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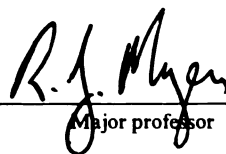
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**THE EFFECTS OF POLICY CHANGES ON SPATIAL GRAIN
MARKET EFFICIENCY IN ETHIOPIA**

presented by

ASFAW NEGASSA MULETA

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**THE EFFECTS OF POLICY CHANGES ON SPATIAL GRAIN MARKET
EFFICIENCY IN ETHIOPIA**

By

Asfaw Negassa Muleta

A DISSERTATION

**Submitted to
Michigan State University
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ABSTRACT

THE EFFECTS OF POLICY CHANGES ON SPATIAL GRAIN MARKET EFFICIENCY IN ETHIOPIA

By

Asfaw Negassa Muleta

Building on the standard parity bounds model (PBM), a stochastic gradual switching model with three trade regimes is developed. The extended parity bounds model (EPBM) improves the standard PBM in two ways. First, it traces the time path of the effect of policy changes on spatial market efficiency and tests whether the effect of the policy changes is instantaneous or gradual. Second, it allows for statistical tests of structural change in spatial market efficiency due to the policy changes. A Monte Carlo simulation experiment is conducted to assess the performance of the EPBM. Then the EPBM is applied to analyze the effect of grain marketing policy changes on spatial efficiency of maize and wheat markets in Ethiopia. The results show that prior to the policy changes there is high probability of spatial inefficiency in maize and wheat markets and the effect of policy changes on spatial market efficiency is not statistically significant in many cases. The cases where policy changes did influence spatial market efficiency have some important implications for the conduct of grain marketing policies in Ethiopia. Furthermore, the nature of observed spatial inefficiency for maize and wheat markets is different implying that the two commodities might require different policy responses in order to improve spatial market efficiency. Maize traders made losses most of the time while wheat traders made excess profits most of the time.

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To Aynalem, Naol, Robsuny and Biruktawit for their love, support and encouragement

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CHAPTER 1

INTRODUCTION

1.1 Background

During the socialist Derg-regime, the Ethiopian government maintained a heavy interventionist approach in its grain marketing policies. Through marketing parastatals and cooperatives, the government controlled grain prices and restricted interregional grain movements and private traders participation in the grain trade. The effects of these policies on the development of grain markets, the agricultural sector, and the national economy have been well studied (e.g. Lirenso, 1987; Franzel et al., 1989; Dadi et al., 1992). In more recent years, however, the Ethiopian government has embarked on various market reform measures to address the problem of poor grain market performance. Many questions remain regarding the speed of adjustment in grain market performance in response to policy changes, and how these policy changes are affecting spatial grain marketing efficiency in Ethiopia.

It has been argued that the management of market reform requires an understanding of the operation of local markets, the strategies and responses of private traders, and how both relate to changes in the institutional and policy environment of markets (Kherallah et al., 2002). Such an understanding is crucial to the design, implementation, and evaluation of marketing policies, institutions, and marketing infrastructure required for the development of grain markets. The key challenge now is to move beyond market liberalization to the issue of how to design input and output markets to catalyze smallholder productivity and income growth (Jayne et al., 2002).

In spatial price analysis, the terms “spatial market efficiency” and “spatial market integration” are very widely used, sometimes interchangeably. However, there has been a growing recognition that these terms are related but not equivalent, and that there is a need to distinguish between them (Fackler, 1996; McNew, 1996; McNew and Fackler, 1997; Fackler and Goodwin, 2001; Barrett et al., 2000; Barrett and Li, 2002). Spatial market efficiency is an equilibrium condition whereby all potential profitable spatial arbitrage opportunities are exploited. Spatial efficiency is concerned with whether the *optimal* amount of trade is occurring. This optimality condition requires that spatial price differentials be less than or equal to transfer costs, equal with trade. If there is no trade, a spatial price differential less than transfer cost is also consistent with spatial market efficiency. However, if the spatial price differential is greater than transfer cost the market is inefficient either with or without trade.

On the other hand, spatial market integration is defined as the extent to which demand and supply shocks arising in one location are transmitted to other locations (Fackler, 1996; McNew, 1996; McNew and Fackler, 1997; Fackler and Goodwin, 2001). Observing direct trade flows between two spatially distinct markets is a sufficient but not necessary condition for some degree of spatial market integration (Barrett et al., 2000; Barrett and Li, 2002). Direct trade linkages between regions are not necessary for spatial integration because if regions belong to a common trading network then price shocks may be transmitted indirectly through the network (Fackler and Goodwin, 2001). Markets that are not well integrated may transmit inaccurate price information that distorts marketing decisions and contributes to inefficient product movements (Goodwin and Schroeder, 1991).

Market integration has usually been conceived in terms of the co-movements or long-run relationship between spatial prices (Fackler, 1996). However, spatial integration is neither necessary nor sufficient for spatial efficiency (and vice versa) so that tests for integration do not always generate the appropriate inference regarding spatial market efficiency (Fackler, 1996; McNew, 1997; McNew and Fackler, 1997; Fackler and Goodwin, 2001; Barrett et al., 2000; Barrett and Li, 2002). The development of the parity bounds model (PBM) represents one attempt to make the distinction between spatial market integration and spatial market efficiency more clear, while overcoming most of the weaknesses of the conventional methods of testing for market integration.¹ When data on prices, transfer costs and trade flows are simultaneously available, the PBM allows a clear distinction between spatial market efficiency and spatial market integration (Barrett and Li, 2002).

1.2 Problem Statement

The effects of policy changes on spatial grain market efficiency can be either instantaneous or gradual. The standard PBM has been used mostly to analyze spatial grain market efficiency within a given (constant) marketing policy regime (e.g. Sexton et al., 1991; Fafchamps and Gavian, 1996; Baulch, 1997; Barrett et al., 2000; Barrett and Li, 2002; Penzhorn and Arndt, 2002). In cases where it has been used to analyze the effects of marketing policy changes on spatial market efficiency, the effect of policy changes is assumed to be instantaneous (e.g. Park et al., 2002). This involves simply estimating a different PBM for different sub-periods, with each sub-period corresponding to a

¹ The weaknesses of the conventional methods to testing market integration are discussed below in Chapter 3.

different policy regime. However, the PBM may be mis-specified and the results and policy implications might be misleading if the actual effect of marketing policy changes on spatial market efficiency is gradual and moves through a transition period, as might be expected in many cases. It may take some time for the traders to learn and understand the new marketing policy changes, assess its implications for reorganizing their businesses, make new investment and disinvestment decisions, and to access resources required to make the necessary adjustments in response to policy changes.

In general, the standard PBM does not allow for a test of a structural change in spatial grain market efficiency due to policy changes. Knowledge of the time path of the effects of market reform on spatial market efficiency would be very useful for properly assessing the effects of marketing policy changes on spatial market efficiency, and for designing marketing policies, institutions and marketing infrastructure. Thus, there is a need to improve and extend the standard PBM so that it allows for gradual transition between spatial market efficiency states as a result of changes in the policy environment, and to develop a test of whether such structural changes in spatial market efficiency are statistically significant. This dissertation addresses both of these needs.

Another problem with implementing the PBM empirically is that time series data on transfer costs are rarely available, particularly in developing countries like Ethiopia. As a result, most empirical PBM studies have assumed transfer costs are equal to a constant plus a serially uncorrelated error for a given marketing policy regime (e.g. Sexton et al., 1991; Fafchamps and Gavian, 1996; Baulch, 1997; Barrett et al., 2000; Barrett and Li, 2002; Penzhorn and Arndt, 2002). However, this assumption is very restrictive, particularly when the PBM is used to analyze the effects of policy changes.

This is because if transfer costs are assumed to be equal to a constant plus a serially uncorrelated error when they actually fluctuate systematically over time, then the PBM may misinterpret spatial price deviations as evidence of inefficiency when they are actually just a rational response to changes in transfer costs. Thus, there is a need to go beyond the conventional transfer cost assumptions and find better ways of using data that are available to construct more appropriate inferences about historical movements in transfer costs. This issue is addressed in this dissertation as well.

In October 1999, in its continued market reform process, the Ethiopian government amalgamated the Ethiopian Grain Trade Enterprise (EGTE) with the Ethiopian Oil Seeds and Pulses Export Corporation (EOPEC) and re-established it as a public enterprise. The amalgamated EGTE is not required to intervene directly to stabilize grain prices, and its major objective is commercial profitability by focusing on exportable grains (Bekele, 2002). The effect of the changes in the EGTE's organizational structure and its reduced role in stabilizing grain prices, on spatial grain market efficiency has not been studied so far. Such information should be useful to policy makers, researchers, and donor communities interested in understanding the effects of grain price stabilization policy changes on grain market development in Ethiopia. It would inform the debate concerning the design and implementation of new grain marketing policies that facilitate the emergence of a well developed and competitive grain marketing system in Ethiopia, and may have implications for other developing countries involved in their own market reform processes.

1.3 Objectives

There are two major objectives in this study: (1) to provide an improved modeling approach for analyzing the adjustment path and the extent of structural change in spatial grain market efficiency in response to policy changes; and (2) to provide empirical evidence on the dynamic adjustment path of structural changes in spatial market efficiency for maize and wheat in Ethiopia as a result of grain marketing policy changes implemented in October 1999.

A stochastic gradual switching model is developed which builds on the standard parity bounds model and extends it in two ways. First, the extended model traces the adjustment path of spatial efficiency changes in response to policy changes and tests whether the effect of a policy change is instantaneous or gradual. If it is gradual, the model also allows determination of the length of time required for the transition from old to new spatial efficiency regime. Second, the extended model allows for statistical tests for structural change in spatial efficiency regimes due to the policy changes. In the process of implementing the extended PBM model to study spatial market efficiency in Ethiopian grain markets, it is shown how the standard transfer costs assumptions can be generalized, even if a full time series of transfer cost data are not available, as long as one has access to cross-sectional transfer cost data for particular periods that have been collected via trader surveys and time series data on truck shipment freight rates.

The remaining sections of the dissertation are organized as follows. The following chapter presents an overview of wholesale grain trade in Ethiopia. The third chapter provides a brief literature review on empirical methods used to analyze spatial market efficiency. The fourth chapter gives a detailed specification of the parity bounds model

and extends it to enable analysis of the dynamic effects of marketing policy changes on spatial grain market efficiency. The fifth chapter presents a Monte Carlo simulation experiment to assess the performance of the extended parity bounds model. The data sources and descriptions are given in chapter six. The empirical results for maize and wheat are presented in chapter seven. Finally, the summary and conclusions are provided in chapter eight.

CHAPTER 2

AN OVERVIEW OF THE WHOLESALE GRAIN TRADE IN ETHIOPIA

2.1 Introduction

This chapter provides background information on the operation of wholesale grain trade in Ethiopia.² This is intended to provide a context in which to analyze and interpret the spatial price relationships for selected regional maize and wheat markets in Ethiopia. First, regional patterns in grain production and trade are discussed. Second, the characteristics and performance of wholesale grain markets are discussed. Third, discussion turns to how marketing infrastructure has changed since market reforms were initiated in 1990. Fourth, the evolution of grain marketing policies in Ethiopia is discussed. Finally, there are concluding comments.

2.2 Regional Patterns in Grain Production

Among eleven regions of Ethiopia (Figure 2.1), the production of grain is concentrated in Oromiya and Amhara. In the 1995/96 production season Oromiya and Amhara accounted for 48.6% and 32.2% of total grain production, respectively (Table 2.1). Within the Oromiya and Amhara regions the production of grain is also concentrated in certain zones. For example, maize production is concentrated in East Wellega, East Shewa, West Shewa and Jimma zones of Oromiya, and the Gojam zone of Amhara region. The production of wheat is concentrated in the Bale and Arsi zones of

² This study is conducted at the wholesale level involving several regional grain markets. Thus, detailed review of the vertical marketing channel is not provided here. However, for detailed discussions of vertical marketing channels the interested readers can refer to Dessalegn et al., 1998; and Gabre-Madhin, 2001.

Oromiya. Thus, the production and consumption of grains are geographically dispersed which gives opportunity for interregional grain trade.

Cereals are the most important grains produced in Ethiopia both in terms of total production and quantity marketed. In the 1995/96 production season, cereals accounted for 87% of total grain production. Furthermore, most of the grain produced is consumed on farm. For example, in the 1995/1996 production season the marketed proportion of grain production for all types of grain was 28%, while the proportion for *teff*, wheat, barley, maize and sorghum was 24%, 25%, 31%, 25%, and 12%, respectively (Negassa and Jayne, 1997).

2.3 Characteristics and Performance

A detailed description of the characteristics of wholesale grain trading firms in Ethiopia can be found in Dessalgen et al., 1998; and Gabre-Madhin, 2001. Some of the important characteristics are highlighted here. Firms involved in wholesale grain trade are small scale and, in most cases, the owner is the sole employee and manager of the business. Grain trade is not specialized in that wholesale traders in a surplus area can be engaged in assembling while wholesale traders in a deficit region can engage in retailing. Wholesale traders are also engaged in other non-grain trade activities. Grain trade enterprises are characterized by a very low asset base. For example, only a few own their transport capital and most of them rent storage space.

One of the most important institutional changes in the Ethiopian grain marketing system following market liberalization has been an increased role of brokers in inter-regional grain movement. Brokers have played a key role in the coordination of grain

buying, selling, and transporting by matching buyers and sellers, inspecting and witnessing transactions, and providing guarantees to enforce contracts (Gabre-Madhin, 1999a; and Gabre-Madhin, 1999b). Coordination through brokers reduces transaction costs of the marketing system (Gabre-Madhin, 1999b).

Major entry barriers in grain markets are lack of sufficient start-up capital for financing grain trade operations, high cost of finding convenient locations in the market place, and lack of access to appropriate and adequate storage (Dessalegn et al. 1998). Recently, economies of scale are also becoming an important entry barrier because of the emerging large private share and large companies owned by regional political parties, which are also occasionally involved in grain trade.³ Both farmers and merchants also lack access to high quality market information needed for making good marketing decisions.

In the post-reform period, restrictions on grain movement have been one of the most serious impediments to interregional grain trade. The introduction of fiscal decentralization in 1992, which defined the sharing of revenue between the central and regional governments, created an opportunity for restrictions on grain trade at the local and regional levels for the purpose of raising tax revenue.⁴ A number of studies have showed that roadblock (“kella”) charges account for a significant proportion of traders’ interregional margin, and argue that the amount of tax and the way of tax collection have increased risk and uncertainty, and consequently increased transaction costs of interregional grain trade (Diskin and Molla, 1994; Tirfe and Abraham, 1994; Negassa and Jayne, 1997; Gabre-Madhin, 2001).

³ This is particularly apparent in the local purchase of food aid, where the capacity of small wholesale traders is limited.

⁴ Proclamation No. 33 of 1992.

These studies noted several weaknesses in the implementation of roadblock charges: the lack of complete information on the exact amount of kella charges by wholesalers and truck drivers; multiplicity of charges; and lack of clarity in the directives used. These problems led to arbitrariness of the charges and misinterpretation by the tax collectors at roadblocks to suit their own individual situations. While the taxes on grain can serve fiscal objectives of the regional governments, they increase grain marketing costs and work against government's efforts to stimulate productivity enhancing technologies.

Several studies have analyzed the effects of market liberalization on spatial market performance in Ethiopia using different methods. For example, following Ravallion (1986) and Dercon (1995) analyzed short-run and long-run price adjustment and found that the integration of regional markets with Addis Ababa (the major urban market in Ethiopia) increased for teff with market liberalization.

Using a pair-wise price correlation analysis, Negassa and Jayne (1998) find that the degree of spatial market integration increased with market liberalization. Similarly, in the Bako area of Ethiopia, market integration tests based on pair-wise price correlation analysis and Granger's co-integration method indicate an improvement in market integration as a result of market liberalization (Negassa, 1996). Negassa (1998) employs spatial price transmission tests using weekly wholesale prices to show that grain markets in Ethiopia exhibit a high degree of vertical and spatial integration following market liberalization. Amha (1999) also found strong short-run and long run relationships between Addis Ababa market and other regional markets. However, there are no studies looking at spatial grain market efficiency in Ethiopia. The spatial grain market efficiency

is an area which need more work because spatial efficiency and spatial integration are not the same thing.

2.4 Marketing Infrastructure

Spatial grain market efficiency depends on the existing marketing infrastructure, institutions, and policies which influence both physical costs of moving, handling, and storing grain as well as the transaction costs involved in searching for trading partners, and negotiating, monitoring, and enforcing contracts. The objectives of this section are to discuss the evolution of marketing infrastructure in Ethiopia and its implications for spatial grain market efficiency.

2.4.1 Roads

Ethiopia is mostly a rural country and development of the road network is important to integrate rural areas into the rest of the economy. In particular, given the country's wide dispersion of production and consumption centers, the development of roads is critical for interregional grain trade and for regional and household food security. An improvement in rural road quantity (length or density) and quality lowers travel time and reduces vehicle running and maintenance costs, which therefore lowers the actual costs of marketing agricultural produce and reduces the costs of delivering inputs to farm households.

There are three classes of road quality used in Ethiopia: asphalt, gravel, and rural. The asphalt and gravel roads are all-weather roads while the rural roads are seasonal and not useable during the rainy season. Figure 2.2 shows the evolution of the road network

in Ethiopia over the period from 1989 to 2001. The quantity of asphalt road was 4,109 km in 1989 while it was 3,924 km in 2001. The reduction in asphalt road is due to lack of maintenance for the existing asphalt roads and limited construction of new asphalt roads.

Gravel roads increased slightly from 8,966 km in 1989 to 12,467 km in 2001. However, the only period when gravel roads showed a significant upward trend was during 1993 to 1995. Since then the quantity of gravel roads has remained almost unchanged. On the other hand, there was a significant upward trend in rural roads in that they increased by 64 percent from 5,232 km in 1989 to 14,480 km in 2001. Thus, road investment was mainly at the level of rural feeder roads, with less improvement in all-weather roads.

The observed road development strategy, which focuses on rural feeder roads, has several implications for grain marketing. First, with rural and gravel roads being the major road types, the major grain transport from production areas to the consumption centers has to be completed over a short time period during the dry season immediately after harvest. This situation deprives producers and regional grain traders the opportunity to store grain on farm or in the production areas to take advantage of higher prices later in the season. Second, there is also pressure on a limited marketing infrastructure to transport grain to consumption centers over a shorter time period, which might increase the demand for marketing services and hence increase marketing costs. Third, the cost of operating trucks on gravel and rural roads are also higher which might increase the marketing cost. It is also more expensive to operate modern trucks with higher capacity on feeder roads due to higher maintenance costs. The feeder roads encourage the use of older and smaller trucks.

2.4.2 Trucks

The public sector dominated the provision of transport services during the socialist regime, during which parastatal transport enterprises owned transport fleets. Grain traders in Ethiopia mostly used (owned or rented) trucks with less than 200 quintals (20 tons) capacity for grain transport. Trucks and trailers of higher capacity were used to transport fertilizer from the port to the distribution centers and to transport relief foods.

Since reforms in the early 1990s, the total number of trucks has increased significantly (Figure 2.3). During the period from 1992/93 to 2000/01, the number of trucks with a capacity up to 70 quintals increased by 155 percent (from 10,630 trucks to 27,069 trucks). On the other hand, trucks with higher capacity of 71 to 180 quintals have increased by 88 percent (from 5,590 trucks to 10,518 trucks). However, the increase in the big trucks was only between 1994 and 1996 and since then the number of big trucks has remained almost the same.

