_{it} \quad (5.8)$$

is the appropriate specification for the Mongolian livestock sector is tested against the alternative hypothesis of the translog production function

$$y_{it} = \beta_0 + \sum_{j=1}^4 \beta_j x_{jit} + \frac{1}{2} \sum_{j=1}^4 \sum_{k=1}^4 \beta_{jk} x_{jit} x_{kit} + \sum_{j=1}^4 \beta_{tj} t x_{jit} + \beta_t t + \frac{1}{2} \beta_{tt} t^2 + \beta_d D_d + v_{it} - u_{it} \quad (5.9)$$

where y is the log of aggregate livestock production, and x are production inputs that are the log of the number of herders, land, number of livestock, and fodder. t is the time trend, and D_d is the dummy variable used to adjust for the harsh winters or *dzud* (in local language terms) of 2001–2003 and 2009–2010. The maximum-likelihood estimates of parameters of equations (5.8) and (5.9) are estimated using the “R” package “frontier” (Coelli and Henningsen, 2013) within the “R software environment for statistical computing and graphics” (R Development Core Team, 2009). The “R” package “frontier” is based on the programming of the software “Frontier 4.1” (Coelli 1996). The associated inefficiency model is of the type:

$$\mu_{it} = \sum_{j=1}^6 z_{jt} \delta_j + \sum_{k=1}^{21} P_k \delta_{pk} \quad (5.10)$$

where z are variables to explain inefficiency. P_k are dummy variables for province k . The result of the null hypothesis strongly rejects the Cobb-Douglas production function specification in favor of the translog production function.

The second hypothesis that there is no technical efficiency ($H_0: \gamma = \delta_j = \delta_{pk} = 0, j = 1, \dots, 6, k = 1, \dots, 21$) is rejected, indicating that the frontier model is a significant improvement over an OLS function. The third test hypothesis that there is no technical change ($H_0: \beta_{tj} = \beta_t = \beta_{tt} = 0, j = 1, \dots, 4$) is also rejected. Therefore, the data indicates that over time there is technical change in the Mongolian livestock sector. Finally, the null

hypothesis that the technical inefficiency effect has a half-normal distribution ($H_0: \mu = \delta_j = \delta_{pk} = 0, j = 1, \dots, 6, k = 1, \dots, 2$) is rejected in favor of the less restrictive truncated-normal distribution.

Therefore, the empirical model is the translog production frontier of equation (5.9) and its associated inefficiency model given by equation (5.10) with the inefficiency term following the $N(\mu_{it}, \sigma_u^2)$ distribution.

5.5. THEORETICAL CONSISTENCY OF THE ESTIMATED TRANSLOG PRODUCTION FRONTIER

A theoretical consistent estimation of a production function requires monotonicity and quasiconcavity in all inputs. Monotonicity means that the quantity of output must not decrease for any increase in inputs, whereas quasiconcavity implies convex isoquants and decreasing marginal rates of technical substitution. The quasiconcavity condition guarantees that an interior solution to the profit maximization problem exists.

Mathematically, monotonicity requires marginal products (MP) of all inputs to be non-negative, that is

$$MP_i(x, \beta) = \frac{\partial f(x, \beta)}{\partial x} \geq 0, \forall i \quad (5.11)$$

where f is a production function, x are inputs, and β are parameters to be estimated.

Furthermore, quasiconcavity requires that the bordered Hessian matrix of the production function f (twice differentiable) is negative semi-definite. The bordered Hessian matrix of production function f can be defined as:

$$\text{BH} = \begin{bmatrix} 0 & MP_1 & MP_2 & \cdots & MP_n \\ MP_1 & f_{11} & f_{12} & \cdots & f_{1n} \\ MP_2 & f_{21} & f_{22} & \cdots & f_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ MP_n & f_{n1} & f_{n2} & \cdots & f_{nn} \end{bmatrix} \quad (5.12)$$