Dessalegn et al. (1998) indicate that only about 15% of grain wholesalers (mostly big traders) have their own truck and non-owners depend on private and state-owned freighters and NGO's. Furthermore, their study shows that more than 55 percent of grain traders reported that it takes a week to get a truck on rental and 12 percent reported that it takes up to two weeks. They also report that truck shortages have tied up their limited working capital in inventory. Thus, in view of the significant number of wholesale grain traders who do not own their own trucks, the availability of trucks, and the rates at which they are rented, are very critical for the well-functioning of interregional grain trade.

There are several types of business firms operating in the transport sector. These include: (1) private limited liability companies that own trucks and run their business

independently; (2) share companies which facilitate finding clients (truck users) for their shareholders but do not own their own trucks; (3) safety net share companies which own trucks and rent to others;⁵ (4) big transport companies which are owned and run by the regional political parties (e.g. Black Lion, Dinsho, Trans, etc.); and (5) public transport enterprise (e.g. Bekelcha).

The transport sector is dominated by big companies linked to political parties which have differential access to capital to buy and own modern fleets. The independent transporters are limited to old-fashioned trucks and operate in the remote areas where the modern fleets can't operate. Most transport activities are related to food aid relief operations in which independent transporters with traditional fleets do not have a competitive advantage to compete with party-owned companies, due to economies of scale. The independent transporters also do not have the capacity to move all the relief items within a short time, as required by relief organizations.

2.4.3 Telephone and Telecommunication Services

Telephone is one of the most important means of communication used by grain traders in Ethiopia to obtain market information needed for trading grain. Thus, the availability and quality of the telephone system affects marketing costs by influencing grain producers and traders' timely access to market information, and by enhancing the ability to find and negotiate transactions with trading partners.

During the socialist regime, access to telephone lines and apparatus was extremely difficult and the waiting time to own a telephone line and apparatus was very

⁵ These are former government employees who owned the government's fleets under the scheme of public enterprise privatization.

long. Under the present regime, there has been a steady improvement in the number of telephone lines and telephone apparatuses (Figure 2.4).⁶ The number of telephone lines has increased by 168 percent from 105,985 in 1987/88 to 283,683 in 2000/2001. Telephone apparatuses also increased by 132 percent from 135,413 in 1987/88 to 313,501 in 2000/01. The telephone density (total number of lines divided by total population) also increased by 72 percent from 0.25 in 1991/92 to 0.43 in 2000/01. The improvement in telephone and telecommunication services has undoubtedly reduced marketing costs associated with obtaining market information. For example, it implies less personal travel time to different markets in order to obtain information about other markets and trading partners.

2.4.4 Marketing and Pricing Information

Grain trader access to market information is very important for the efficient operation of interregional grain trade. The availability of market information and the ability of grain traders to utilize it efficiently affect the extent to which grain traders can exploit profitable spatial arbitrage opportunities. Likewise, producers also need market information to make their production and marketing decisions and policy makers need it to make effective policy decisions.

Traditionally, grain traders relied on informal sources of market information, such as friends and neighbors who visited markets, calling friends or traders in different markets, making a visit to the market, etc. Under the socialist regime, the way traders got market information did not change. A few government organizations like the Agricultural Marketing Corporation (AMC) collected agricultural prices around the country.

⁶ Recently, the cell-phone is also getting very popular in Ethiopia but we do not have statistics on its use.

However, AMC collected the prices for its own internal marketing and administrative decision-making. The information collected was not adequately analyzed and communicated to other economic agents.

In most cases, regional wholesale grain traders have relied on brokers in central markets for information about prices in those central markets. Recently, a system of collection and dissemination of price information through radio broadcast and bulletins was started by the Grain Market Research Project (GMRP) in 1996. However, when the project ended in 1998, the data collection continued but the analysis, radio broadcast, and reporting of the market information either discontinued or continued on a very limited scale.

In addition to price information, actors in the grain market need information on food aid pledges and arrivals; planned and actual local grain purchases by donor agencies; planned and actual commercial imports and exports of grains; the expected production situation (surpluses and shortages); stock release from the food security reserve or intended purchases for the food security reserve; changes in demand for grain. Currently, there are no well coordinated channels through which this information is communicated to the various participants. Thus, the information gap in the market continues to be sizable and contributes to higher coordination costs and increased risk in the market.

2.5 Evolution of Grain Marketing Policies in Ethiopia

Over the last several years the nature of government interventions in Ethiopia grain marketing, either through direct participation in grain marketing activities (buying,

storing, selling, transporting, etc) or in designing and implementing grain marketing policies, witnessed several changes. Different political regimes enacted different sets of policies that influenced the current state of grain market development in Ethiopia. The objective of this section is to document and analyze grain marketing policy changes under three political regimes: the imperial regime (prior to 1974); the socialist regime (1974 to 1990); and the present regime (1991 to the present) and to see how these evolving grain marketing policies have affected grain market development. The chronology of major government grain market interventions in Ethiopia is given in Table 2.3.

2.5.1 Imperial Regime

The first attempt by the imperial government to intervene in grain markets was the establishment of the Ethiopian Grain Board (EGB) in 1950.⁷ The EGB was involved in grain export licensing; quality control; overseeing marketing intelligence; and the regulation of domestic and export purchases and sales (Holmberg, 1977; Lirensso, 1987). However, it has been argued that government intervention in grain market during the imperial regime was geared exclusively toward providing services to private exporting organizations and merchants, which were feudal landlords or those with close relationships with feudal landlords (Gutema, 1988).

The EGB was able to control prices of exported grains but failed to stabilize domestic prices because it did not hold stocks. As a result, the government established the Ethiopian Grain Corporation (EGC) in 1960.⁸ The objectives of EGC were to hold

⁷ Ethiopian Grain Board Proclamation No. 113 of 1950.

⁸ General Notice No. 267 of 1960.

stocks, stabilize grain prices and improve grain production for export. However, the EGC was also ineffective because of its very low market share in relation to a strong private sector (Lirenso, 1987). The EGC also suffered from lack of sufficient capital and an inability to generate sufficient profit to cover its administrative and overhead costs (Holmberg, 1977). There were strong intra-year and inter-year fluctuations in grain prices and the EGC was not able to stabilize grain prices to any great extent.

The literature on Ethiopian agriculture during the imperial period suggests the following. First, government intervention in grain marketing and pricing was very limited. The attempted interventions were also not effective due to lack of sufficient resources to implement the planned interventions. The major objectives of the interventions were neither to improve the incentive structure for producers nor to improve the food security of consumers, but to serve the interests of the landlords as the landlords were the main sellers of grain. The interventions were urban biased in that the major focus was the stabilization of the wholesale and retail prices in major cities. The interventions also focused on certain production regions and urban areas while neglecting other regions (particularly, remote areas). As a result, the interventions did not contribute much toward the development of interregional grain trade. Lack of well-developed marketing infrastructure also characterizes the grain marketing system that existed during this period.

2.5.2 Socialist Regime

In order to meet its objectives of socializing production, distribution and marketing, the government designed and implemented various policy instruments (for

details, see: Lirenso, 1987; Lirenso, 1994; Franzel, 1989; and Lemma, 1996). The government determined the annual quantity of grain purchased by the government-marketing agency through compulsory delivery quotas; fixed grain prices; restricted private grain trade and interregional grain movement; determined the days on which the local markets were held; and rationed grain to urban consumers.

The government's desire to integrate the organizations engaged in the procurement and distribution of inputs and grain marketing resulted in the establishment of the Agricultural Marketing Corporation (AMC) in 1976. The AMC operated under the Ministry of Agriculture as an autonomous public enterprise and obtained its support from the World Bank.⁹ The principal objective of the corporation was to execute the government's policy in grain marketing, procurement and distribution of inputs, and maintaining a national grain reserve.

Specifically, the AMC was involved in functions such as purchasing agricultural products for export, or importing agricultural products and selling in the domestic market. The AMC was also given the responsibility for purchasing and selling inputs in the domestic and foreign markets; could purchase, process, mill, transport, sell or store agricultural products or inputs; and could construct, equip and maintain buildings, silos, storage facilities, grain elevators and other structures and machinery.

The AMC, which had its head office in Addis Ababa and branch offices in other parts of the country, was managed by a board of directors drawn from various government offices. The functions of the board were to lay down policy guidelines; approve the budget, annual reports and accounts; and approve the corporation's strategy at the opening of each season for implementation of the government's decision on prices,

⁹ Agricultural Marketing Corporation Establishment Proclamation No. 105/1976.

imports, buffer-stock, exports of agricultural products and input supply and distributions. The board also analyzed management's recommendations with regard to the monthly adjustment of the corporation's buying price structure and supervised the operations of the corporation.

The AMC was revamped in 1987.¹⁰ The board of directors stopped managing AMC. Instead, the corporation had a general manager and was allowed to have deputy managers and other necessary staff. The supervising ministry was the Ministry of Domestic Trade. The major objectives of the AMC remained to buy grain, at prices fixed by the Government, from suppliers and sell it in wholesale quantities with a view to socializing distribution and creating an equitable market. The AMC was no longer responsible for direct export of grains, import of agricultural products, and purchase and sale of inputs. The major focus became domestic grain procurement, distribution and marketing.

The AMC continued buying grain from suppliers (individual producers, producer cooperatives, service cooperatives, state farms, and private traders) and sold to public organizations and other organizations engaged in retail trade, public enterprises engaged in export trade, and government offices. The AMC supplied grain to the government, public organizations and private factories that used grain as raw material. The AMC was also engaged in other activities, such as maintaining a national emergency grain reserve and constructing, equipping and maintaining buildings, silos, storage facilities, grain elevators and other structures.

The AMC had a nationwide marketing network and owned a huge amount of resources. In 1987, AMC had 104 purchase and/or sales centers (Gutema, 1987). During

¹⁰ Legal Notice No. 103 of 1987.

the same year, AMC had 6.3 million quintals of storage capacity in 81 locations in the country and owned a fleet of 225 trucks that handled 25 to 30 percent of its annual transport requirement. In subsequent years, the resources and the extent of activities of the AMC increased. During the period from 1989 to 1990, the AMC had 8 regional offices, 27 branch offices, 121 purchasing and/or selling centers and 2013 grain collection points (Lirenso, 1994).

The AMC procured grain from the peasant sector, service cooperatives, and private merchants (who served as collection agents to whom the corporation paid a commission of 4 to 5 Birr/quintal) (Lirenso, 1987). AMC also received direct delivery from producer cooperatives and state farms based on planned production targets. The domestic grain procurement from the peasant sector was based on directives issued by the government.

Grain procurement by AMC was concentrated in the major grain producing regions. For example, more than 80 percent of AMC's grain supplies came from three regions: Shewa, Gojam and Arsi (Gutema, 1987; Lirenso, 1987). The role of private grain traders shrank under the socialist regime. For example, over the period from 1982 to 1986, the licensed traders' share in AMC's annual purchase decreased from 70 percent to 10 percent (Gutema, 1987). In general, with complete socialization, it was expected that the AMC would be the only public wholesale grain market organization in the country. In the country's Ten Year Development Plan, the AMC's share of marketable surplus was to increase to 80 percent in 1990 as compared to 59 percent in 1987 (Gutema, 1987).

Generally, private traders were banned from trading. In areas where the AMC was not able to handle surplus grain, private traders were allowed to operate. But the traders

were required to sell a significant proportion of their purchases to AMC at prices 15 percent to 20 percent higher than the prices received by the farmers for their crops (Franzel et al., 1989). Franzel et al. (1989) indicate that individuals were also restricted from transporting more than 100 kg of grain and this was strongly enforced during the period before the area's quota has been fulfilled.

Important critiques of the socialist government's grain marketing and pricing policies are provided by several researchers (e.g., Pausewang, 1986; Lirenso, 1987; Franzel et al., 1989; Dadi et al., 1992; and Lemma, 1996). First, the fixed prices did not adequately account for the cost of production and cost of marketing. Second, the amount of quota allocated did not take into account the production capacity and consumption requirements of farm households. For example, farmers had to buy from the market to meet quota requirement and buy grain for home consumption after making quota delivery. Moreover, the quota system and fixed price did not provide incentives to the producers.

The forced quota delivery at a fixed price had negative impacts on farmers. It reduced farmer incomes, promoted the marketing of low-quality produce, increased farmers' dependence on local markets, decreased regional grain market integration, and decreased the profitability of fertilizer use in grain production (Franzel et al. 1989). Quota delivery and tax payments came immediately after harvest and contributed to the weak bargaining position of farmers (Kefyalew and Negassa, 1993).

The public grain marketing system also had negative impacts on the operational efficiency of private sector grain trade. First, regional governments were a considerable impediment to interregional grain trade. The participation of private traders varied from

region to region. In some regions the private sector was banned totally from participating. Whenever they were allowed to operate, they were asked to meet several conditions to stay in the grain marketing business. These conditions included delivering quality grain to AMC, meeting the quota within the specified time limit, quota delivery to AMC (accounting for at least 50 percent of traders' purchases), respect fixed producer price, no hoarding, and avoiding the illegal movement of grain (Lirenso, 1987).

The Ministry of Domestic Trade issued licenses to private grain traders upon recommendation from the GPTF in their respective regions, and proof that the applicants were not engaged in any other non-grain business activity. The private traders participated after meeting all these conditions. The government enforced the restrictions on the private grain trade through roadblocks. Any trader attempting to move grain prior to meeting the quota delivery and without getting permission from the GPTF lost all the grain at the roadblock, as well as his/her trading license (Franzel et al., 1989).

The socialist government started introducing changes in grain marketing policies in 1988 due to donor pressure for more reform, internal political pressure, worsening economic conditions, and the ideological and economic policy changes in the former USSR and Eastern European countries (Lirenso, 1994, Amha, 1995). In 1988, the government allowed private permits to move grain as long as traders agreed to sell half of their grain to AMC at AMC prices (Franzel et al., 1989). In March 1990, the government undertook major grain marketing policy reform. The government removed restrictions on private trade and interregional trade, abolished the fixed price and forced quota delivery, and eliminated the monopoly power of AMC.

2.5.3 Recent Developments

Under the present regime, direct government intervention in grain marketing through marketing parastatals has decreased considerably compared to the socialist regime. Following the overthrow of the socialist government in May 1991, various economic reform programs were launched. The reorganization of government parastatals began in 1992.¹¹ As a result, the Agricultural Marketing Corporation (AMC) was reorganized in 1992 as a public enterprise and allowed to operate in the open market in competition with the private sector.¹² Its name was also changed to the Ethiopian Grain Trade Enterprise (EGTE). Its objectives included stabilization of markets and producer prices to encourage increased output, stabilization of grain prices and markets to protect consumers from unfair grain prices, earning foreign exchange through exporting grains to the world market, and maintaining a grain buffer stock for market stabilization.

Since its re-organization in 1992, the EGTE has implemented the government's policies of grain price stabilization using a variety of instruments, such as producer floor prices, pre-announced producer prices, holding of stocks, and export market development (Bekele, 2002). However, it has been argued that the social objective of price stabilization has negatively affected the enterprise's commercial objectives of competitiveness and profitability (Bekele, 2002). Furthermore, EGTE was also not effective in stabilizing grain prices due to its limited grain purchases and sales network and shortage of working capital. The closure of branch offices and purchase and/or sales centers in regions with less potential for grain production, and in remote areas, resulted in shrinkage of EGTE's grain-marketing network, and consequently reduced procurement

¹¹ Council of Ministers Regulation No. 25/1992

¹² Council of Ministers Regulations No. 104/1992.

and led to under utilization of EGTE's resources (Lirenso, 1994). For example, since 1992, EGTE has accounted for less than 5 percent of cereal traded nationally (Jayne et al., 1998).

In October of 1999, the government amalgamated EGTE with the Ethiopian Oil Seeds and Pulses Export Corporation (EOPEC) and re-established it as a public enterprise.¹³ As of now, the EGTE has three objectives - to purchase grain from farmers and sell in local and export markets, to contribute towards stabilization of markets for farmers to encourage them to increase outputs, and to engage in other related activities conducive to the attainment of its purposes. The amalgamated EGTE is not required to directly intervene in grain price stabilization and its major focus is on exportable grains (Bekele, 2002). Clearly, the focus has changed to the commercial viability of the EGTE.

The effect of recent changes in the EGTE's organizational structure on spatial grain market efficiency has not been studied so far. It is hard to predict with certainty the likely effect of these policy changes on spatial grain market efficiency. However, there are three possible scenarios. First, the policy changes may have no effect on spatial grain market efficiency. This is possible if the constraints faced by EGTE before the marketing policy change such as reduced marketing network, shortage of working capital and reduced market share, limited its effectiveness and performance. There are no indications that these constraints have been alleviated.

Second, with its reduced role in price stabilization, the EGTE would be in a better position to pursue its commercial objectives of profitability more aggressively and compete in the open market more effectively. This might induce more competition in the grain market and improve spatial market efficiency. Even though the EGTE has not been

¹³ Council of Ministers Regulations No. 58/1999.

effective in stabilizing prices, its mere presence in the market with a price stabilization objective had influenced the psychology and operation of private sector grain traders. This is because of the uncertainty involving when, where and how the EGTE was going to intervene in the market. With this uncertainty reduced because EGTE has now dropped its price stabilization objective, grain trader participation and the operation of the grain market may improve.

Third, with the sole objective of commercial profitability, it is also possible that the EGTE might act as a monopsony and/or monopoly and reduce competition in the grain market. When considered as an individual grain trading entity, the EGTE is in a much better position than small scale wholesale traders in terms of resources (e.g., trucks, storage facility, working capital, etc.) needed to operate the grain business, and might take advantage of this to influence prices in its favor. Thus, it might reduce the spatial efficiency of grain markets. EGTE might also focus on more profitable and accessible markets resulting in lower market integration.

Additional information on the effects of the changes in the government's price stabilization policy on spatial grain market efficiency in Ethiopia should be useful to policy makers, researchers, and donor communities interested in understanding the effects of such marketing policy changes on grain market development in Ethiopia. It would inform the debate on designing and implementing new grain marketing policies that facilitate the emergence of a well developed and competitive grain marketing system. The research would also broaden understanding of the on-going market reform process.

2.6 Conclusions

In Ethiopia there is geographic dispersion of grain production which provides an opportunity for interregional grain trade. It is observed that firms involved in wholesale grain trade are small- scale, owner managed, lack specialization, and have a very low asset base. Major entry barriers in grain markets are found to be lack of sufficient start-up capital for financing grain trade operations, high cost of finding convenient locations in the market place, and lack of access to appropriate and adequate storage. In the post-reform period, restrictions on regional grain movement have been one of the most serious impediments to interregional grain trade. Such restrictions have increased costs and risks associated with interregional grain trade. A review of grain marketing policies also shows that the private grain marketing system has not been developed in Ethiopia because either the government knowingly or unknowingly discouraged its development.

Table 2.1 Productions of Major Food Crops by Regions in Ethiopia
('000 quintals)

Region	Production season		Average	
	1999/2000	2000/2001	Production	Percentage
Tigray	6223.0	6579.5	6401.3	6.8
Afar	245.9	301.8	273.9	0.3
Amhara	28807.1	32304.2	30555.7	32.2
Oromiya	43719.8	48512.9	46116.4	48.6
Somalia	225.2	262.5	243.9	0.3
BeniShangul	1845.5	1770.6	1808.1	1.9
SNNPR	7387.6	10455.1	8921.4	9.4
Gambela	249.1	297.5	273.3	0.3
Harari	58.1	44.0	51.1	0.1
Addis Ababa	83.0	127.0	105.0	0.1
Dire Dawa	61.4	86.9	74.2	0.1
All regions	88910	100742	94826.0	100

Source: Based on Table 1b in Amha 2002.

Table 2.2 Productions of Major Food Crops in Ethiopia ('000 quintals)

Type of grain	Production season		Average	
	1999/2000	2000/2001	Production	Percentage
Cereals	77412.6	88108.0	82760.3	87.3
Teff	17175.3	19187.9	18181.6	19.2
Barley	7419.3	7583.5	7501.4	7.9
Wheat	12126.2	13689.6	129079.0	13.6
Maize	25254.7	28858.8	27056.8	28.5
Sorghum	11811.4	15232.5	13522.0	14.3
Millet	3195.1	3042.8	1597.6	3.3
Oats	430.3	512.9	471.6	0.5
Pulses	9594.5	10067.9	9831.2	10.4
Oilseeds	1902.9	2566.1	2234.5	2.3
All crops	88910.0	100742.0	94826	100.0

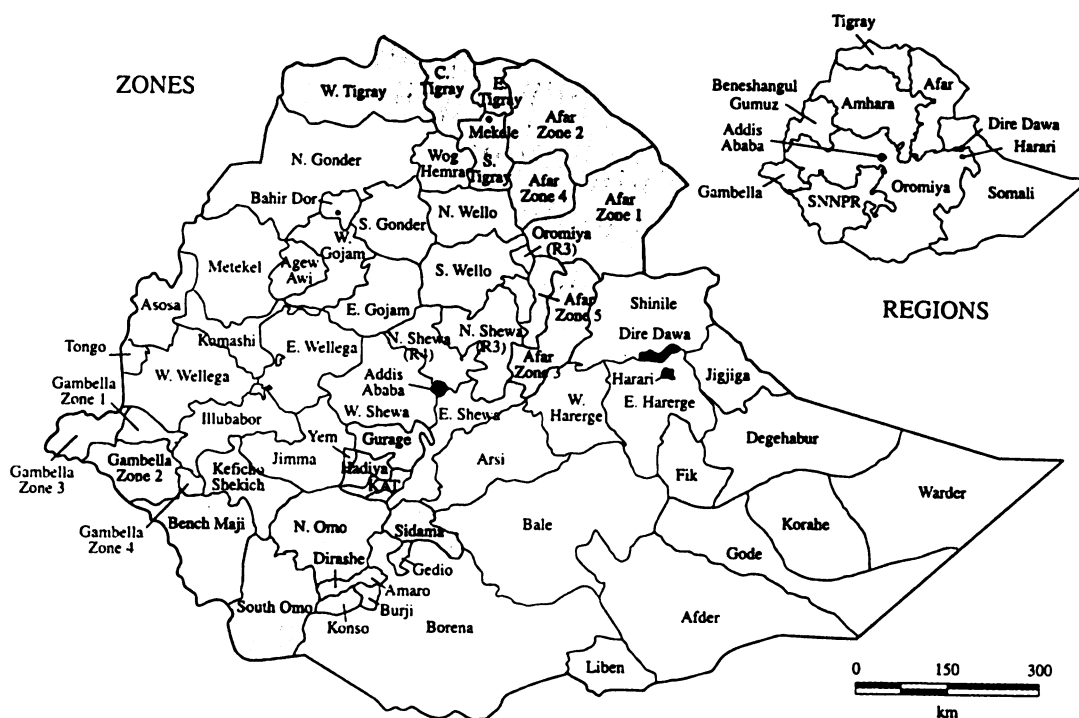
Source: Based on Table 1a in Amha 2002.

Table 2.3 Chronology of Government Grain Market Interventions in Ethiopia

Year	Intervention	Stated objectives
1950	Ethiopian Grain Board (EGB)	• To license grain export and control quality • To oversee marketing intelligence • To regulate domestic and export purchases and export sales prices
1960	Ethiopian Grain Corporation (EGC)	• To purchase and sell grain in the local and foreign markets • To establish grain purchase and sales outlets throughout the country • To hold stocks to stabilize prices
1976	Agricultural Marketing Corporation (AMC)	• To purchase agricultural products for export or sell in the domestic market • To import agricultural products • To purchase and sell inputs within Ethiopia or abroad • To purchase, process, mill, transport, sell or store, agricultural products and inputs for profit or otherwise • To construct, equip and maintain buildings, silos, storage facilities, grain elevators and other structures and machinery • To maintain a national grain reserve
1987	Agricultural Marketing Corporation (AMC)	• To buy grain from supplies and sell to: a) mass organizations and other organs engaged in retail trade, b) public enterprises engaged in export trade, and c) government offices • To supply grain to government, mass organization and private factories that use same as raw material • To maintain a national emergency grain reserve • To construct, equip and maintain, for its own use, buildings, silos, storage facilities, grain elevators and other structures and machinery • To sell or otherwise dispose of, in accordance with directives from the Minister, any grain prone to deterioration or unfit for human consumption
1992	Ethiopian Grain Trade Enterprise (EGTE)	• To stabilize markets and prices in order to encourage producers to increase their output and protect consumers from unfair grain prices • To export grains to earn foreign exchange • To maintain grain buffer stock for market stabilization • To engage in any other related activity for the attainment of its objectives
1999	Ethiopian Grain Trade Enterprise (EGTE)	• To purchase grain from farmers and sell in local and mainly in export markets • To contribute towards stabilization of markets for farmers' produce to encourage them to increase their outputs • To engage in other related activities conducive to the attainment of its purposes

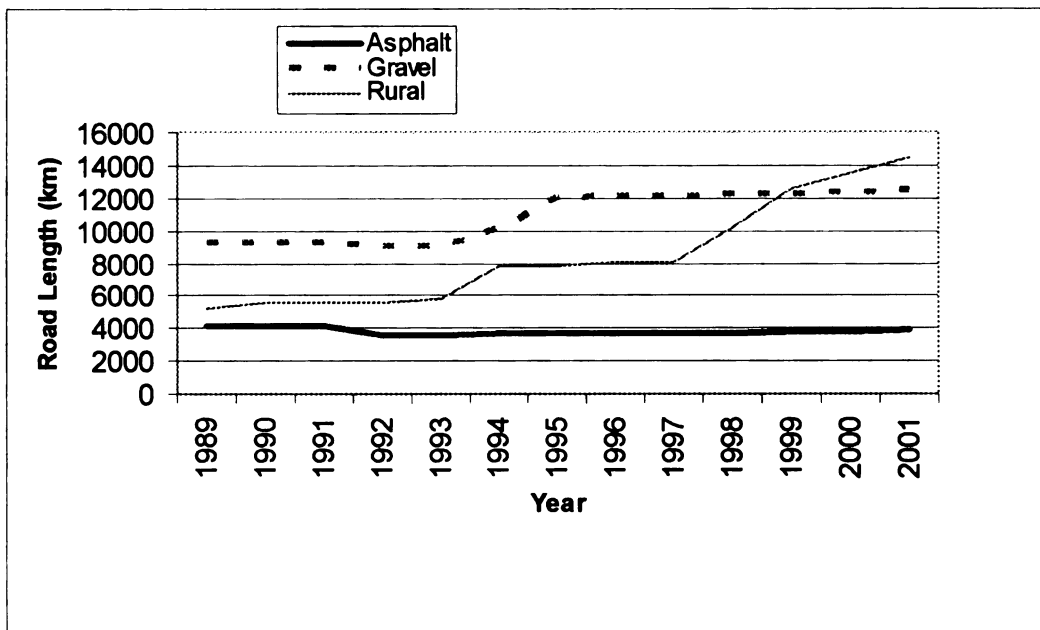
Source: Various issues of Negarite Gazetta.

Figure 2.1 Administrative regions and zones of Ethiopia



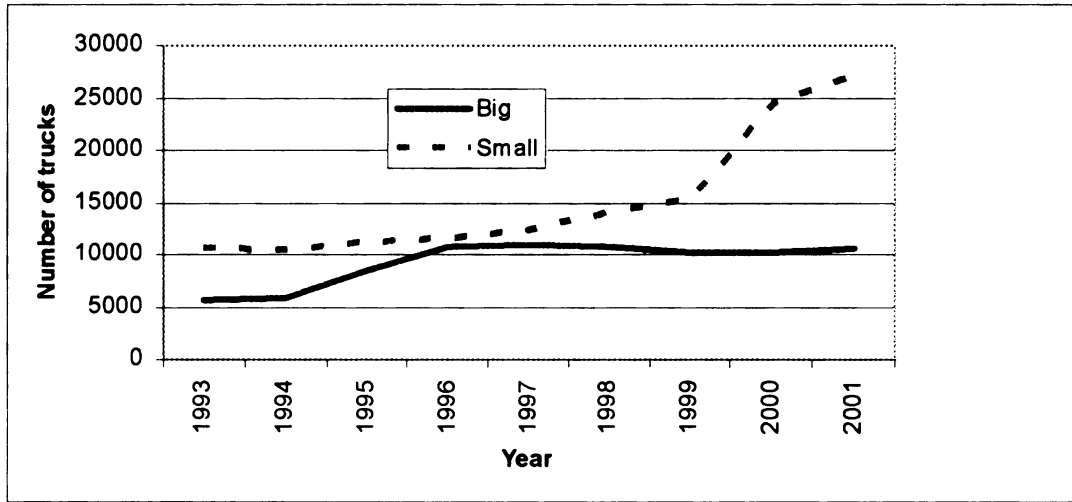
Source: United Nations Emergency Unit for Ethiopia, March 2000

Figure 2.2 Road Lengths in Ethiopia for Different Classes of Roads



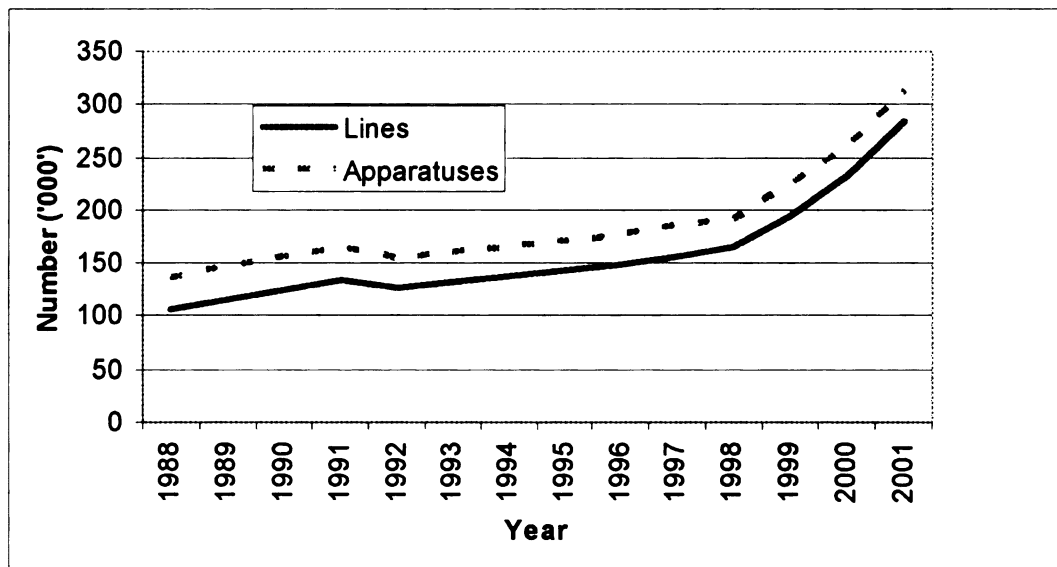
Source: Ethiopian Road Authority (2002)

Figure 2.3 The Number of Registered Small (7 tons capacity) and Big (7.1 to 18 tons) Trucks



Source: Central Statistical Authority (2002).

Figure 2.4 The Number of Telephone Lines and Apparatuses



Source: Source unknown (obtained from Dr. Mulat Demeke, 2002).

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

There have been continuous improvements in empirical methods used in evaluating the performance of agricultural markets in terms of spatial efficiency. This chapter provides a brief review of methods used in the analysis of spatial market efficiency. The strengths and weaknesses of the various methods are discussed and some of the weaknesses in existing empirical methods for analyzing spatial grain market efficiency are identified.

3.2 Spatial Price Correlation Analysis

Spatial price analysis methods typically require time series data either for prices only, for prices and transfer costs, or for prices, transfer costs and trade flows.¹⁴ In early studies the degree of spatial market integration was measured using price correlations between two different price series (e.g. Jones, 1968; Blyn, 1973; Timmer, 1974). Price correlation is a relatively simple way to measure market integration, but suffers from various weaknesses.

First, price correlation assumes instantaneous price adjustment and can't capture the dynamic nature of a marketing system (Heytens, 1986; Ravallion, 1986; Sexton et al., 1991). Second, it is possible that price correlation might suggest spurious market integration because the prices may tend to move together for reasons other than market integration; like common trends, common seasonality, monopoly price fixing, etc. (Harriss, 1979; Delgado, 1986; Heytens, 1986). Third, price correlation tests may also

¹⁴ A detailed review of methods of spatial price analysis can be found in Fackler and Goodwin (2001).

overestimate lack of market integration if a lag in market information produces a lag in the price response between markets (Barrett, 1996). Fourth, price correlation treats only a pair of markets at a time and can't be used for evaluating the marketing system as a whole (Delgado, 1986). In order to overcome the weaknesses of price correlation tests, various alternative methods have been developed (e.g. Delgado, 1986; Ravallion, 1986; Engle and Granger, 1987; Johansen, 1988).

3.3 Delgado Method

Delgado's variance decomposition approach tests market integration for the marketing system as a whole instead of using pair-wise tests. The method purges out the common trends and seasonality present in the price series before testing for market integration. It implicitly assumes constant transport and transaction costs for any two markets within a system for a given season. The spatial integration between pairs of markets for a given season is indicated by the equality between the spatial price spread and the constant transport and transaction costs during that season, subject to random noise. However, this approach is based on a test of contemporaneous price relationships and does not allow for dynamic relationships between prices in different markets.

3.4 Ravallion Method

The Ravallion (1986) method assumes a radial spatial market structure between a group of local markets and a single central market, and price formation in the local markets is mainly influenced by trade with the central market. This method allows testing of several hypotheses regarding spatial market integration (market segmentation, short-

run market integration, and long-run market integration) between local and central markets, after controlling for seasonality, common trend, and autocorrelation. However, this method also has weaknesses. First, the assumption of radial market structure does not always hold due to inter-seasonal flow reversals and direct trade links between regions (Barrett, 1996). Second, the method assumes constant inter-market transfer costs, and if transfer costs are time-varying, the test of market integration is biased against market integration (Barrett, 1996). Third, the method also does not distinguish market integration due to non-competitive behavior such as collusion (Faminow and Benson, 1990).

3.5 Co-integration Methods

Commodity prices exhibit several common stochastic properties such as high volatility, stochastic trends (unit roots), comovements in commodity prices, time varying volatility, and excess kurtosis. These properties have implications for the econometric methods used in spatial price analysis (Myers, 1994). For example, Ravallion (1986) uses OLS regression to test various hypotheses of spatial market integration. However, in the presence of stochastic trends (unit roots) in the price series the classical assumptions of OLS regression are violated and hypothesis testing may be problematic. This led to the application of co-integration analysis which tests for market integration by taking the presence of stochastic trends in the price series into account. The idea behind cointegration analysis is that a set of economic variables move together in the long-run, even if they drift apart in the short-run, because of common economic forces such as the market mechanism and government intervention (Engle and Granger, 1987).

Cointegration analysis involves several steps (for details, see: Engle and Granger, 1987). The first, step is to determine the order of integration of the univariate price series using appropriate unit root tests.¹⁵ Second, if both prices series are integrated of the same order, run a cointegrating regression of one series on the other. Third, apply unit root tests to the residuals from the cointegration regression. The absence of a stochastic trend in the residual from the cointegration regression indicates that there is a cointegrating (long-run equilibrium) relationship between the two price series. Fourth, if cointegration is accepted, error correction models can be developed to study the short-run price relationships (Engle and Granger, 1987).

The Engle and Granger cointegration approach assumes a stationary spatial marketing margin for markets to be integrated. However, it has been argued that if transaction costs are non-stationary, lack of cointegration can also be consistent with market integration (Barrett, 1996). Also, finding cointegration does not always mean market integration. If the markets are subject to cointegrated supply and/or demand shocks, macroeconomic shocks (for example, money supply or interest rates), speculation or overreaction, then prices can be cointegrated without market integration or market efficiency (Pindyck and Rotemberg, 1990).

Furthermore, the Engle and Granger cointegration approach does not allow for the investigation of all possible cointegrating vectors in a multivariate system (Myers, 1994; Fackler, 1996). Johansen (1988) developed a multivariate method of cointegration analysis which uses a maximum likelihood test of the hypothesis of cointegrating relationships among several economic time series. Following Johansen, a multivariate

¹⁵ The order of integration is the number of differences required before the series becomes stationary (Engle and Granger, 1987).

test for market integration under nonstationary prices has also been developed and applied (see, for example, Gonzalez-Rivera and Helfand, 2001; Asche et al., 1999).

In general, the different methods of testing for market integration discussed above depend on an assessment of the comovement of price series, or the long-run relationship between prices, and have been found to have several weaknesses (Barrett, 1996; Fackler, 1996; and Baulch, 1997). These methods assume stationary spatial marketing margins, stationary transaction costs, and/or that markets are linked by a constant trade pattern (uni-directional and continuous). However, these assumptions are often violated and so the resulting test of market integration may be misleading (Fackler, 1996). The key argument here is that cointegration measures a linear spatial price relationship and when there are discontinuities in trade and trade reversals, the spatial price relationships are no longer linear and cointegration tests are invalid (Baulch, 1997).

Recently, there have been two major developments in methods used to account for transaction costs in spatial price analysis - threshold cointegration tests and the parity bounds model (PBM).¹⁶ Threshold cointegration is based on the idea that the presence of transactions cost creates a “neutral band” within which prices in different markets are not linked (Blake and Fomby, 1997; Mainardi, 2001; Abdulai, 2000; Goodwin and Piggott, 2001; Goodwin and Harper, 2000). It is argued that equilibrium is restored only when localized shocks result in price differences which exceed the “neutral band”. The major advantage of threshold cointegration is that it does not require observations on transaction

¹⁶ The PBM refers to the situation where there are statistically determined upper and lower bounds of transfer costs, and is discussed in section 3.6. Spatial price efficiency requires that the spatial price differentials be within these bounds. Early studies on tests of spatial market efficiency based on the comparison of spatial price differentials and transfer costs are found in Hay and McCoy (1977); and Gupta and Mueller (1982).

costs. However, it is highly parameterized and still assumes fixed transaction costs (Fackler and Goodwin, 2001).

3.6 Parity Bounds Model

Early developments and applications of the PBM are found in Spiller and Haung (1986) and Spiller and Wood (1988). The PBM has been further developed and applied by several researchers (e.g. Sexton et al., 1991; Fafchamps and Gavian, 1996; Baulch, 1997; Barrett et al., 2000; Barrett and Li, 2002; Park et al., 2002; Penzhorn and Arndt, 2002). The PBM allows for transfer costs, trade reversals, and autarky. It measures the probabilities of being in different spatial market efficiency regimes over the sample period. The PBM can indicate not only whether the markets are efficient but also the extent to which the markets are inefficient.