where $f_{ij} = \partial^2 f / (\partial x_i \partial x_j)$ is the second derivative of the production function with respect to i -th and j -th inputs. The bordered Hessian matrix is negative semi-definite if and only if the determinants of all of its leading principal minors of n -th order have the same sign as $(-1)^n$ or equal to zero. In other words, the necessary and sufficient condition for the bordered Hessian matrix to be negative semi-definite is:

$$|\text{BH}_1| \leq 0, |\text{BH}_2| \geq 0, \dots, (-1)^n |\text{BH}_n| \geq 0 \quad (5.13)$$

where $|\text{BH}_1| = \begin{vmatrix} 0 & MP_1 \\ MP_1 & f_{11} \end{vmatrix}, |\text{BH}_2| = \begin{vmatrix} 0 & MP_1 & MP_2 \\ MP_1 & f_{11} & f_{12} \\ MP_2 & f_{21} & f_{22} \end{vmatrix}, \dots, |\text{BH}_n| = |\text{BH}|.$

Violations of the monotonicity and quasiconcavity properties of the production function in a stochastic frontier analysis lead to over- or under-estimation of the “true” inefficiency and thus result in severe misperceptions (Sauer et al, 2006). In empirical studies, these properties of the production function are often subject to violations in

flexible functional forms such as translog production function. Because the translog function contains quadratic terms that form a parabolic shape, the monotonicity condition could not often be achieved globally. Likewise, the quasiconcavity condition is further violated when the logarithmic transformation of inputs are applied (Sauer et al, 2006).

To check the theoretical properties of the translog production frontier for the Mongolian livestock sector, equations (5.9) and (5.10) are estimated by the maximum-likelihood estimates using the “R” package “frontier” (Coelli and Henningsen, 2013) within the “R software environment for statistical computing and graphics” (R Development Core Team, 2009). The results are reported in Table 5.3.

The monotonicity and quasiconcavity conditions of the estimated translog production frontier of Table 5.3 are checked by using equations (5.11), (5.12), and (5.13) for each input and observation. Results show that 72.7%, 38.8%, 100%, and 86.4% of all observations satisfy the monotonicity condition for “Number of herders”, “Pasture land”, “Number of livestock”, and “Fodder” inputs respectively. However, the quasiconcavity condition is not fulfilled. Therefore, these results cannot be meaningfully interpreted.

Table 5.3 The stochastic production frontier estimation for Mongolian livestock sector (unrestricted)

	Translog Model			Inefficiency Model	
	Coefficient	Std.err		Coefficient	Std.err
Constant	0.09	0.04 **	Farm size per household	0.00	0.00
Number of herders	0.10	0.09 *	Share of households with		
Pasture land	-0.06	0.05	electricity	0.00	0.00
Number of total livestock	0.89	0.09 ***	auto vehicles	0.01	0.00 *
Fodder	0.25	0.03 ***	livestock fences	0.00	0.00
Time trend	0.06	0.01 ***	Fodder per livestock	0.00	0.00 **
Herders ²	0.49	0.26 *	Exposure to trade	-0.01	0.00 **
Herders x Land	-0.20	0.08 **			
Herders x Livestock	-0.20	0.24	Sigma-squared	0.01	0.00 ***
Herders x Fodder	-0.17	0.05 ***	Gamma	0.01	0.00 ***
Herders x Time	0.02	0.01	Log likelihood function	184.70	
Land ²	0.06	0.05			
Land x Livestock	0.22	0.08 **	Mean technical efficiency	0.82	
Land x Fodder	0.01	0.03			
Land x Time	0.00	0.01			
Livestock ²	0.02	0.32			
Livestock x Fodder	0.08	0.06			
Livestock x Time	-0.02	0.02			
Fodder ²	0.16	0.02 ***			
Fodder x Time	0.00	0.00			
Time ²	-0.02	0.00 ***			
<i>Dzud</i> dummy	-0.10	0.02 ***			

Source: Author's estimations

Notes: Maximum likelihood estimates. *, **, and *** denote statistical significance at 10, 5, and 1% levels respectively.