Furthermore, when data on prices, transfer costs and trade flow are simultaneously available, the PBM allows a clear distinction between spatial market efficiency and spatial market integration (Barrett and Li, 2002). Barrett and Li (2002) identify six market conditions based on the relationship between spatial price differentials and transfer costs, and whether there is trade. This distinction is lacking in other studies that use only prices or only prices and transfer costs.

However, the PBM has also been criticized on many grounds. Fackler (1996) provides three major critiques with regard to the PBM. First, he argues that there is no link between economic theory and the distributional assumptions used in the PBM. From this, it is argued that the appropriateness of the interpretation of regime probabilities depends on the validity of distributional assumptions made. In response, Monte Carlo

experiments have been used to test for the sensitivity of the results to different distributional assumptions (Baulch, 1997; Barrett and Li, 2002). Second, this model handles only a pair of markets at a time. Third, the result may be misleading because the approach considers short-run deviations from equilibrium as inefficiency whereas it may actually represent traders' rational responses to lags in information and shipment flows.

In the context of on-going market reform and policy changes in developing countries, the standard PBM also needs further improvements in order to properly assess the effect of policy changes on spatial market efficiency. This is because the standard PBM has been used mostly to analyze spatial market efficiency within a given, constant marketing policy regime (e.g. Sexton et al., 1991; Fafchamps and Gavian, 1996; Baulch, 1997; Barrett et al., 2000; Barrett and Li, 2002; Penzhorn and Arndt, 2002). In cases where it has been used to analyze the effects of marketing policy changes on spatial market efficiency, the effect of policy changes is assumed to be instantaneous (e.g. Park et al., 2002). However, the PBM is mis-specified and the results and policy implications might be misleading if the actual effect of marketing policy changes on spatial market efficiency is gradual and moves through a transition period, as might expected in many cases.

3.7 Conclusions

The standard PBM overcomes many weaknesses of the traditional methods of spatial price analysis discussed above. However, in the context of ongoing market reform and policy changes in developing countries, it does not allow for a test of a structural change in spatial grain market efficiency conditions due to marketing policy changes.

Thus, there is a need to improve and extend the standard PBM so that it allows for gradual transition between spatial market efficiency states as a result of changes in the policy environment, and to develop a test of whether such structural change in spatial market efficiency is statistically significant.

CHAPTER 4

EMPIRICAL MODEL

4.1 Introduction

In Ethiopia, there is a great diversity among different regions in terms of their agricultural production conditions such as soils, climate, and rainfall. As a result, it has been observed that some regions have excess supply while other regions have excess demand which gives rise to the possibility of interregional grain trade. This chapter discusses the conceptual framework for analyzing the performance of interregional grain trade in terms of efficiently allocating grain over space. Building on the standard parity bounds model, an empirical model that allows for an adjustment path and a test of structural change in spatial market efficiency due to policy changes is developed and outlined.

4.2 Conceptual Framework

A recent review of models used in spatial price analysis can be found in Fackler and Goodwin (2001). In general, empirical tests of the performance of spatially separated markets are conducted within the framework of spatial price equilibrium (SPE) theory developed by Enke (1951), Samuelson (1964) and Takayama and Judge (1964). The key prediction of this theory is that price relationships between spatially separated competitive markets depend on the size of transfer costs. In particular, in spatially efficient markets the price difference between regions engaged in trade should be less than or equal to transfer costs.

Consider two markets located in different regions (i and j) that may engage in trade for a given homogenous commodity. For the two regional markets, the autarky prices (prices which equalize the supply and demand in respective regional markets without trade) at time t for market i and j can be represented as:

$$(4.1) P_{it}^A = \alpha_{it} + \zeta_{it}$$

$$(4.2) P_{jt}^A = \alpha_{jt} + \zeta_{jt}$$

where α_{it} and α_{jt} are time varying mean autarky prices which depend on supply and demand shifters in the local markets, and ζ_{it} and ζ_{jt} are stochastic disturbance terms affecting the autarky prices in the respective regional markets. The transfer costs, TC_{jit} , for conducting interregional trade between the two regional markets at time t is modeled as a random variable with time varying mean transfer costs, γ_{jit} and random component e_{jit} :

$$(4.3) TC_{jit} = \gamma_{jit} + e_{jit}$$

where e_{jit} is normally distributed with mean zero and variance σ_e^2 for all trade regime probabilities. Given the above formulation of autarky prices and transfer costs, three mutually exclusive and exhaustive spatial arbitrage conditions or trade regimes could be

identified based on the relative sizes of contemporaneous spatial price differentials and transfer costs.¹⁷

In regime one, trade may or may not be occurring and the spatial price differential is equal to transfer cost:

$$(4.4) \ P_{it} - P_{jt} = TC_{jit}$$

where P_{it} and P_{jt} are contemporaneous prices in the i^{th} and j^{th} regional markets, respectively. This is a condition for a spatially efficient market either with or without trade. In this regime, due to competitive pressure in the marketing system, the traders are not making excessive or economic profits from regional trade. With trade between the two regional markets, the actual prices P_{it} and P_{jt} may differ from the autarky prices and the price movements in different markets are related due to changes in either market's supply and demand conditions or the stochastic disturbance terms.

In regime two, the spatial price differential is less than transfer cost and is given as:

$$(4.5) \ P_{it} - P_{jt} < TC_{jit} .$$

This regime represents a market condition where no profitable arbitrage opportunities exist between the two markets. The two markets may be in autarky but prices are

¹⁸ The assumption of contemporaneous relationship between spatial prices can also be relaxed. Thus, trading regimes that take into account the lag/lead relationships between the spatial market prices can also be formulated.

efficient. However, if there is trade it is inefficient because traders are making losses. This indicates that efficient allocation does not necessarily require physical trade flows between markets. In this regime the autarky prices and the actual prices are identical in the respective regional markets. The prices in the two regions are independent due to very high transfer costs, and shocks are not transmitted across the markets.

Finally, regime three is given as a condition where trade may or may not be occurring and the spatial price differential is greater than the transfer cost:

$$(4.6) \quad P_{it} - P_{jt} > TC_{jit} \quad .$$

In this regime, the spatial arbitrage condition is violated and the markets are not efficient but may be integrated to some extent if some trade is occurring. In this regime, there are opportunities for profitable spatial arbitrage that are not being exploited. If the markets are efficient, competition is expected to equalize the spatial price differentials and transfer costs, and the transfer costs are the largest price difference that can exist between two markets engaged in trade. It is argued that violation of the spatial arbitrage condition is an indication of the existence of impediments to trade between markets and should be considered as evidence supporting the lack of perfect market integration (Baulch, 1997). Among several conditions that may lead to regime three is the existence of transportation bottlenecks, non-competitive pricing practices, government controls on product flows between regions, government price support activities, licensing requirements, and quotas (Tomek and Robinson, 1990; Baulch, 1997). The empirical model is discussed next.

4.3 The Extended Parity Bounds Model

The empirical model developed here to analyze the effects of the policy changes on spatial grain market efficiency is a stochastic gradual switching model. Building on the earlier work of Baulch (1997), Sexton et al. (1991) and Spiller and Wood (1988), this model extends the standard PBM in two ways. First, it traces the time path of the effects of the policy changes on the spatial efficiency regime probabilities. This allows determination of whether the effect of the policy changes is instantaneous or gradual and if it is gradual the approach also allows the determination of the time period required for the full effects of the policy changes to be realized. Thus, the extended model provides a better understanding of the nature of transition from old to new policy regime. Second, the extended PBM also allows for statistical tests of structural change in the probabilities of spatial efficiency regimes due to the policy changes.

Let the probability of regimes one, two, and three defined as before be λ_1 , λ_2 , and λ_3 , respectively. Suppose that transfer costs are unobservable but known to be related to an (possibly biased) observable transfer cost estimate γ_{jit}^o . Then, the unobservable transfer costs can be modeled as:

$$(4.7) \quad TC_{jit} = \beta_0 + \beta_1 \gamma_{jit}^o + e_{jit}$$

where γ_{jit}^o is the observable transfer cost estimate, β_0 and β_1 are unknown parameters and e_{jit} is a random shock.¹⁸ The γ_{jit}^o is also given as:

¹⁸ The detailed discussion of the procedures used in the construction of grain transfer costs from cross-sectional surveys of grain traders and time series data on truck shipment freight rates is given in section 3.

$$(4.8) \quad \gamma_{jit}^o = \alpha_1 FR_t + \alpha_2 (P_{jit} + \alpha_1 FR_t)$$

where α_1 is the proportion of transport cost in the interregional grain trade computed from cross-sectional surveys of grain traders, FR_t is the freight rate at time t and α_2 is traders normal profit assumed to be 7% of the sum of grain purchase price (P_{jit}) plus $\alpha_1 FR_t$. Then, assuming that spatial prices and transfer costs are stochastic and the transfer cost between the two markets is independent of the direction of trade flows, we can redefine the conditions for regimes one, two and three given in equations (4), (5) and (6), respectively, as follows:

$$(4.9) \quad |P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o = e_{jit}$$

$$(4.10) \quad |P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o = e_{jit} - u_{jit}$$

$$(4.11) \quad |P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o = e_{jit} + v_{jit}$$

where u_{jit} and v_{jit} are non-negatively valued random variables that measure the deviation (if any) between price differentials and transfer costs. The error terms e_{jit} , u_{jit} , and v_{jit} are assumed to be normal, half-normal, and half-normal independently distributed random variables with standard deviation equal to σ_e , σ_u , and σ_v , respectively. The e_{jit} is an error term which applies to the transfer costs. The u_{jit} and v_{jit} are composite error terms of the

disturbance terms in the demand and supply functions for the pair of markets considered, and their magnitude depends on the relative imbalances between demand and supply in individual markets.

In regime one, the markets are spatially efficient and the variance of the spatial price differentials is given by the variance of transfer costs between the two markets, σ_e^2 . In other words, the variability in the spatial price differentials is explained fully by the variability in the transfer costs between the two markets. Then, the parity bounds (or confidence interval) for the spatial price differentials can be constructed using the variance of the disturbance term for regime one and the exogenously given or endogenously estimated transfer costs. Thus, the parity bounds for spatial price differentials can be given as $\beta_0 + \beta_1 \gamma_{jit}^o \pm Z\sigma_e$, where Z is a critical value for normal distribution at a given statistical significance level. On the other hand, the variance of the spatial price differentials under the autarky condition is given as $\sigma_e^2 + \sigma_u^2$ while the variance of spatial price differentials for regime three is given as $\sigma_e^2 + \sigma_v^2$.

Let the contemporaneous difference between spatial price differentials and transfer costs be given as a random variable $\pi_i = |P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o$, where π_i can be considered as expected “economic” profit made from regional trade.¹⁹ Then, the joint probability density function for π_i over the entire trading regime is given as:

$$(4.12) \quad f_i(\pi_i | \theta) = \lambda_1 f_{1i}(\pi_i | \theta) + \lambda_2 f_{2i}(\pi_i | \theta) + (1 - \lambda_1 - \lambda_2) f_{3i}(\pi_i | \theta)$$

¹⁹ The spatial price differential is also corrected for losses during storage and transporting grain and the procedure used is discussed in chapter 6.

where λ_1 , λ_2 and $\lambda_3 = (1 - \lambda_1 - \lambda_2)$ are defined as before; the f_{it} 's are mixture normal distributions which are given for regime one, two, and three, respectively; and θ is a parameter vector (λ_1 , λ_2 , λ_3 , β_0 , β_1 , σ_e^2 , σ_u^2 , and σ_v^2) to be estimated. The probability density function for regime one is the ordinary normal density function while for regime two and regime three the density functions are truncated half-normal density functions and are given as follows:

$$(4.13) \quad f_{1t} = \frac{1}{\sigma_e} \varphi \left[\frac{|P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o}{\sigma_e} \right]$$

(4.14)

$$f_{2t} = \left[\frac{2}{(\sigma_e^2 + \sigma_u^2)^{1/2}} \right] \varphi \left[\frac{|P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o}{(\sigma_e^2 + \sigma_u^2)^{1/2}} \right] \left[1 - \Phi \left[\frac{(|P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o) \frac{\sigma_u}{\sigma_e}}{(\sigma_e^2 + \sigma_u^2)^{1/2}} \right] \right]$$

(4.15)

$$f_{3t} = \left[\frac{2}{(\sigma_e^2 + \sigma_v^2)^{1/2}} \right] \varphi \left[\frac{|P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o}{(\sigma_e^2 + \sigma_v^2)^{1/2}} \right] \left[1 - \Phi \left[\frac{-(|P_{it} - P_{jt}| - \beta_0 - \beta_1 \gamma_{jit}^o) \frac{\sigma_v}{\sigma_e}}{(\sigma_e^2 + \sigma_v^2)^{1/2}} \right] \right]$$

where $\varphi (\cdot)$ and $\Phi (\cdot)$ denote the standard normal probability density and cumulative distribution functions, respectively.

The likelihood function for π_t based on the joint probability density functions defined above for the different trade regimes over the entire study period is given as:

$$(4.16) L = \prod_{t=1}^T [\lambda_1 f_{1t} + \lambda_2 f_{2t} + (1 - \lambda_1 - \lambda_2) f_{3t}].$$

The parameters can be obtained by maximizing the logarithm of the above likelihood function using numerical optimization. However, this is the standard PBM that does not allow us to see the adjustment paths and the effects of the policy changes on the probabilities of different trade regimes.

Park et al. (2002) were the first to apply the PBM to analyze the effects of market reform on spatial market efficiency. Park et al. (2002) estimated the relative frequencies of realized spatial arbitrage opportunities for Chinese grain markets over four sub-periods under the implicit assumption that the effects of policy changes on the regime probabilities are instantaneous. Here, however, we allow both for instantaneous and gradual change in regime probabilities due to the policy changes. In other words, our model allows us to estimate the length of adjustment period required for the full effects of policy changes to be realized.

Our proposed PBM extension changes the standard PBM from a stochastic switching model to a stochastic switching model with gradual probability changes. Hereafter we call this the extended parity bounds model (EPBM). The model allows the identification of time paths characterizing the structural changes in regime probabilities as a result of the policy changes. It is possible that there may be immediate adjustment from the old to the new policy regime, which implies that the full effects of the policy changes are instantaneous or abrupt. However, the assumption of instantaneous adjustment in market conditions in response to policy changes may be unrealistic. It might take some time for the traders to learn and understand the new policy changes,

assess the implications for reorganizing their business, make investment and disinvestment decisions, and to obtain resources required to make necessary adjustments. The EPBM allows determining the path of structural changes in regime probabilities as a result of the policy changes.²⁰

To accomplish the above objectives we modify the joint probability density function and likelihood function for standard PBM given in (12) and (13) as follows:

(4.17)

$$f_t(\pi_t | \theta) = \lambda_1 f_{1t}(\pi_t | \theta) + \delta_1 D_t f_{1t}(\pi_t | \theta) + \lambda_2 f_{2t}(\pi_t | \theta) + \delta_2 D_t f_{2t}(\pi_t | \theta) + (1 - \lambda_1 - \lambda_2 - \delta_1 D_t - \delta_2 D_t) f_{3t}(\pi_t | \theta)$$

(4.18)

$$L = \prod_{t=1}^T [\lambda_1 f_{1t} + \delta_1 D_t f_{1t} + \lambda_2 f_{2t} + \delta_2 D_t f_{2t} + (1 - \lambda_1 - \lambda_2 - \delta_1 D_t - \delta_2 D_t) f_{3t}]$$

where δ_k measures the structural change in the probability of being in regime k due to the policy changes and D_t is a transition variable which characterizes the alternative time path of structural change in regime probabilities and is constructed following Ohtani and Katayama (1986) as described below.

Let the end date of the old marketing policy regime and the beginning date for realization of the full effect of the new policy on regime probabilities be denoted by τ_1 and τ_2 , respectively. Then, D_t takes the value of 0 for τ_1 and earlier dates, between 0 and 1

²⁰ The information on the nature of the adjustment path across several markets is useful to see if there are differential responses to policy changes among different markets and to determine what policy changes are required in order to speed up the response.

for the period between τ_1 and τ_2 , and 1 for τ_2 and later dates. The length of period between τ_1 and τ_2 represents the length of transition period required for the adjustment in the grain marketing system before the full effects of the policy changes on trade regime probabilities are realized.

The pattern of transition from τ_1 to τ_2 can be represented using different functional forms (linear or non-linear). Figure 2.1 shows alternative linear time paths for the transition from τ_1 to τ_2 as represented by different D_t 's. For example, if the length of transition period is 10 months then 1/10 (10%) of the adjustment occurs every month and by the 5th month half of the adjustment is complete. Thus, the linear functional form for the transition period assumes constant speed of adjustment over the whole transition period.²¹ In our model, τ_1 is known but τ_2 is treated as a parameter to be estimated. The log likelihood function is maximized for different possible τ_2 values and the τ_2 value that has the maximum log likelihood function is selected. The different lengths of transition period are captured by using $N-\tau_1$ different transition variables corresponding to each time period since the introduction of the new policy regime, where N is the total number of observations. In our case, $N-\tau_1$ is equal to 35 and thus the number of maximized log likelihood values is 35.

The approach followed here is similar to that of Moschini and Meilke (1989), which is used in the estimation of the time path of structural change in U.S. meat demand. However, there is one basic difference between our approach and Moschini and Meilke (1989). In the case of Moschini and Meilke (1989), both the starting date (τ_1) and

²¹ In other studies of structural changes, functional forms which allow for different speed of adjustment during the different times of the transition period are also used (for example, see: Goodwin and Brester, 1995).

the end date (τ_2) are to be estimated from the model. But in our case the starting date is known and only the end date is to be estimated from the model. The optimum length of transition period is given by the length of time elapsed between τ_1 and τ_2 . The case where τ_2 is equal to τ_1+1 (a period immediately after the policy changes) represents abrupt or instantaneous change in policy regime which implies no transition period.

On the other hand, τ_2 greater than τ_1+1 represents a gradual transition from old to the new policy regime. The length of transition period depends on the flexibility that grain traders have to make investment or disinvestment decisions as deemed necessary in response to the new marketing policy changes. It also depends on the extent of awareness of grain traders about the new marketing policy changes and how they perceive the effects of policy regime changes on their grain business operation. It can be hypothesized that different grain traders in different regions have different capacity and ability to assess and respond to changes in the marketing policy environment.

The case where the effect of the policy changes is instantaneous is a special case of EPBM which is equivalent to separately estimating the PBM parameters for different sub-periods. This corresponds to the Park et al. (2002) specification. The joint test of structural changes in all regime probabilities is conducted using the likelihood ratio test based on the restricted (no structural change) and unrestricted EPBM parameter estimations. The restricted EPBM is estimated by setting all δ 's to zero which means under the null hypothesis of no structural change the LR test statistic is χ^2 distributed with three degrees of freedom. In addition, where the LR test shows significant structural change, individual t-tests are used to test significance of EPBM parameters. For example,

statistically significant values for δ_k indicate that there has been structural change in the probability of trade regime k as a result of a given policy change.

Thus, the probabilities for the different trade regimes are determined simultaneously for the three periods: (1) period before the policy changes, (2) during the transitional period, (3) the period during the full effect of the policy changes. For example, a time path of structural change in a regime probability where the probability has increased as a result of policy change is given for a hypothetical case in Figure 2.2. For the period before the policy changes, the probability estimates for the different trade regimes are given by λ_i . On the other hand, the probability estimates for the transition period and after the full effect of the policy changes is realized are given as:

$$(4.19) \lambda_i + \delta_i D_t .$$

Since the parameter estimates are probabilities, the probabilities for a given time period should add up to one over the entire trade regimes, which requires the impositions of the following restrictions during the estimation procedure:

$$(4.20) 0 \leq \lambda_i \leq 1$$

$$(4.21) 0 \leq \lambda_i + \delta_i \leq 1$$

$$(4.22) \sum \lambda_i = 1$$

$$(4.23) \sum \delta_i = 0$$

In general, the EPBM represents an improvement over the standard PBM in that it allows tracing of the time path and a statistical test of structural change in spatial market efficiency due to the policy changes. However, the EPBM also has several weaknesses similar to that of the standard PBM which are discussed by Fackler (1996). First, the results are often sensitive to the distributional assumptions made. Second, the difficulty in accurately estimating the transfer costs might also bias the results. Third, there is also the identification problem that any estimated effects may be due to other changes that occurred around the time of the policy change.

4.4 Estimation Procedures

There are four basic stages in EPBM estimation. The first stage is to collect grain prices and transfer cost data. The second stage is to specify the appropriate log likelihood function to be maximized using a maximization algorithm. The third stage is to determine the optimum time length required for the transition from old to new policy regime. The optimum time length is determined by maximizing the value of log likelihood function for all possible time lengths of transition period. Finally, the EPBM parameters estimates are obtained conditional on the optimum length of time required for the transition from the old to the new policy regime.

The log likelihood function being maximized to obtain EPBM parameters estimates is highly non-linear. As a result, there are two major problems that might be

encountered in numerical maximization: (1) the existence of multiple local maxima, and (2) lack of convergence. There are several strategies that can be used to tackle these problems, as discussed in the TSP users guide (Hall and Cummins, 1999). These strategies include: (1) the choice of appropriate maximum likelihood estimation algorithm, (2) the choice of appropriate starting values, and (3) grid search on certain difficult parameters or full grid search on all parameters. In addition, graphical analysis of the relationship between spatial price differentials and the transfer costs series is also useful in assessing the EPBM estimates.

There are several algorithms provided in TSP to maximize the log likelihood function. In our case, we used the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm, which is found to perform best in our situation as compared to other algorithms available. The BFGS uses analytic first derivatives and a rank one update approximation to the Hessian (Hall and Cummins, 1999). During the estimation procedure, the values of regime probabilities are restricted to the range between 0 and 1 and the standard deviations are also restricted to be positive using implicit functional forms.

4.5 Conclusions

In the context of on-going market reform in developing countries, there is a need for an improvement in the existing methods of spatial market efficiency analysis in order to better inform the debate toward designing and implementing new grain marketing policies that facilitate the emergence of a well developed and competitive grain marketing system. The standard parity bounds model, while it addresses most of the weaknesses in the conventional methods, does not allow for a test of structural change in

spatial market efficiency as a result of policy changes. This dissertation, building on the standard parity bounds model, develops an empirical model that allows for tracing the time path of structural change in spatial market efficiency conditions due to the effect of policy changes. However, the EPBM also has several weaknesses similar to that of the standard PBM such as the sensitivity of the results to the distributional assumptions made.

Figure 4.1 Alternative Linear Time Paths of Structural Change in Trade Regime Probabilities

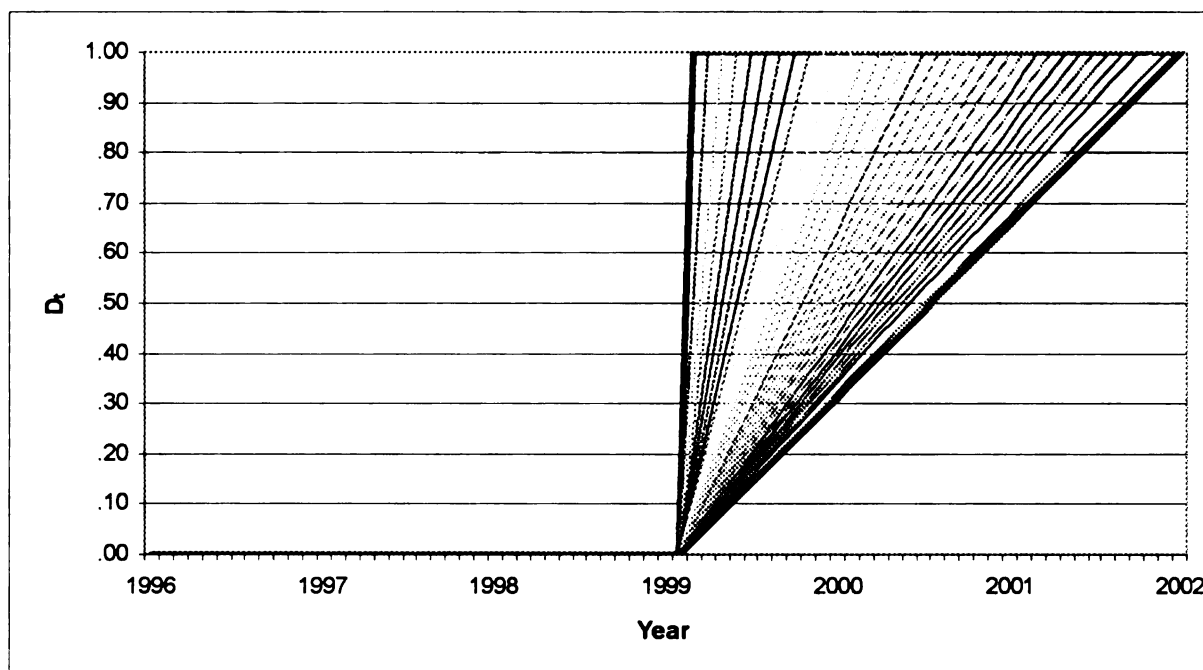
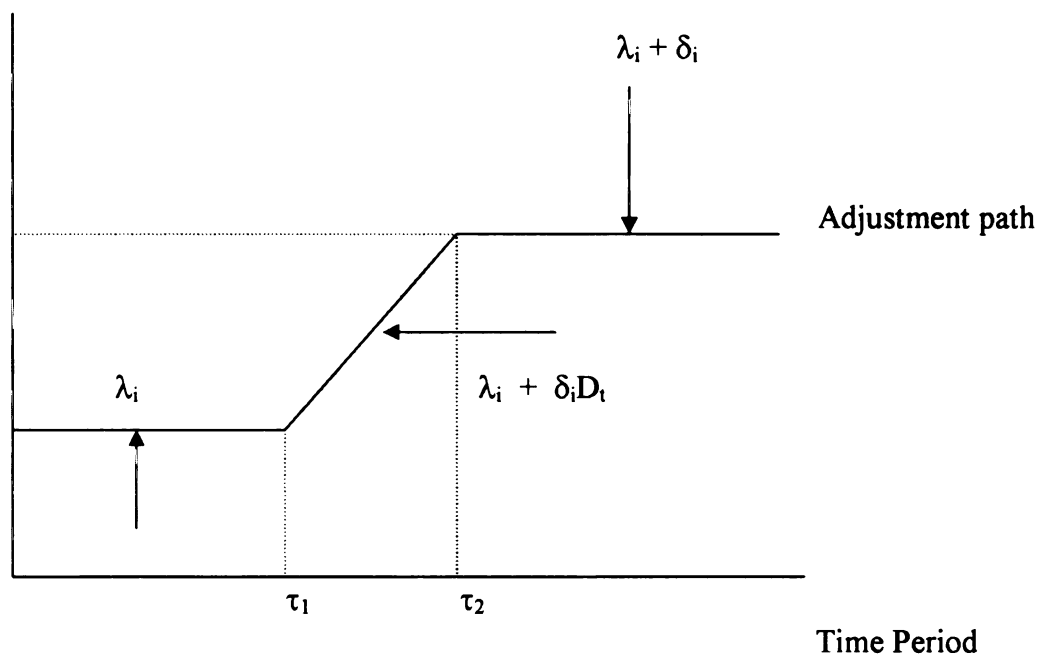


Figure 4.2 Time Path of Structural Change in Trade Regime Probability due to the Policy Changes for a Hypothetical Case

Regime probability



CHAPTER 5

MONTE CARLO SIMULATION EXPERIMENTS

5.1 Introduction

A Monte Carlo experiment is conducted to evaluate the performance of EPBM and improve understanding of how the PBM works. This is useful in the consequent implementation of the model using a real dataset. The simulated prices and transfer cost data are randomly generated by making assumptions regarding the distributional properties of the data series and using a well-defined economic model.

By construction, the simulated prices are spatially efficient (at equilibrium) each period. Then, in order to allow for inefficiencies in the marketing system, the equilibrium condition is shocked to create a wedge between spatial price differentials and transfer costs. In other words, the simulated data allow us to mimic the different trade regimes with known probabilities. The following sections present the details of the procedures used and the results of the Monte Carlo experiments.

5.2 Simulation Model

The simulation model used in conducting the Monte Carlo experiment is a two-location version of a three-location spatial equilibrium model developed by McNew and Fackler (1997). For a given homogenous commodity, each location is assumed to have a linear excess demand function:

$$(5.1) \quad q_{it} = b_i(a_{it} - p_{it}), \quad i = 1, 2$$

where q_{it} is the quantity of excess demand, b_i is the slope of the excess demand curve, a_{it} is the autarky price and p_{it} is the price in the market i when there is trade between the two locations. The necessary and sufficient conditions for equilibrium in a two-location model are that the excess demand for the two locations sum to zero and the complementary slackness condition between profits to spatial arbitrage and the quantity of trade is satisfied:

$$(5.2) \quad \sum q_i = 0, \quad i = 1, 2$$

$$(5.3) \quad p_{2t} - p_{1t} - tc_{12t} \leq 0, \quad s_{12t} \geq 0, \quad (p_{2t} - p_{1t} - tc_{12t})s_{12t} = 0$$

where tc_{12t} is a positive transfer cost required to move one unit of homogeneous commodity from location 1 to location 2 at time t ; and s_{12t} is the quantity of homogeneous product shipped from location 1 to location 2 at time t .²² There are three possible trade regimes based on the observed relative sizes of the spatial price differentials and transfer costs: (1) the efficient trade regime where the spatial price differentials and transfer costs are equal; (2) the autarkic trade regime where the spatial price differential is less than the transfer costs; and (3) the inefficient trade regime where the spatial price differential is greater than the transfer costs.

The price series used in the Monte Carlo experiments are constructed based on the spatial equilibrium conditions given in (5.2) and (5.3). Assuming that location 2 has a higher autarky price than location 1 and trade is taking place, the equilibrium prices for location 1 (p_{1t}) and location 2 (p_{2t}) are given as:

²² There can also be trade from 2 to 1, this is handled by assuming that there is symmetric transfer costs between 2 and 1 and taking the absolute value of spatial price differentials.

$$(5.4) \quad p_{1t} = \frac{1}{b_1 + b_2} (b_1 a_{1t} + b_2 a_{2t} - b_2 t c_{12t}),$$

$$(5.5) \quad p_{2t} = p_{1t} + t c_{12t}$$

The autarky prices in each market are assumed to have a first-order autoregressive structure:

$$(5.6) \quad a_{1t} = \mu_{10} + \mu_{11} a_{1t-1} + \varepsilon_{1t}$$

$$(5.7) \quad a_{2t} = \mu_{20} + \mu_{21} a_{2t-1} + \varepsilon_{2t}$$

where the μ 's are parameters which characterize the time series properties of autarky prices, ε_{1t} and ε_{2t} are disturbance terms for the respective autarky prices. In principle, there are several possible time series representations of autarky prices depending on the values of the μ s chosen. Here, to make the experiment simple, the constant terms (μ_{i0} 's) in the autarky prices equations are set to 0 and the coefficients on lagged autarky prices (μ_{i1} 's) are set to 1. Thus, the autarky prices are non-stationary unit-root processes with zero drift. The mean and variance of the disturbance terms for autarky prices can also vary, but here the time series observations for the disturbance terms are drawn from independent normal distributions with mean 0 and standard deviations of 2 using a random number generator. Then, given the initial autarky prices and the time series observations of disturbance terms, the autarky price series are created using equation

(5.6) and (5.7). The initial autarky prices for market 1 and 2 are set at 95 and 102, respectively.

The transfer cost between the two locations is assumed to be stationary and drawn from a normal distribution with mean 2 and standard deviation of 0.25. The initial transfer cost is set to 4. However, to create a wedge between the spatial price differentials and transfer costs, the mean value of transfer costs was either increased by 2 or decreased by 1 for some randomly selected observations. The observations on a given set of transfer cost and price data are randomly assigned to a given regime for each period using a uniform normal distribution. The choice of the number by how much to increase or decrease the transfer costs is arbitrary. However, the increase (decrease) should be sufficient for the spatial price differentials to lie below (above) the parity bounds, thus creating three trade regimes with known probabilities for a given policy regime.

After the prices and transfer costs are generated with known trade regime probabilities a Monte Carlo experiment is conducted to investigate the accuracy of EPBM in measuring the levels and changes in the actual trade regime probabilities for the simulated dataset. For this purpose, the time series observations of transfer costs and price data are divided into two periods (before and after policy change) with known but different trade regime probabilities under each policy regime. The actual probabilities of regime 1, 2, and 3 are 50%, 25%, and 25%, respectively before the policy change and 25%, 10%, and 65%, respectively, after the policy change. In the experiment, the above underlying true regime probabilities for the period before and after policy change are estimated conditional on zero time length required for adjustment. In order to assess the sensitivity of EPBM parameter estimates to sample size, the experiment is conducted for

three different sample sizes ($N = 76, 120, \text{ and } 200$) which are assumed to be representative of the lengths of available price series in developing countries. The simulation is repeated 1000 times for each sample size.

The EPBM is also tested for its accuracy in identifying the optimum length of time required for the full effect of policy change to be realized on regime probabilities. For this purpose, the data is simulated under 6 different time lengths required for adjustment: 0, 2, 5, 10, 15, and 20 periods. A sample size of 76 involving 500 replications is used for this simulation.

5.3 Results of the Simulation Experiments

The EPBM parameter estimates for each replication are obtained by maximizing the conditional log likelihood function given in equation (4.18).²³ The estimation results using the simulated data set are presented in Table 5.1. The summary statistics reported include sample means, bias, standard error, root mean square error, and minimum and maximum values for each parameter estimate. The sample means of EPBM parameter estimates is the average of the 1000 estimates from the simulation experiments. The experiments indicate that the sample mean is equal to the true EPBM parameter values to the nearest two decimal points.

The bias of the EPBM parameter estimate is obtained by subtracting the actual EPBM parameter value used in generating the simulated data set from the mean value of the corresponding EPBM parameter estimate obtained from the simulated dataset. The bias of EPBM parameter estimate indicates, on average, how much the estimator will over-estimate (positive bias) or under-estimate (negative bias) the actual parameter value.

²³ Conditional on zero time length for transition period

Both negative and positive biases are observed for the estimated parameters from the simulation experiment. However, the size of bias is very close to zero in all cases indicating the unbiasedness of EPBM in predicting the regime probabilities and capturing the structural changes in regime probabilities.

The precision of EPBM parameters estimators are also assessed using the standard error (SE) and the root mean square error (RMSE) of the estimates. The SE of the parameter estimate measures the dispersion of the parameter estimate around the sample mean. On the other hand, the RMSE measures the dispersion of the parameter estimate around the true parameter value. Both the SE and the RMSE measures are very close to zero indicating the EPBM parameter estimates are precise. The minimum and maximum values for the parameter estimates also indicate narrow ranges over which the EPBM parameter estimates are obtained.

Figure 5.2 shows the values of the log likelihood function under different time lengths for transition period. The estimated optimal time path for the simulated data set is also presented in Table 5.2. The results show that when the true lengths of the adjustment period in the data generating mechanism get higher the EPBM estimates of the length of time required for transition is biased downward in all cases, and the size of bias increases as the actual length of transition period underlying the data generating process increases. For example, the actual transition length of 0, 2, 5, 10, 15 and 20 periods are used in the simulation, the average estimated time lengths are 0, 1, 3, 7, 10, and 12 months, respectively. This indicates some caution should be exercised in using and interpreting results from estimation of the length of the adjustment period using the EPBM.

5.4 Conclusions

The results of Monte Carlo experiments indicate that the EPBM estimates the levels and the changes in trade regime probabilities with very high accuracy regardless of the sample size used, conditional on a zero time length for the transition period. The fact that the EPBM also performed very well in the small sample case is very encouraging given limited sample sizes often available for spatial price analysis. The EPBM provides unbiased prediction of the optimum length of transition period when the actual time length required for transition period is zero. However, the EPBM estimate of the length of the transition period is biased downward when the actual length required for the transition period is greater than zero. The size of bias also increases as the actual length of transition period increases. Thus caution must be exercised in using EPBM when the transition period is very long, for example, more than a year.

Table 5.1 Results of Monte Carlo Simulation Experiments to Assess the Performance of EPBM

Summary	PBM parameters			Structural changes		
Statistics	$\lambda_1=0.50^*$	$\lambda_2=0.25$	$\lambda_3=0.25$	$\delta_1=-0.25$	$\delta_2=-0.15$	$\delta_3=0.40$
N=76						
Mean	0.49973	0.25062	0.24965	-0.25036	-0.14885	0.39921
Bias	-0.00027	0.00062	-0.00035	-0.00036	0.00115	-0.00079
SE	0.00176	0.00360	0.00417	0.00198	0.00748	0.00788
RMSE	0.00178	0.00365	0.00419	0.00201	0.00756	0.00791
Min	0.49908	0.24982	0.19495	-0.27815	-0.17799	0.35032
Max	0.52751	0.27802	0.25044	-0.22643	-0.10012	0.45569
N=120						
Mean	0.49966	0.25086	0.24949	-0.25020	-0.14959	0.39980
Bias	-0.00034	0.00086	-0.00051	-0.00020	0.00041	-0.00020
SE	0.00132	0.00333	0.00358	0.00166	0.00566	0.00587
RMSE	0.00136	0.00344	0.00362	0.00167	0.00568	0.00587
Min	0.49926	0.24995	0.23351	-0.26694	-0.16699	0.36701
Max	0.51626	0.26695	0.25045	-0.23379	-0.11673	0.41721
N=200						
Mean	0.49968	0.25054	0.24978	-0.25024	-0.14908	0.39933
Bias	-0.00032	0.00054	-0.00022	-0.00024	0.00092	-0.00067
SE	0.00058	0.00206	0.00214	0.00118	0.00421	0.00438
RMSE	0.00066	0.00212	0.00215	0.00121	0.00431	0.00443
Min	0.49941	0.24993	0.23023	-0.26032	-0.17008	0.37037
Max	0.50965	0.27013	0.25039	-0.24025	-0.12007	0.42042

Note: * These are actual probabilities used in the simulation and convergence is achieved in all replications. The estimates are also conditional on instant transition from old to new policy regime.

Table 5.2 Results of Monte Carlo Simulation Experiments to Assess the Performance of EPBM Estimates of the Transition Period

Summary Statistics	Length of Adjustment in months (ℓ) [*]					
	$\ell=0$	$\ell=2$	$\ell=5$	$\ell=10$	$\ell=15$	$\ell=20$
Mean	0.038	1.188	3.006	6.998	10.014	12.004
Bias	0.038	-0.812	-1.994	-3.002	-4.986	-7.996
SE	0.381	1.494	0.118	0.265	0.161	0.245
RMSE	0.382	1.699	1.998	3.014	4.989	8.00
Min	0	1	2	6	10	11
Max	4	14	5	10	12	14
Mode	0(99.2%)	1(98.4%)	3(99.2%)	7(96.8%)	10(99.2%)	12(96.4%)

Note: ^{*} ℓ is the time length between τ_1 and τ_2 .