There are several approaches in the literature that restrict coefficients of the translog production function in order to achieve theoretically consistent results. However, imposing theoretical consistency globally destroys the flexibility of the translog production function. In addition, methods to impose monotonicity and concavity are often difficult to implement due to non-linear functional forms and complex inequality constraints. Thus, theoretical consistency has often been disregarded in the efficiency

literature.

Nevertheless, it is important to impose theoretical consistency on the stochastic production frontier estimation for the Mongolian livestock sector as monotonicity and quasiconcavity are not fulfilled. To impose theoretical consistency on the translog production function, a three-step procedure proposed by Henningsen and Henning (2009) is adopted. This method imposes the monotonicity constraint rather than the concavity constraint on the production frontier. The authors argue that the monotonicity property of the production function is more important in measuring technical efficiency than imposing concavity, because technical efficiency is measured assuming that producers maximize output given an input set, but not that producers maximize profits. In addition, even a non-concave point in the production function could reflect profit maximization behavior if prices are endogenous or input uses are restricted. Imposing monotonicity could also improve the curvature condition of the production function. (Henningsen and Henning (2009) show that imposing monotonicity on the translog production function results in monotonicity and quasiconcavity for all observations). Furthermore, this approach has an advantage that it does not destroy the second order flexibility of translog production functions.

The three-step procedure is as follows. In the first step, the unrestricted stochastic

production frontier model (Equation 5.9 and Table 5.3) is estimated. In the second step, restricted parameters are obtained by solving the following constrained optimization problem by minimum distance estimation:

$$\hat{\beta}^0 = \text{argmin}[(\hat{\beta} - \hat{\beta}^0)\hat{\Sigma}_{\beta}^{-1}(\hat{\beta} - \hat{\beta}^0)] \quad (5.14)$$

$$\text{subject to } MP_i(x, \hat{\beta}^0) \geq 0, \text{ for } \forall i, x \quad (5.15)$$

where $\hat{\beta}$ is the vector of parameters of the unrestricted production frontier, $\hat{\Sigma}_{\beta}$ is their covariance matrix, and $\hat{\beta}^0$ is the vector of restricted parameters. In the third step, the efficiency scores of each province are estimated based on the theoretical consistent production frontier as:

$$y_{it} = \beta_0 + \beta_1 \hat{y}_{it} - u_{it} + v_{it} \quad (5.16)$$

$$\text{with } \mu_{it} = \sum_{j=1}^6 z_{jt} \delta_j + \sum_{k=1}^{21} P_k \delta_{pk} + \varepsilon_{it}$$

where y_{it} is the log of output, \hat{y}_{it} is the fitted value of output from the restricted frontier model ($\hat{y}_{it} = f(x, \hat{\beta}^0)$), the rest of the variables are as defined before.

The three-step approach was implemented by using “R” packages namely “frontier” (Coelli and Henningsen, 2013), “micEcon” (Henningsen, 2013), and “quadprog” (Turlach and Weingessel, 2007). The results of the first step are the same as those reported in Table 5.3. Using these parameters, restricted parameters are derived by minimum distance estimation expressed by equations (5.14) and (5.15) in Table 5.4. With the derived

restricted parameters, monotonicity is fully achieved for all inputs except for “Pasture land”, where monotonicity is fulfilled at 94% of observations. In addition, the quasiconcavity condition is satisfied at 83% of observations. Therefore, interpretations based on the restricted production frontier are now theoretically consistent at least at 83–94% of the observations.

Table 5.4 Restricted stochastic production frontier estimates for Mongolian livestock sector

	Translog Model		
	Coefficient	Diff	Diff/std.err
Constant	0.22	0.13	3.17
Number of herders	0.08	-0.02	-0.24
Pasture land	0.00	0.06	1.28
Number of total livestock	0.65	-0.24	-2.63
Fodder	0.27	0.02	0.84
Time trend	0.07	0.01	0.92
Herders ²	0.01	-0.48	-1.86
Herders x Land	0.00	0.20	2.46
Herders x Livestock	-0.03	0.17	0.69
Herders x Fodder	-0.04	0.13	2.63
Herders x Time	0.00	-0.01	-0.81
Land ²	0.00	-0.06	-1.34
Land x Livestock	0.00	-0.22	-2.70
Land x Fodder	0.00	-0.01	-0.24
Land x Time	0.00	0.00	0.59
Livestock ²	0.18	0.16	0.49
Livestock x Fodder	-0.04	-0.12	-1.94
Livestock x Time	-0.01	0.01	0.48
Fodder ²	0.09	-0.07	-2.98
Fodder x Time	0.00	0.00	1.06
Time ²	-0.01	0.00	1.56
<i>Dzud</i> dummy	-0.10	0.00	0.00