Figure 5.1 Simulated Spatial Price Differentials (SPD) and Transfer Costs (TC)

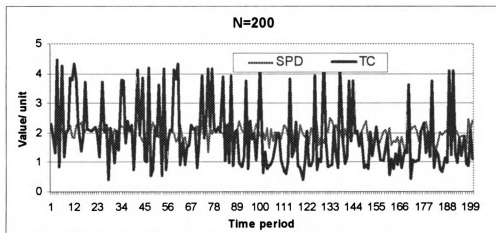
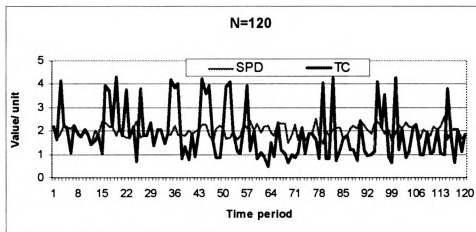
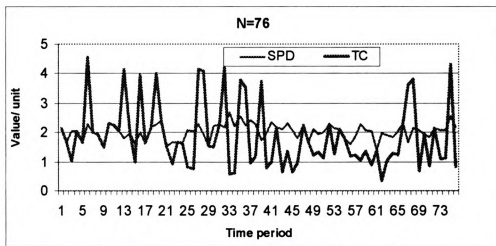
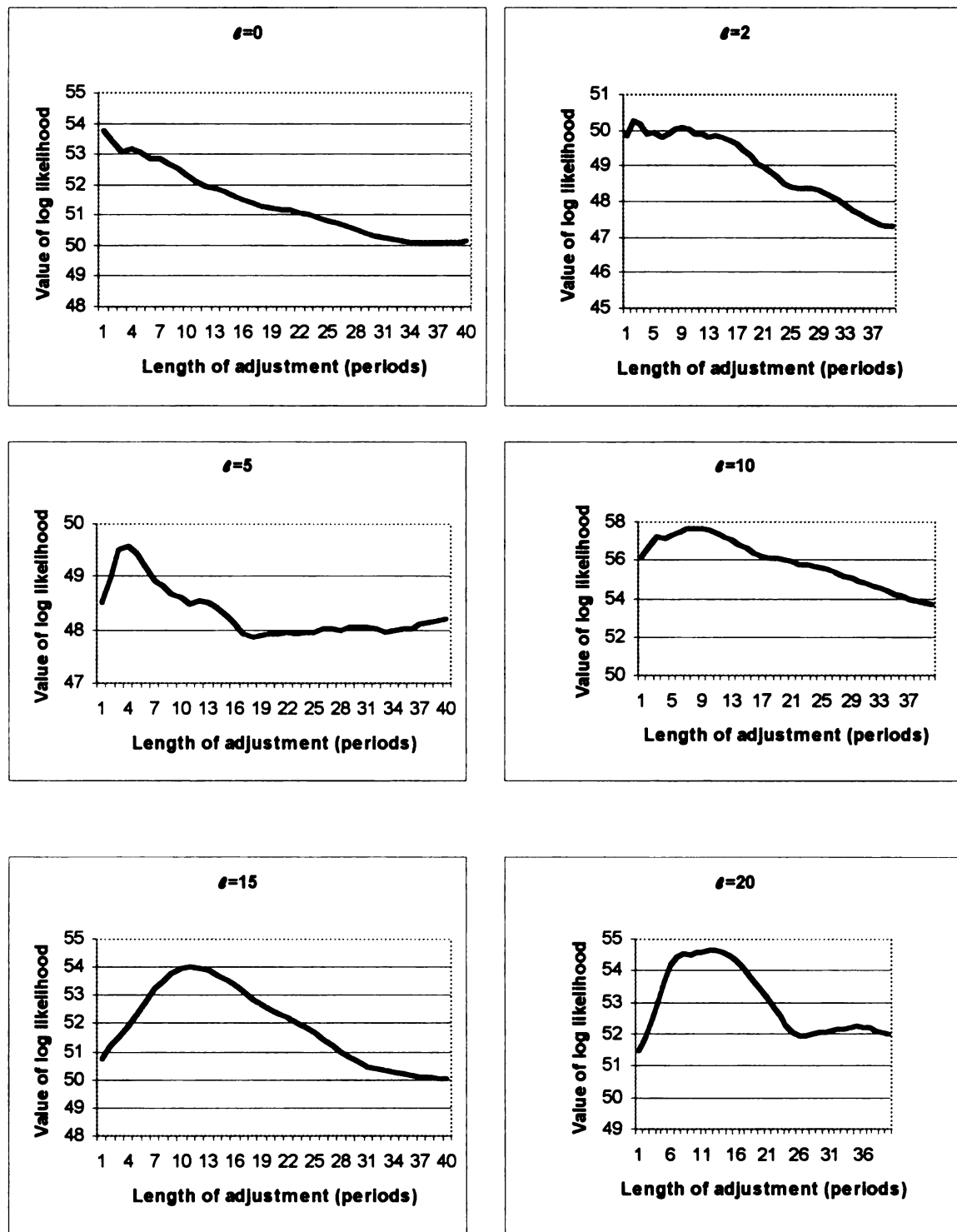


Figure 5.2 Log Likelihood Function for Different Lengths of Transition Period Using Simulated Dataset



CHAPTER 6

DATA SOURCES AND DESCRIPTION

6.1 Data Sources

There are two cereal crops, white maize and white wheat (from now on, simply referred to as maize and wheat), which are considered in this study based on the completeness of the dataset available, importance in interregional grain trade, and degree of homogeneity of consumer preferences. *Teff*, which is a very important staple crop in Ethiopia, is not included in this study due to the difficulties involved in examining spatial price relationships among regional *teff* markets. This is because *teff* varieties grown in different locations are heterogeneous and consumer preferences for these varieties are variable, but the available *teff* price data for Addis Ababa and other regional markets are based only on the color of *teff*. The more appropriate *teff* price data needed for spatial price analysis would be collected by color and origin of *teff*.

The main data required for estimating the parity bounds model are wholesale grain prices for different markets, interregional grain transfer costs and the start date for the new policy regime. For this purpose, weekly wholesale maize and wheat price data are obtained from the Ethiopian Grain Trade Enterprise (EGTE) for the period from August 1996 to August 2002.

Since August of 1996, the EGTE has collected weekly price data for different varieties of five major cereal crops at different stages of the vertical marketing channels (producer, wholesale and retail) in 26 markets. The cereal crops consisted of maize (white and yellow), *teff* (white, mixed, and red), wheat (white, red, mixed, and food aid

wheat), sorghum (white, yellow, and red), and barley (white, black and mixed).²⁴ The price data are collected by EGTE field staff who transmit weekly price data to the EGTE's headquarters in Addis Ababa by telephone. Then, the price data are entered into computer spreadsheets and compiled for further analysis or for distribution of raw data to various users.

The weekly price series are converted into monthly series by taking the unweighted mean of weekly price observations for a given month. The weekly price series is converted into monthly price series for two main reasons. First, the frequencies of transfer costs were monthly or annual, so monthly aggregation is needed to have comparable levels of aggregation for both wholesale prices and transfer costs. Second, the use of low frequency (monthly or annual) price data is recommended in order to allow sufficient time for the realization of inter-market arbitrage (Baulch, 1997).

The EGTE has also collected qualitative weekly grain flow data for the same markets and this data is available for the periods from August 1997 to June 1998 and from January 1999 to August 2002. The grain flow data collection was interrupted for six months, from July 1998 to December 1998. This period coincides with the last phase of the Grain Market Research Project. After GMRP was phased out in 1998, the grain price and flow data collection has continued with the financial support from the European Union (EU). For the selected commodities, the EGTE grain flow dataset consists of market level weekly data on total quantity purchased in the market, percentage purchased outside the market, the first and second most important sources of grain inflows to the

²⁴ A well-organized and systematic grain price and flow data collection was started by Grain Market Research Project (GMRP) in August of 1996 having EGTE as an institutional home. The Grain Market Research Project was a collaborative research project among Ministry of Economic Development and Cooperation (MEDaC) of Ethiopia, Michigan State University (MSU) and USAID/Ethiopia.

market, total quantity sold in the market, percentage sold outside the market and the first and second most important destinations of grain outflows from the market.²⁵

Interregional grain transfer costs are estimated using cross-sectional surveys on marketing costs of interregional grain trade and time series truck shipment freight rates data. The marketing costs of interregional grain trade are calculated based on two cross-sectional surveys of grain traders in Ethiopia. The first survey was conducted by Gabre-Madhin in 1996 while the second one was conducted in 2002 by International Food Policy Research Institute (IFPRI) and International Livestock Research Institute (ILRI). These surveys document detailed marketing costs on the latest transaction involving either intraregional or interregional grain trade.

Monthly and annual time series freight rates data are collected from MEDaC and the Ministry of Transport Authority (MTA) for the period from 1993 to 2002. The portion of the freight rate dataset series which is available only on an annual basis is converted into a monthly series using a monthly freight rate index constructed from the monthly freight rate series. Next, the construction of estimates of total grain transfer costs using these two sources of data are discussed.

6.2 Construction of Interregional Grain Transfer Costs

A complete time series data on interregional grain transfer cost is rarely available, particularly in developing countries like Ethiopia. Given this problem, several approaches have been used in measuring the transfer costs data needed for the implementation of the PBM. If time series transfer cost data is readily available, it can be considered exogenous

²⁵ The important sources and destinations markets are determined based on subjective assessment of EGTE filed staff and no actual grain flows are recorded by sources and destinations.

in the PBM analysis (e.g., Barrett et al., 2000; Barrett and Li, 2002). However, if time series transfer cost data is not available, there are two alternatives. The first alternative is to estimate the transfer costs using the PBM based on the observed spatial price differentials (e.g., Park et al., 2002). However, this implicitly assumes a time invariant transfer cost. The second alternative is to estimate transfer cost data either using the marketing cost computed from grain trader surveys and adjusting for inflation (e.g., Baulch, 1997) or inflating the time series transport cost data by a certain percentage to account for the unmeasured components of transfer costs (e.g., Penzhorn and Arndt, 2002).

In our case, the specific procedures used in calculating interregional grain transfer costs data for the implementation of the EPBM are as follows. The first step is to calculate variable marketing costs for recently completed interregional grain trade from cross-sectional surveys of grain traders. Following Gabre-Madhin (1996), the marketing cost is classified into eight broad categories: sacking, handling, storage, transport, roadblocks, broker's service, travel, and tips and others. The average variable marketing costs estimated for both 1996 and 2002 are roughly the same, about 26 Birr/100 kg (Table 6.4). An examination of the structure of variable marketing costs indicates that the transport cost is one of the most important components of the cost. For example, in 1996 about 61% of variable marketing cost is attributed to transport while in 2002 this percentage is 72%. The unweighted average percentage of transport cost in the variable marketing cost for the two sample grain traders' surveys is found to be 68.16%.²⁶

²⁶ The percentage of transport cost in the variable marketing cost is computed for the aggregate overall surveyed markets instead of computing it for individual markets or specific trade routes. This is because of limited number of observations for individual markets and trade routes in the grain trader surveys. The assumption of constant percentage of transport costs in marketing costs may be very strong and implies that

In the second step, the computed unweighted average percentage of transport cost is applied to time series freight rate data in order to obtain time series data on variable marketing costs. For example, if transport cost accounts for 50% of the variable marketing cost, the time series variable marketing cost data is generated by multiplying the time series freight rates by two.²⁷

The opportunity cost of the wholesale grain trader as a manager of a grain business is also included in the computation of the variable marketing cost of regional grain trade. Thus, the computed value of interregional grain transfer cost is given as the sum of the variable marketing costs and regional grain traders' 'normal' profit margin. In the context of regional grain trade, the 'normal' profit margin could be the minimum profit the regional wholesale trader would be willing to accept to engage in interregional grain trade. In other words, the normal profit is what the regional trader would earn from the second best alternative employment. There is no readily available estimate of traders' normal profit in Ethiopia. In this study, following Dessalegn et al. (1998), the regional grain traders' normal profit is assumed to be 7% of the sum of wholesale grain price in the exporting market and variable grain marketing costs.²⁸ Finally, the computed

the only source of temporal variation in the transfer cost data is the freight rate. However, here the transfer cost computed from the trader's survey is used only as a starting point in the EPBM estimation. Hence the assumption of constant percentage might not be as restrictive as it initially appears.

²⁷ The fixed/ operating costs like vehicle maintenance, storage and pest control, taxes and fees, wages, losses and costs of capital are difficult to obtain and are not included in the computation of marketing cost.

²⁸ Conceptually, the opportunity cost of those engaged in grain trade must be included in the computation of grain transfer cost. However, there is difficulty in obtaining accurate opportunity cost for managers of grain trade business and as a result very rough assumptions are made regarding trader's normal profit. For example, Baulch (1997) adds certain fixed margins to the freight rates in order to derive the transfer costs. In our case, the normal profit is given as 7% of marketing costs and grain purchase price in the export market. The actual normal profit margin could be lower or higher than 7%. However, this assumption may not have a very significant impact on the EPBM results as the transfer costs computed from trader surveys are used only as starting points in the parametric estimation of transfer costs using the EPBM.

interregional grain transfer costs is used as a starting point in the subsequent estimation of interregional grain transfer costs and trade regime probabilities using the EPBM.

The spatial price differentials are obtained by taking the differences between the wholesale grain prices in the importing and exporting markets after adjusting the wholesale prices in the importing markets for grain losses (due to, for example, weight losses, pests, spillages, etc.,) in the process of exporting grain. In this study, an average of 2.18% grain loss in transporting grain from one regional market to another is assumed based on the estimate from grain trader survey by Dessalegn et al. (1998). They indicated that 83% of the surveyed merchants experience weight loss ranging from 0.1% to 16%. Thus, the importing market wholesale prices are multiplied by 0.9782 ($1 - 0.0218$) to obtain the spatial price differentials used in the EPBM estimation.

6.3 Descriptive Analysis

6.3.1 Wholesale Grain Prices

Descriptive statistics for the price data used for this study are given in Table 6.1. One important observation is that both maize and wheat wholesale price levels have declined in all markets after the grain marketing policy changes in October 1999. The average wholesale prices for maize decreased by 3 to 28 Birr/ 100 kg, depending on the markets while for wheat the wholesale prices have decreased by 6 to 36 Birr/ 100 kg. On the other hand, the levels of price variability as measured by the coefficient of variation have increased after the policy change for all maize and wheat markets considered. The coefficient of variation for maize markets increased from 1% to 14% while for wheat markets it increased from 5 to 17%. The observation of minimum and maximum values

also shows that prices fluctuated widely for both maize and wheat. The other notable feature of the price series is that the level of variability is higher for the markets in the surplus producing areas than the markets in the deficit regions.

From the plots of maize and wheat wholesale prices, a high level of co-movement is observed in the selected maize and wheat market pairs (Figures 6.1 and 6.2). This is also reflected in large and statistically significant spatial correlation coefficients computed for the periods before and after policy changes and the entire study period (Table 6.2). For example, for the price series covering the entire study period, the price correlation coefficients are found to be greater than 0.80 for all maize market pairs and for 6 of 8 wheat market pairs. These high levels of co-movement might seem to indicate spatial grain market efficiency. However, a careful examination of the relationships between observed inter-market price differences and costs of transferring grain is required for a full investigation of this issue, which is the subject of this dissertation research.

6.3.2 Truck Shipment Rates

The summary statistics of open market truck shipment rates covering the period from 1994 to 2002 for inbound and outbound shipments in reference to Addis Ababa market are also presented in Table 6.3. The average freight rates have showed very little change during the period from 1994 to 2002. For outbound shipments, the average freight rates varied from 3.50 cents/100 kg/km to 4.5 cents/100 kg/km. The variability in freight rates on both outbound and inbound shipments is relatively low. For example, the coefficient of variation is less than 15% for 8 of 9 routes for outbound shipments and 8 of

9 routes on inbound shipments. In general, the freight rates were already high before the initiation of reforms and did not show a downward trend with the improvement in truck availability, which might be an indication of lack of competitive pressure in the transport sector. The high freight rate could also be due to high cost of operation on poor roads and increases in fuel prices.

6.3.3 Grain Transfer Costs and Spatial Price Differentials

The evolution of grain transfer costs and spatial grain price differentials for selected maize and wheat market pairs are given in Figure 6.3 and 6.4, respectively. The summary statistics are also given in Table 6.5. For the entire study period, the lowest level of maize spatial price differential, about 12 Birr/ 100 kg, is observed between Addis Ababa and Jimma markets. On the other hand, the highest maize spatial price differential, 34 Birr/ 100 kg, is observed between Addis Ababa and Mekele. The level of variability in maize spatial price differentials varied from 41% to 61% while it varied from 30% to 80% in the case of wheat. The spatial price differential variability is larger than the level of variability observed for grain transfer costs estimated from the survey and from the EPBM. For the selected market pairs where both maize and wheat are considered, the grain transfer costs estimated by EPBM are higher for maize than wheat in 5 of 6 cases.

6.4 Conclusions

The EGTE price and grain flow database provides an opportunity for the analysis of the effect of the policy changes on the spatial market efficiency in Ethiopia. However, a time series grain transfer cost data on interregional grain trade is not available. In order

to overcome this problem, the grain transfer cost data is constructed using cross-sectional surveys of grain traders and truck shipment freight rate data available from secondary sources.

Table 6.1 Summary Statistics of Monthly Wholesale Prices (Birr/100 kg) of Maize and Wheat for Selected Markets (1996:08 to 2002:08)

Markets	Maize			Wheat		
	Mean	Min	Max	Mean	Min	Max
1996:08 to 1999:09						
Addis Ababa	103.41(26)*	63.00	169.50	174.26(16)	125.20	247.00
Bale Robe	--	--	--	126.34(18)	83.25	169.25
Dessie	112.50(22)	79.50	170.80	188.01(15)	142.50	264.25
Dire Dawa	126.24(22)	87.20	196.80	217.66(11)	174.50	268.00
Hosanna	101.21(27)	--	--	136.27(18)	93.75	188.00
Jimma	91.15(34)	47.50	164.75	--	--	--
Mekele	142.64(15)	115.25	189.00	243.69(7)	205.00	272.50
Nazareth	104.02(29)	58.25	175.19	165.01(17)	111.44	225.25
Nekempte	88.11(33)	45.00	151.56	--	--	--
Shashamane	92.68(33)	50.60	168.00	153.65(18)	102.80	209.50
1999:10 to 2002:08						
Addis Ababa	85.97(36)	48.50	133.75	160.74(25)	106.25	243.25
Bale Robe	--	--	--	108.08(32)	56.40	161.40
Dessie	98.98(30)	61.00	145.75	170.15(20)	108.50	223.60
Dire Dawa	123.67(23)	83.75	183.25	211.74(16)	147.50	267.00
Hosanna	--	--	--	118.22(35)	66.25	189.80
Jimma	71.31(43)	37.50	119.50	--	--	--
Mekele	120.88(28)	72.50	199.25	207.86(17)	135.94	252.00
Nazareth	90.08(33)	53.75	140.00	148.68(25)	97.63	222.50
Nekempte	60.12(47)	27.00	122.50	--	--	--
Shashamane	85.72(39)	45.25	145.40	138.13(31)	80.00	206.40
1996:08 to 2002:08						
Addis Ababa	95.05(32)	48.50	169.50	167.78(21)	106.25	247.00
Bale Robe	--	--	--	117.59(26)	56.40	169.25
Dessie	106.02(26)	61.00	170.00	179.45(18)	108.50	264.25
Dire Dawa	125.01(22)	83.75	196.80	214.82(14)	147.50	268.00
Hosanna	--	--	--	127.62(27)	66.25	189.80
Jimma	81.64(40)	37.50	164.75	--	--	--
Mekele	132.21(23)	72.50	199.25	226.51(14)	135.94	272.50
Nazareth	97.33(32)	53.75	175.19	157.18(22)	97.63	225.25
Nekempte	74.69(43)	27.00	151.56	--	--	--
Shashamane	89.34(35)	45.25	168.00	146.21(25)	80.00	209.00

Note: * Figures in parenthesis are coefficient of variation expressed in percentages and (--) indicates that statistics not computed because either data is not available or not relevant in that case.