Source: Author's estimation

Lastly, efficiency scores of each province are estimated by equation (5.16). The results of the final step are reported in Table 5.5.

Table 5.5 Technical inefficiency model

	Coefficient	Std.err	
Farm size per household	-0.009	0.002	***
Share of households with electricity	-0.001	0.001	
Share of households with auto vehicles	0.015	0.004	***
Share of households with livestock fences	0.003	0.002	
Fodder per livestock	0.003	0.001	***
Exposure to trade	-0.061	0.025	**
sigma-squared	0.020	0.002	***
gamma	0.000	0.000	***
Mean technical inefficiency	0.825		

Source: Author's estimation

Notes: Maximum likelihood estimates. *, **, and *** denote statistical significance at 10, 5, and 1% levels respectively.

5.6. DISCUSSIONS

The translog production function variables are mean-corrected, so that the estimated parameters can be interpreted as production elasticities (evaluated at the sample mean). The sum of the production elasticities (Table 5.4) demonstrates that the livestock sector in Mongolia has constant returns to scale. The production elasticities are dominated by the elasticity of the livestock number. This finding is consistent with the fact that

Mongolian livestock produces constant low yield per animal over time due to high dependence on weather conditions and the livestock production is primarily characterized by large size. The privatization of livestock created incentives for herders to increase their herd size. As there are few investment alternatives, herders invest their surplus income in livestock. Furthermore, the disappearance of the support infrastructure following the collapse of the collectives and consecutive natural disasters led herders to increase the number of livestock to manage risks.

The elasticities of labor and fodder show that each additional unit of these inputs increases livestock production. Conversely, the elasticity of land is insignificant and close to zero. This result may suggest operation in stage 3 of the production function, where adding more land to the livestock production activities does not increase output. In addition, it indicates that a large amount of land is already been used by the sector. Currently, more than 70% of the total land is used for pasture (NSO, 2013). It has been argued recently that the number of livestock has already exceeded the land capacity and over-stocking degrades land productivity, leading to desertification, which in turn decreases productivity of the sector. According to the Ministry of Environment and Green Development of Mongolia, the pasture land capacity is exceeded in approximately 20% of the total pasture land area. Furthermore, nearly 78% of the total land area in Mongolia is affected by desertification,

of which 17% have severe and very severe desertification and soil degradation as of 2010. Still, herders have no incentive to improve land productivity; they merely grow the herd size as the pastoral land belongs to the state, whereas livestock is privatized.

The time trend and its square are both statistically significant. Inclusion of time trend as a measure of technical change suggests technology has been increasing but at a decreasing rate. Technical progress occurred in the livestock sector at the rate of 7% annually. However, the growth rate has been declining by 1% annually. The livestock production declines during the years of the harsh winters or *dzud*.

The technical efficiency is driven by the increased farm size, and exposure to trade (Table 5.5). Particularly, production inefficiency is reduced for each additional stock of animal. According to the World Bank (2010), subsistence-based herders are unable to survive harsh winters; consequently, they are forced to migrate out of the livestock sector. Conversely, herders with a sufficient number of livestock (more than 300 sheep units or approximately 50 *bod* units) can manage to overcome extreme weather conditions and produce marketable surplus. These herders are profit oriented, commercial producers, who rationally respond to changes in markets. In addition, herders with more than 500 sheep units are wealthy, commercial herders, who are the most profitable.

The exposure to international trade reduces farm inefficiency. This indicator can as well be interpreted as a proxy for access to markets. It can be implied that herders have more access or can afford market information, if they are more exposed to markets or international trade. Therefore, these herders have an incentive to create greater marketable surplus, which can easily be exchanged for cash in markets. An example could be cashmere production, which has increased substantially since Mongolia's accession to the World Trade Organization in 1997. Currently, raw cashmere is the most exported livestock product of Mongolia.

The result that fodder per livestock increases inefficiency may be unusual for livestock farms in other countries. However, in the case of Mongolia, this is very likely because animals graze almost exclusively on natural pastureland, while commercial fodder is rare. Fodder production has fallen dramatically since the collapse of state farms. Currently, there are considerable constraints for herders to produce fodder due to the restrictions on public pastureland. Herders often encounter difficulties to obtain permission to cultivate fodder crops and conflicts arise with other herders on the use of land. In addition, herders lack working equipment, machinery, skills, and experience to cultivate land and sow fodder crops. Therefore, only a small amount of natural fodder is prepared for winter. In the case of natural disasters, fodder is often distributed by the state

free of charge as disaster support. Therefore, increasing fodder concentration may indicate the time of a natural disaster.

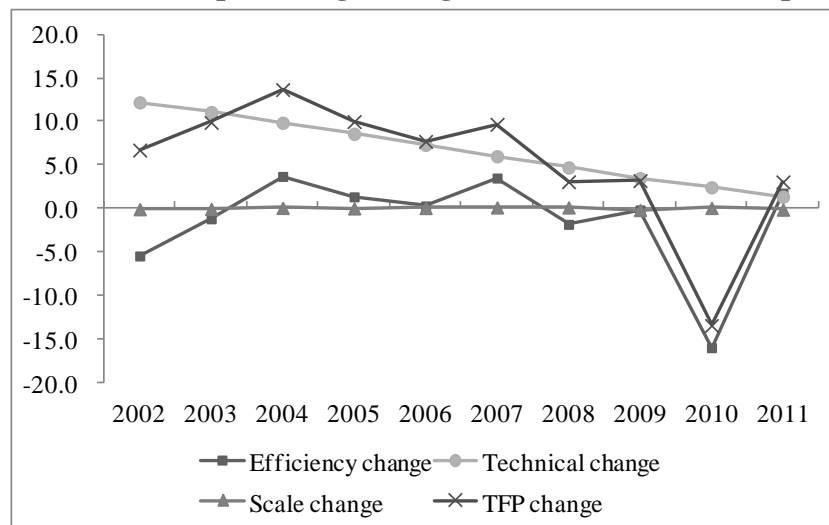
Finally, having an auto vehicle increases inefficiency whereas animal fences and access to electricity have no statistical significance on inefficiency. It should be noted that our data on these variables do not distinguish between type, quality and capacity of vehicles and fences, hours connected with electricity; rather they just provided as an aggregate number. If such data was available, it could be interesting to analyze the effects of different types of vehicles and fences on farm efficiency. With the current data, the statistically significant positive coefficient on auto vehicle may imply that holding an auto vehicle is associated with distance to markets. In addition, poor road infrastructure in rural areas makes it difficult for herders living far away from markets to commercialize.

Moreover, using the results of the stochastic frontier analysis, the Malmquist TFP index is constructed to measure changes in TFP and its decomposition over time. The results are presented in Figure 5.1. Changes by provinces are reported in Table A5.1

The result shows that the TEC is quite stochastic, which is common to the agricultural sector because of its dependence on random variables, such as weather. The TFP change mostly follows the technical efficiency change, as it is the most important component contributing to the TFP. On average, the TFP grew by 5.4% annually during

2001–2011. However, its growth has been declining by approximately 1.6% annually. Therefore, TFP growth has become smaller over time. Peaks in TEC correspond to recovery periods from the *dzud* of 2000–2003, foot and mouth disease of 2006, and *dzud* of 2009–2010. The results also indicate that the recovery after each disaster has become smaller over time. The scale change component shows almost no change during the period. The technical change is progressive, but its growth rate is declining by 1.2% annually, indicating pressing need to invest in technology change in the sector.