Table 6.2 Spatial Correlation of Monthly Wholesale Prices (Birr/100 kg) of Maize and Wheat by Different Time Periods

Market pairs	Distance (km)	1996:08 to 1999:09		1999:10 to 2002:08		1996:08 to 2002:08	
		Maize	Wheat	Maize	Wheat	Maize	Wheat
Addis & Bale Robe	442	--	0.874	--	0.934	--	0.913
Addis & Dessie	402	0.936	0.873	0.985	0.937	0.964	0.911
Addis & Dire Dawa	515	0.890	0.779	0.827	0.884	0.832	0.847
Addis & Hosanna	232	--	0.944	--	0.924	--	0.930
Addis & Jimma	346	0.976	--	0.984	--	0.980	--
Addis & Mekele	783	0.855	0.570	0.907	0.766	0.885	0.681
Addis & Nekempte	327	0.929	--	0.947	--	0.931	--
Dire Dawa & Nazareth	417	0.908	0.683	0.778	0.849	0.832	0.785
Dire Dawa & Shashamane	572	0.911	0.749	0.704	0.850	0.804	0.814

Table 6.3 Summary Statistics of Open Market Truck Shipment Freight Rates (cents/100 kg/km) for Selected Routes in Ethiopia (1994 to 2002)

Transport Route	Outbound				Inbound			
	Mean	CV (%)	Min	Max	Mean	CV (%)	Min	Max
Addis ↔ Awassa	3.624	5	3.321	4.121	3.529	3	3.335	3.767
Addis ↔ Dessie	3.474	9	2.755	4.007	3.494	3	3.212	3.679
Addis ↔ Debre Markos	4.527	19	2.963	5.585	4.363	21	2.841	5.585
Addis ↔ Dire Dawa	3.980	13	2.877	5.863	2.872	16	1.941	3.845
Addis ↔ Gonder	3.701	6	3.233	4.137	3.371	6	2.886	3.733
Addis ↔ Jimma	3.577	7	3.072	4.631	3.538	6	3.340	4.137
Addis ↔ Mekele	3.950	10	2.873	4.797	3.487	3	3.124	3.651
Addis ↔ Metu	3.568	5	3.205	4.082	3.627	6	3.300	4.254
Addis ↔ Nekempte	3.576	6	2.540	4.111	3.516	4	3.277	4.035

Source: Computed based on data from Ministry of Economic Development and Cooperation (MEDaC), 1998; and Ministry of Transport Authority (MTA), 2002.

**Table 6.4 Structure of Grain Transfer Costs (Birr/ 100 kg) Based on
Cross-Sectional Surveys of Grain Traders**

Cost category	1996			2002		
	Mean	Min	Max	Mean	Min	Max
Sacking	1.31(118)	0.00	6.00	1.55(62)	0.00	5.60
Handling	1.96(49)	0.00	6.50	1.54(53)	0.00	4.00
Storage	0.08(350)	0.00	1.50	0.05(520)	0.00	2.00
Transport	15.38(73)	1.00	70.00	19.30(81)	2.00	93.00
Road blocks	2.43(113)	0.00	13.00	0.31(335)	0.00	5.25
Brokers	1.01(92)	0.00	5.50	0.57(118)	0.00	3.00
Travel	0.38(226)	0.00	6.00	0.85(227)	0.00	12.00
Tips/ others	3.37(264)	0.00	60.00	1.08(195)	0.00	10.05
Total cost	25.93(69)	4.00	113.00	25.24(65)	4.45	98.77
Transport (%)	60.72(26)	1.32	89.80	71.71(24)	8.85	97.22
Observations		150			129	

Source: Computed based on Grain trader surveys by Gabre-Madhin (1996) and IFPRI and ILRI (2002) for grain traders involved in interregional grain trade. Figures in parenthesis are coefficient of variation expressed in percentages.

Table 6.5 Summary Statistics of Grain Transfer Costs and Spatial Price Differentials for Maize and Wheat

Market pairs	Estimated Transfer costs (Birr/ 100 kg)		Absolute spatial price differentials (Birr/ 100 kg)	
	Maize	Wheat	Maize	wheat
1996:08 to 1999:09				
Addis & Bale	--	31.37(2)	--	44.12(31)
Addis & Dessie	13.31(9)	12.57(13)	9.67(68)	13.08(76)
Addis & Dire Dawa	30.54(15)	39.26(20)	20.82(55)	38.66(46)
Addis & Hosanna	--	21.71(12)	--	34.19(27)
Addis & Jimma	12.29(12)	--	10.61(65)	--
Addis & Mekele	32.26(9)	41.39(28)	36.13(40)	64.12(36)
Addis & Nekempte	20.19(1)	--	15.27(47)	--
Dire Dawa & Nazareth	25.40(17)	53.62(15)	20.26(56)	47.91(44)
Dire Dawa & Shashamane	38.45(18)	52.16(18)	30.56(41)	58.83(32)
1999:10 to 2002:08				
Addis & Bale	--	23.81(4)	--	49.15(30)
Addis & Dessie	14.37(12)	13.88(20)	11.00(46)	11.87(90)
Addis & Dire Dawa	32.35(17)	42.02(23)	35.23(48)	46.38(42)
Addis & Hosanna	--	23.22(19)	--	39.02(41)
Addis & Jimma	12.64(19)	--	12.79(43)	--
Addis & Mekele	32.94(9)	43.67(29)	32.27(43)	42.58(62)
Addis & Nekempte	20.27(1)	--	23.98(40)	--
Dire Dawa & Nazareth	27.08(19)	57.09(18)	31.90(55)	58.45(34)
Dire Dawa & Shashamane	40.27(19)	55.84(21)	36.89(57)	66.00(35)
1996:08 to 2002:08				
Addis & Bale	--	31.16(3)	--	46.54(30)
Addis & Dessie	13.82(11)	13.02(18)	10.31(57)	12.88(80)
Addis & Dire Dawa	31.41(16)	40.59(22)	27.73(58)	42.36(44)
Addis & Hosanna	--	22.43(16)	--	36.51(36)
Addis & Jimma	12.46(16)	--	11.66(54)	--
Addis & Mekele	32.94(9)	42.48(28)	34.28(41)	53.80(50)
Addis & Nekempte	20.23(1)	--	19.45(49)	--
Dire Dawa & Nazareth	26.20(19)	55.28(17)	25.84(61)	52.96(40)
Dire Dawa & Shashamane	39.34(19)	53.95(20)	33.64(52)	63.78(34)

Note: * Figures in parenthesis are coefficient of variation expressed in percentages and (--) indicates that the statistics not computed.

Figure 6.1 Co-movements in Maize Price Levels (1996:08 to 2002:08)

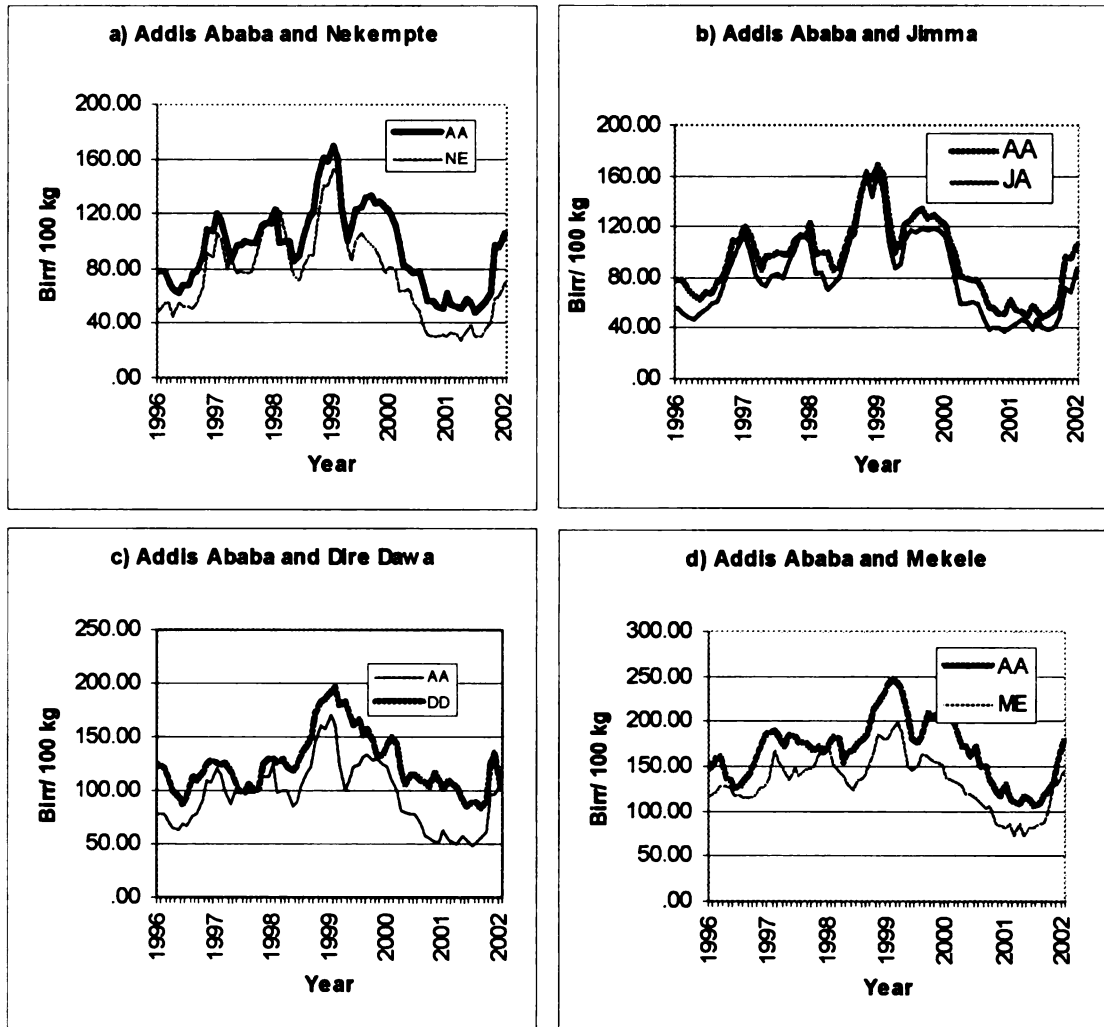


Figure 6.1 (Continued)

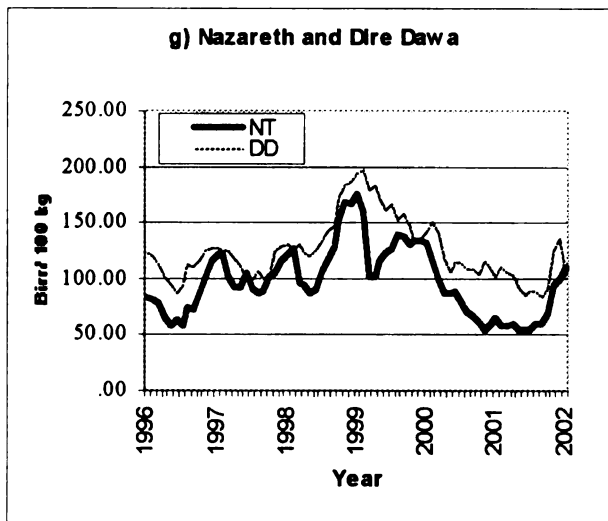
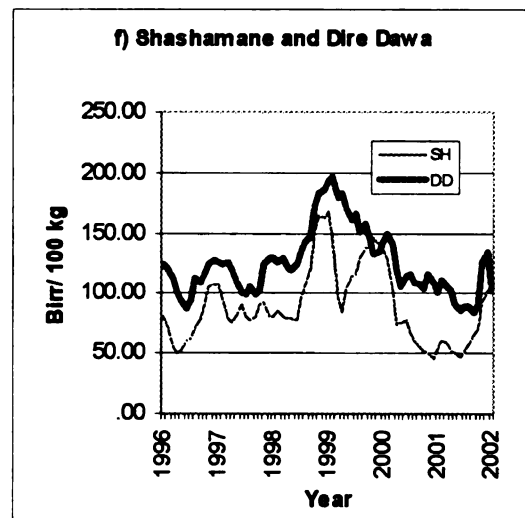
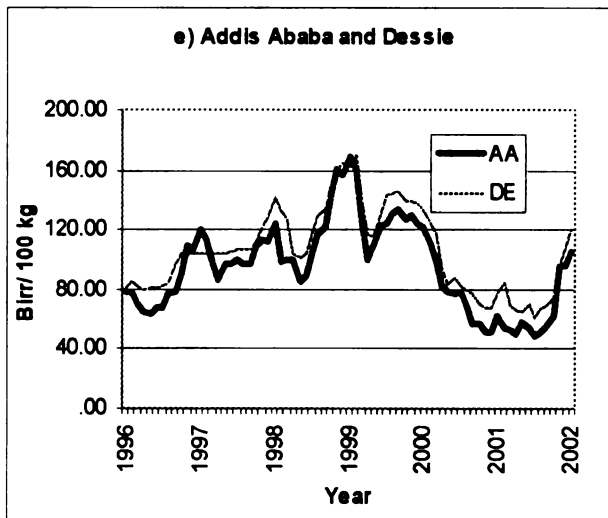


Figure 6.2 Co-movements in Wheat Price Levels (1996:08 to 2002:08)

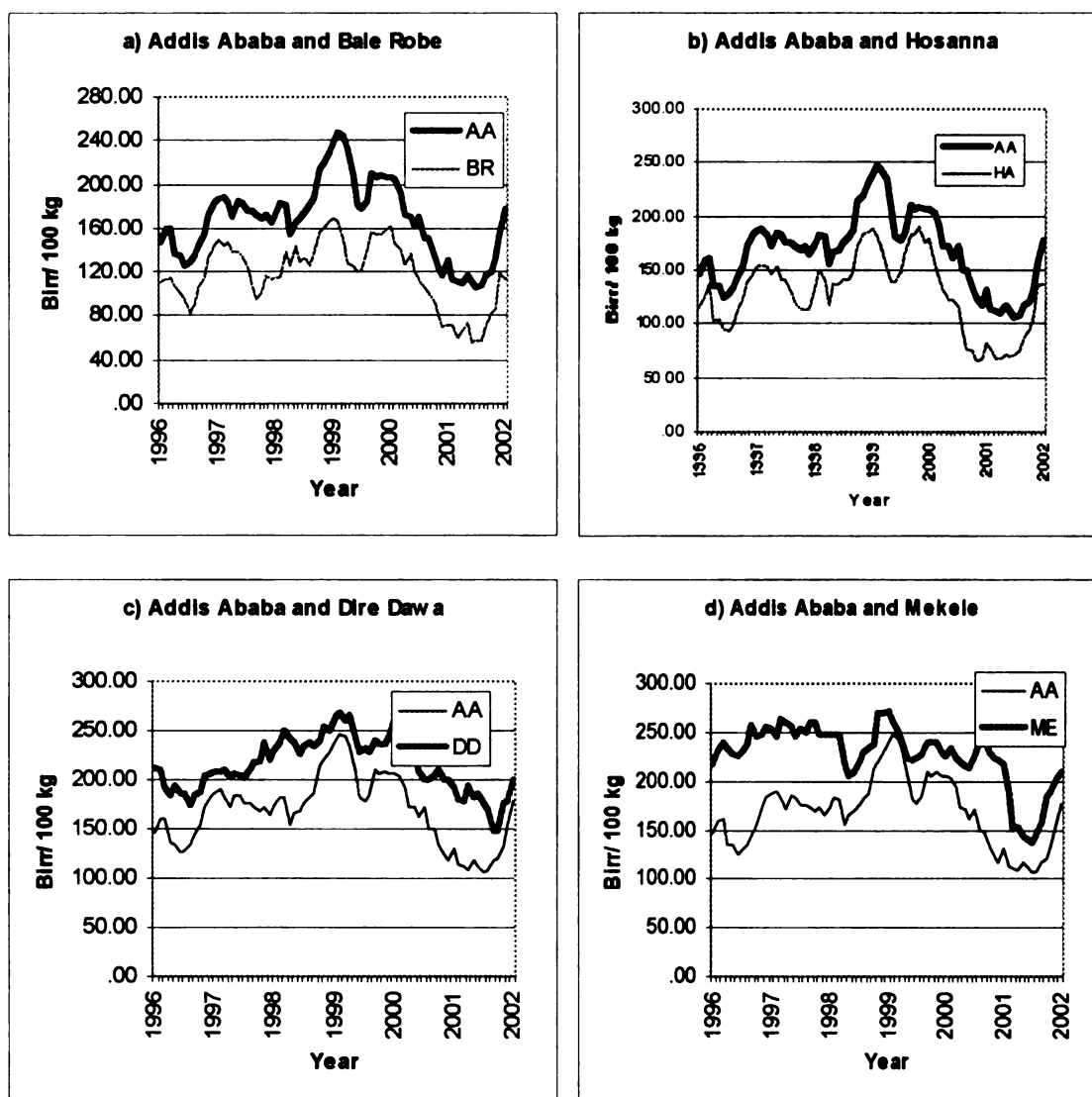


Figure 6.2 (Continued)