Figure 5.1 Annual percentage changes in TFP and its decomposition



Source: Author's computation

5.7. CONCLUSION

An important challenge facing the Mongolian livestock sector is to transform into a more commercialized production system and compete in world markets. Therefore, it has become inevitable to invest in technology and productivity improvement in the sector. This study, to the best of the author's knowledge, is the first study to measure productivity and efficiency of the livestock sector in Mongolia. Furthermore, this study aims to contribute to the empirical literature regarding the link between trade openness and technical inefficiency in the agricultural sector.

The findings suggest that labor, capital livestock, and fodder are important production inputs, whereas pastureland does not add to output. This result indicates that the sector may be operating in stage 3 of the production function; adding land to production activities does not affect the output level. Moreover, overstocking to increase output could have resulted in degradation of pastureland, while the public nature of pastureland discourages herders to invest in land productivity. To improve land productivity and avoid desertification, which further decreases productivity of the livestock sector, proper land tenure rights or land titles should be implemented.

Results from the inefficiency model show that farm efficiency increases with herd size, and greater exposure to trade. Therefore, the results demonstrate that trade openness

is associated with greater efficiency in the Mongolian livestock sector. This may also indicate that herders have increasing incentive to commercialize, if there are markets for their production.

Meanwhile, efficiency is reduced with auto vehicle ownership and fodder per livestock. The result on the fodder per animal may indicate the free distribution of fodder by the state during disaster times, whereas in regular times, animals graze on natural pasture and commercial fodder is rare. To become fully commercialized producers, herders should have access to input markets and credits to obtain working equipment, machinery, and supplementary fodder. Furthermore, they should be trained to gain skills to sow fodder crops as to decrease the dependence on natural forage and reduce risks. Infrastructure development in rural areas is also crucial to help herders to access markets.

The technical efficiency change is quite stochastic because the sector is subject to random shocks such as weather. The TFP change largely follows the technical efficiency change, as it is the most important component of the TFP. During 2001–2011, the TFP grew by 5.4% annually, but at a decreasing rate. Recovery after each disaster has become smaller over time. The technical change is progressive although its growth rate is declining, indicating need to invest in technology change in the sector.

APPENDIX TO CHAPTER 5

Table A5.1 Average percentage changes in TFP and its decomposition by province, 2002–2011

Province	Efficiency change	Technical change	Scale change	TFP change
Bayan-Olgii	-3.21	7.06	-0.03	3.82
Govi-Altai	-2.84	6.58	0.01	3.75
Zavkhan	-1.44	6.36	0.02	4.94
Uvs	-1.84	6.56	0.06	4.78
Khovd	-2.52	6.68	0.04	4.20
Arkhangai	-1.92	6.09	0.15	4.31
Bayankhongor	-0.91	6.29	-0.05	5.34
Bulgan	-2.18	6.35	0.17	4.34
Orkhon	0.00	8.09	0.21	8.30
Ovorkhangai	-2.36	6.42	0.04	4.09
Khovsgol	-1.93	6.25	0.29	4.61
Govisumber	-0.33	7.92	-0.94	6.65
Darkhan-Uul	0.00	8.18	-0.23	7.95
Dornogovi	-0.15	6.20	-0.02	6.04
Dundgovi	0.00	6.34	0.05	6.39
Omnogovi	-0.39	6.54	-0.02	6.13
Selenge	0.00	7.00	0.18	7.17
Tov	-3.18	6.23	0.37	3.42
Dornod	-1.30	6.46	0.12	5.29
Sukhbaatar	-2.14	6.13	0.04	4.04
Khentii	-1.63	6.28	0.18	4.83
Ulaanbaatar	0.00	7.79	0.03	7.82

Source: Author's computations

6. CONCLUSIONS

This doctoral dissertation aimed to assess the impact of trade liberalization and related complementary policies on agricultural trade, growth, and poverty in Mongolia. While trade liberalization involves comprehensive trade policies, it should not be taken in isolation from other domestic policies. In fact, complementary policies are crucial for a country to be able to gain from trade liberalization and achieve overall growth and reduce poverty. Therefore, this dissertation argued that complementary policies aimed to facilitate trade by reducing trade costs and to improve productive capacity of domestic producers are important.

The objective of the dissertation was approached by asking three research questions, which were attempted in Chapters 3–5 respectively, by using innovative new approaches and modifications of them on recent available data for Mongolia.

Chapter 3 aimed to answer the first research question on how different types of trade liberalization affect growth and poverty. Trade liberalization has been implemented unilaterally, bilaterally, and/or multilaterally worldwide. Each type of liberalization is

expected to have a different impact on a country's growth and poverty levels. Chapter 3 further distinguished the types of liberalization into agricultural and non-agricultural reforms. The study applied a macro–micro approach that links the GTAP model with a microsimulation one due to its advantage over a conventional CGE model in that it allows for the estimation of welfare impacts of trade reforms at the household level and addresses household heterogeneities. Welfare effects were estimated across 11,172 sampled households in the Mongolian Household Socio-Economic Survey (HSES) for 2007–2008, and are assumed to be more realistic than representative household CGE models.

The results of the study show that bilateral trade liberalization with China and Russia have more positive effects on growth and poverty reduction than the other types of reforms. Contrary, multilateral liberalization is likely to result in a decline in growth and an increase in poverty in Mongolia. In general, trade liberalization brings overall world welfare gain, but, its impact varies across countries with some economies are better positioned to gain while others are much more vulnerable to adverse effects. There could be several reasons to explain why trade liberalization causes a negative outcome. First, terms of trade deterioration outweighs allocative efficiency gain resulted from trade. This is particularly true in the case of Mongolia because its main exports consist of a few mineral ores and agricultural raw materials whose prices are subject to frequent

fluctuations, and income elasticities are low. Second, erosion of preferences to certain developed countries could occur if such preferential access is granted to all countries equally. Currently, Mongolia is a beneficiary of the US GSP and EU GSP Plus. Third, trade liberalization may reduce tariff revenues accrued to the government, thereby, reducing spending on social safety nets, efforts to reduce macroeconomic stability, and implementation costs of trade reform. Therefore, the results clearly indicate a need for complementary policies if Mongolia is to benefit from multilateral trade liberalization.

Furthermore, the findings in Chapter 3 show that effects of agricultural trade liberalization are generally smaller in magnitude than those of non-agricultural reforms. This may reflect the shrinking share of agriculture in GDP and trade in Mongolia. Yet, all types of agricultural reforms improve total welfare of the country, indicating the importance of agriculture in poverty reduction.

While Chapter 3 considered removals of trade policy related distortions, they are not the only obstacles to trade. Substantial trade liberalization efforts could be hampered by non-trade policy related costs. Even if all trade policy barriers are eliminated, there still exist trade costs related to environment. Considering high trade costs are major impediments to agricultural trade, Chapter 4 quantified the overall agricultural trade costs for Mongolia with its major trading partners, including China, Italy, Japan, Korea, Russia,

Switzerland, the United Kingdom, and the United States. The overall trade costs are derived from micro founded theoretical gravity model by using an analytical method, which has remedied two common problems of gravity model studies of trade costs: the partial coverage of trade costs and the arbitrary trade cost functional form. Another advantage of this method is that trade costs can be computed from readily observable domestic and international trade data. Presently, studies on trade costs are generally limited to developed countries where data on various types of trade costs are available. However, the analytical method provides an opportunity to extend the trade cost literature to developing countries like Mongolia where quality data are scarce.

In addition to being large and variable across time and sectors, trade costs have great implications for welfare. By using the derived measure of overall trade costs, Chapter 4 assesses the impact of trade costs on trade and welfare in Mongolia. For this purpose, an Armington-type partial equilibrium model of trade is modified to include total trade costs. The results demonstrate that agricultural trade costs are decreasing over time in Mongolia, although they are still considerable. A decrease in overall trade costs increases both trade and welfare more than tariff reduction alone in Mongolia.

Except for trade costs, a lack of competitive capacity in domestic producers obstructs agricultural trade potential. Trade liberalization exposes domestic producers to

the fiercely competitive world market. In order to successfully take part in the international market, domestic producers need to increase their efficiency and productivity. Concerning this issue, Chapter 5 measured technical efficiency and its sources, including trade openness, of the Mongolian livestock sector, which has been an important source of livelihood thought-out the Mongolian history. Although its importance has declined in recent years, the livestock sector still employs majority of rural population. Since Mongolia initiated its transition towards democracy and a market economy, important changes have taken place in the sector.

In order to measure productivity and efficiency of the livestock sector, a stochastic production frontier analysis is applied on province-level panel data for the period 2001–2011. The stochastic frontier analysis has a number of advantages over other methods of efficiency and productivity, because it takes account of both measurement errors and random noises upon the frontier and allows the estimation of standard errors and hypothesis tests. Thus, the method is suitable for transition countries like Mongolia where data are likely to have random noises. Moreover, changes in TFP are decomposed using the results from the stochastic frontier analysis and the Malmquist TFP index.

The results demonstrate that trade openness is associated with greater efficiency in the Mongolian livestock sector. In addition, efficiency of the livestock sector increases

as herd size increases. On the other hand, efficiency is reduced with auto ownership and fodder concentration. Changes in the technical efficiency are quite stochastic because the sector is subject to random shocks such as weather. The TFP change largely follows the technical efficiency change, as it is the most important component of the TFP. During 2001–2011, the TFP grew by 5.4% annually, but at a decreasing rate. Recovery after each disaster has become smaller over time. The technical change is progressive; however, its growth rate is declining. Therefore, it would be important to invest in technology change to improve the efficiency and productivity of the sector.

Several policy recommendations could be drawn from the results. As results demonstrate that there would be winners and losers from each type of trade liberalization, complementary policies that help the poor overcome the adverse effects of liberalization should be implemented. For example, investment in human capital may help to alleviate poverty, as the low educated tend to lose in trade liberalization. Moreover, macroeconomic stability policies should be implemented to reduce short-term shocks of trade reforms.

Benefits from trade liberalization could be expanded if non-trade policy barriers are reduced in addition to trade policy barriers. Thus, trade facilitation policies and investment in infrastructure would help reduce trade costs, which in turn, increase agricultural trade and improve welfare. Infrastructure development in rural areas would also

help herders to have access to markets and improve their productivity. Herders should have access to input markets and credits to obtain working equipment, machinery, and supplementary fodder.

The fact that the current production management of the livestock sector is almost exclusively dependent on natural forage makes the sector vulnerable to weather shocks, which lead to increasing rural poverty. Therefore, herders should be trained to gain skills to sow fodder crops as to decrease the dependence on natural forage and reduce risks. The livestock sector would also benefit from agricultural research and extension services to improve declining agricultural technological progress.

The results of the core chapters indicate some directions for future research for Mongolia. Dynamic gains resulting from technical progress and productivity growth may exist that are not being captured by macro-micro model used in Chapter 3. Such dynamic gains can be captured by applying a dynamic CGE model and household survey panel data. A lack of data on some non-tariff barriers such as rules of origin, technical barriers to trade, and sanitary and phytosanitary measures prevents the assessment of their impact on growth and poverty. However, these barriers have become ever more important because tariffs have been reduced successfully worldwide due to increasing bilateralism and multilateralism. Thus, such data is essential for future research on possible impacts of

trade liberalization.

In the absence of data on non-tariff barriers, the measure of overall trade costs derived in Chapter 4 could be used as a proxy. However, it should be noted that the analytical method to derive the measure of trade costs can be sensitive to data noises, although the advantage of using the method for Mongolia is apparent for that it is possible to be computed from readily available data. Therefore, future studies to quantify overall trade costs could be improved by finding a way to build confidence intervals for the measure.

Finally, the efficiency and productivity study for the Mongolian livestock sector could be extended at the farm level if such data become available. Acknowledging these limitations and possibilities for improvements, it is believed that the results of this dissertation provide evidence on the possible growth and welfare impacts of trade policy, and related policies to reduce trade costs and improve productivity of domestic producers in Mongolia.

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