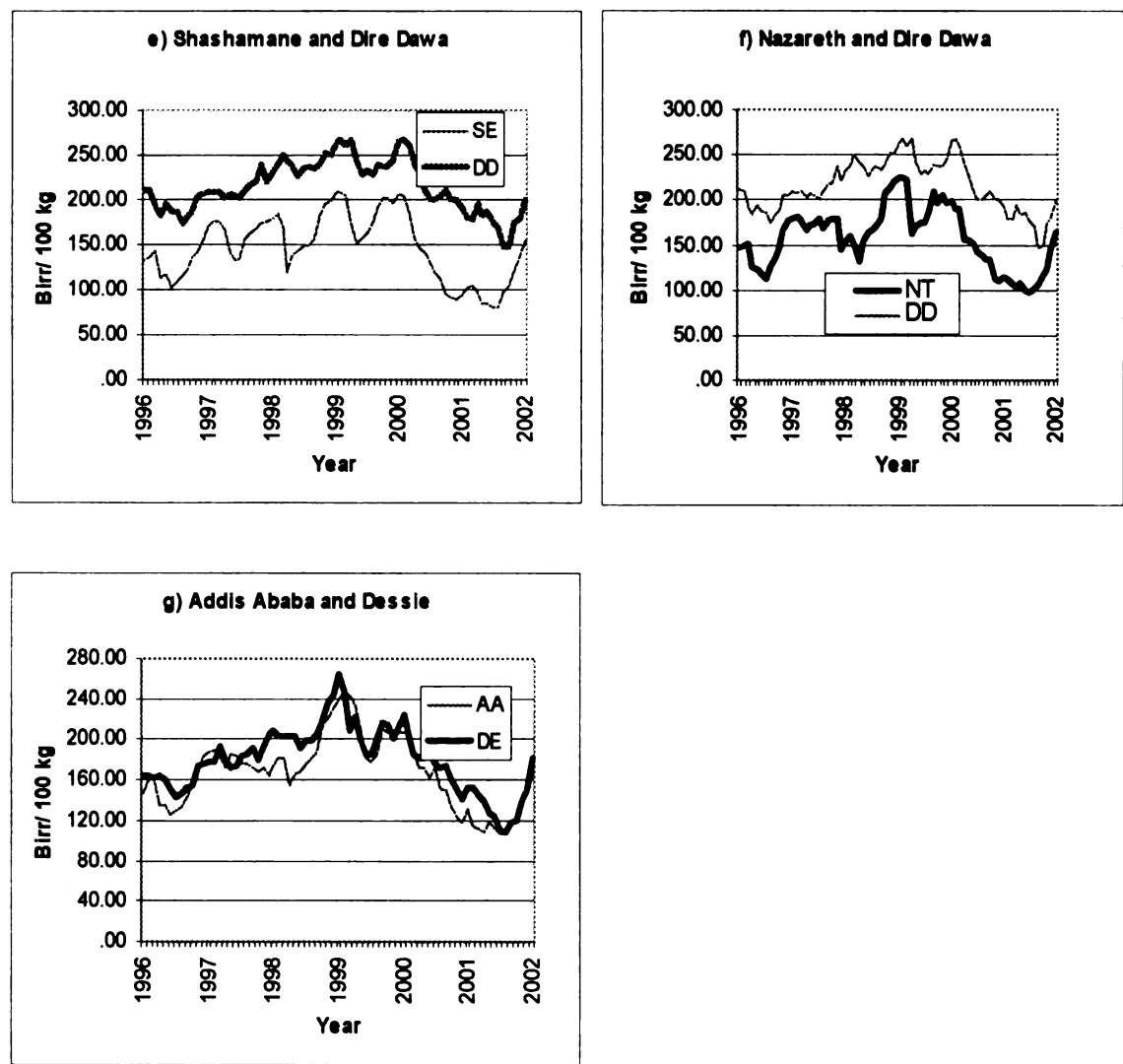


Figure 6.3 Maize Spatial Price Differentials (SPD) and Transfer Costs (TC)
(1996:08 to 2002:08)

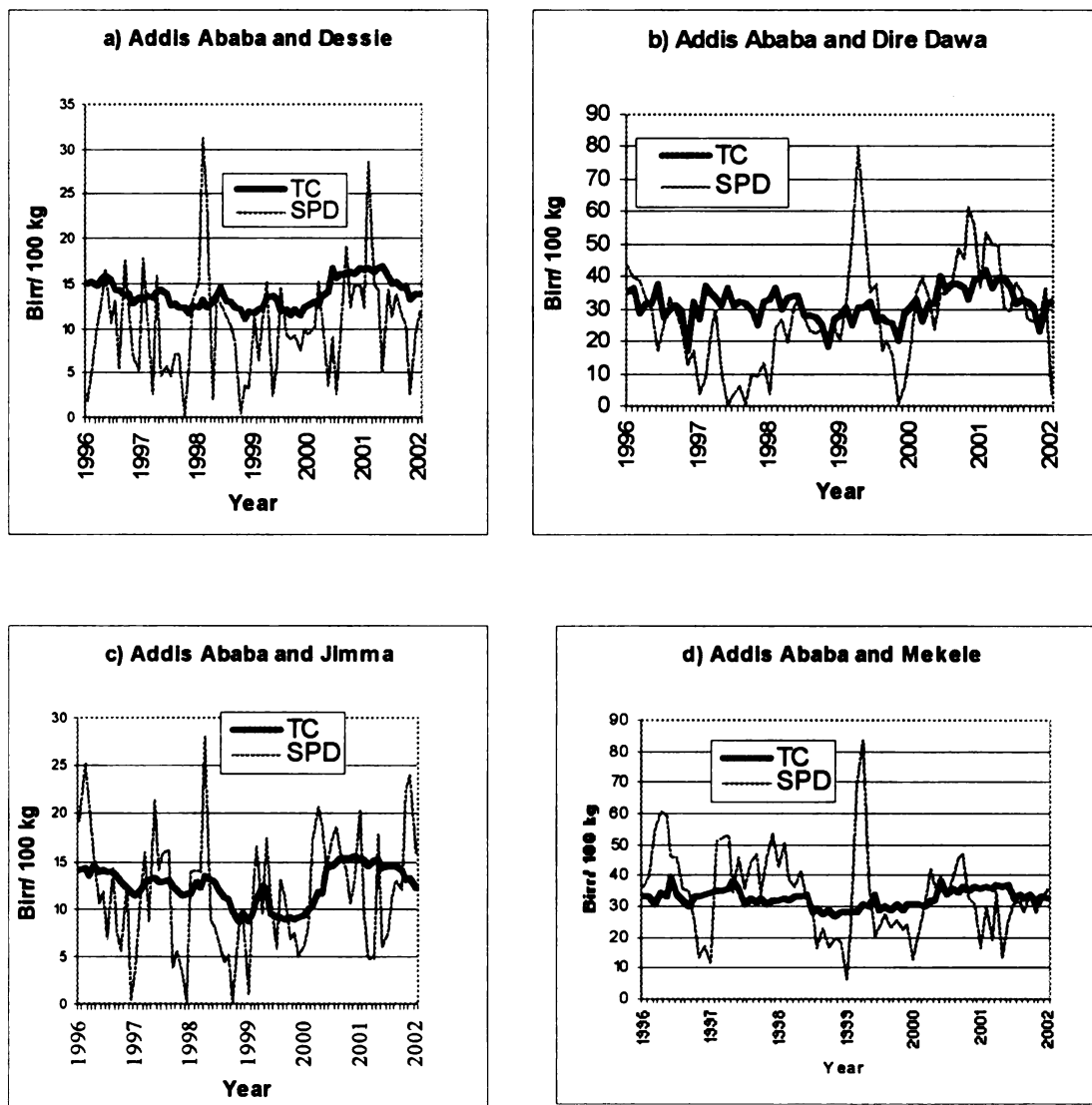


Figure 6.3 (Continued)

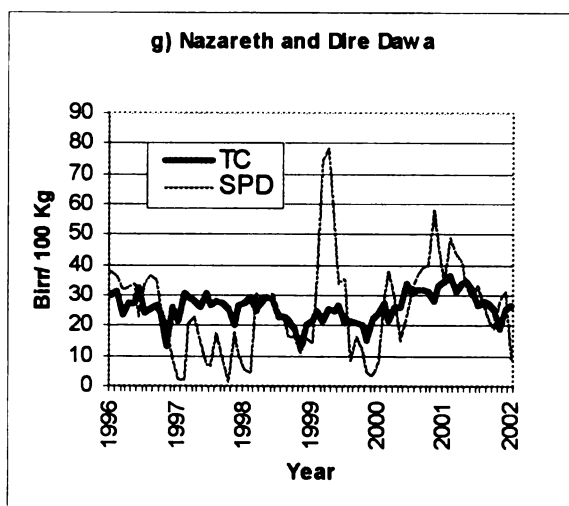
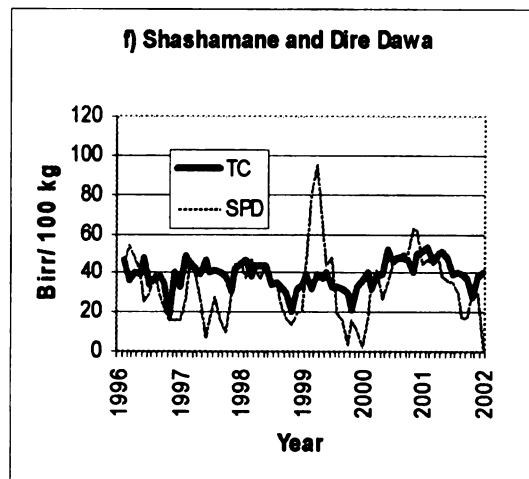
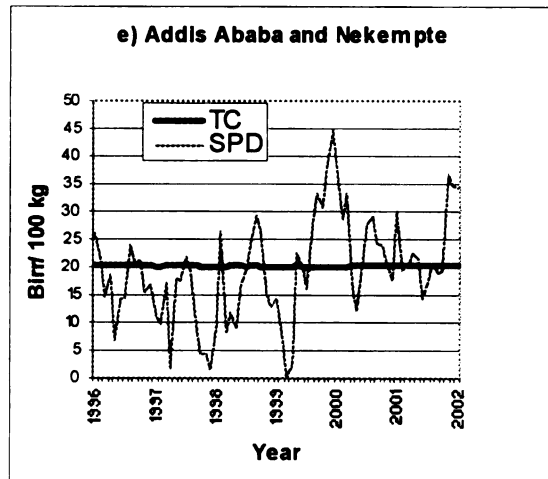


Figure 6.4 Wheat Spatial Price Differentials (SPD) and Transfer Costs (TC)
(1996:08 to 2002:08)

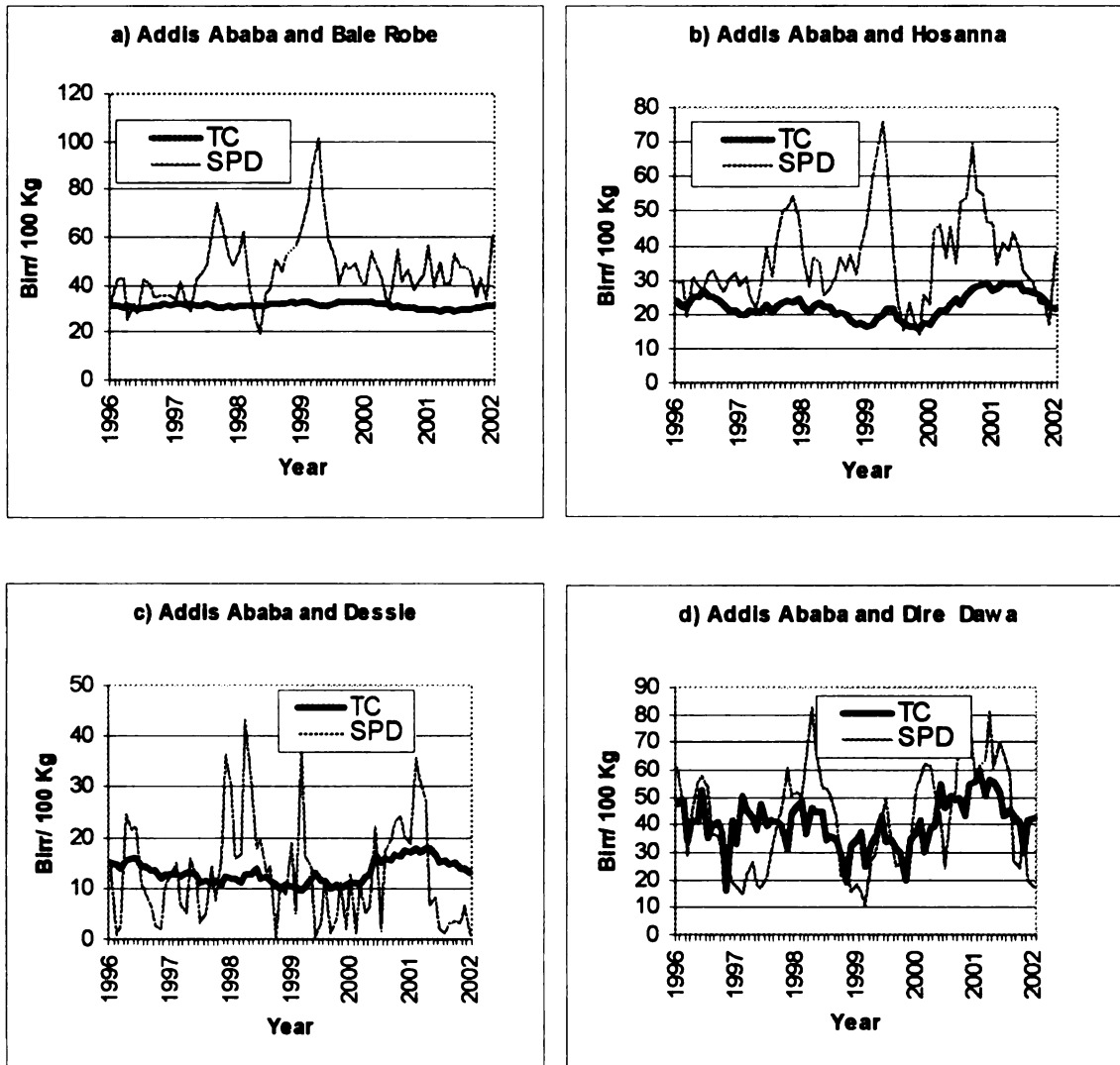
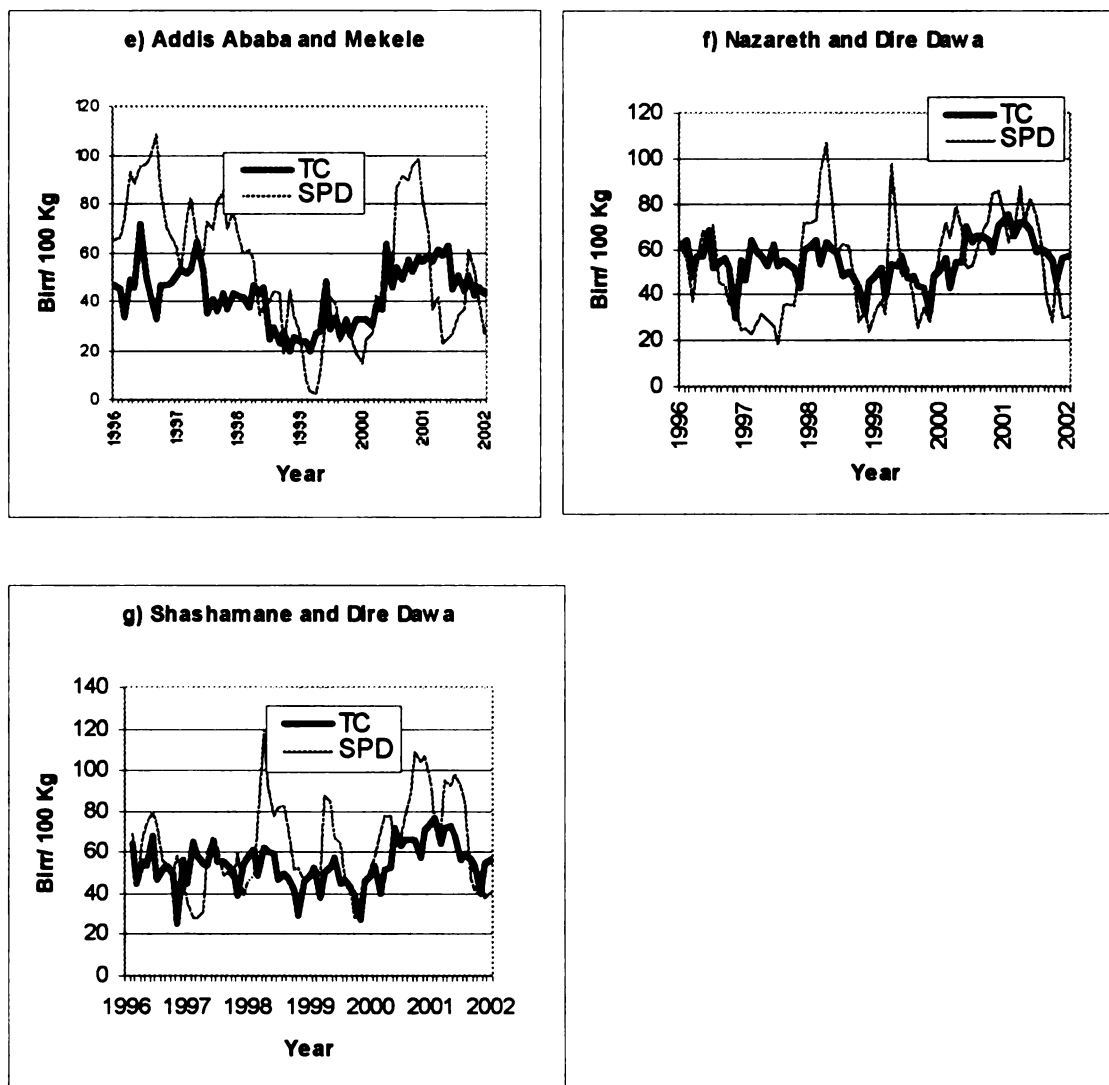


Figure 6.4 (Continued)



CHAPTER 7

EMPIRICAL RESULTS

7.1 Introduction

Without information on the actual grain trade flow data, it is generally not possible to estimate the exact probabilities of being in spatially efficient and spatially inefficient regimes. This is because regime one (with or without trade) represents spatially efficient arbitrage and regime three (with or without trade) represents spatially inefficient arbitrage, but regime two could be either spatially efficient (without trade) or spatially inefficient (with trade). In the presence of a significant probability of regime two, actual trade flow data are required to separate the probability of regime two into spatially efficient and inefficient outcomes. The EGTE grain flow data is used in the interpretation of trade regime probabilities estimated by EPBM. Thus, in order to facilitate the presentation of empirical results we first provide a brief description of EGTE grain flow data involving the markets included in this study.

There are ten important markets which are considered in this study which are either from grain surplus areas or grain deficit areas. The markets selected from the surplus producing regions include Addis Ababa, Bale Robe, Hosanna, Jimma, Nazareth, Nekempte, and Shashemene, while the markets selected from the deficit regions include Dessie, Dire Dawa, and Mekele. Most of these markets are considered in the spatial price analysis of both maize and wheat, while a few are considered only for either maize (e.g., Jimma and Nekempte) or wheat (e.g., Bale Robe and Hosanna).

The minimum observed frequencies of maize and wheat trade flows for selected market pairs are given in Table 7.1. The frequency of flow data for a given market pair is

determined based on the weekly observations of first and second most important sources and destinations markets for a given commodity and a given market.²⁹ The flow data is observed on a weekly basis and aggregated to monthly flow observations and the frequencies reported here are based on the number of months for which trade flow was observed out of the possible 26 months before the policy changes and 35 months after the policy changes.

The minimum frequency of maize flows between selected markets varied from 15% to 100%. The lowest frequency of maize flow is observed between Dire Dawa and Nazareth prior to the policy changes. After the policy changes, the frequency of maize flow decreased for 3 of 7 market pairs, increased for 3 of 7 market pairs and remained the same for one market pair. In the case of wheat, the frequency of trade flow varied from 39% to 100% for the period before the policy changes, and after the policy changes the frequency of trade flow increased in two cases, decreased in two cases and remained the same in three cases. In general, even with limited grain flow data, it is observed that most of the selected market pairs are linked by continuous trade flows for most of the time during the study period.

7.2 Empirical Results for Maize

Empirical results from the EPBM are given in Table 7.2 for selected maize market pairs. The conditional maximum likelihood estimates of trade regime probabilities (λ 's), the change in trade regime probabilities (δ 's) due to the policy changes, the standard

²⁹ Furthermore, the frequencies are minimum observations because the information on trade flows when the market is less important (e.g. third, fourth, fifth, etc.) as source or destination market is not collected. Thus the actual frequencies of trade flows could be equal or higher than the frequencies reported here.

deviations of profit for different trade regimes (σ 's), and the parameter estimates of transfer costs (β 's) are shown at the top of Table 7.2. The estimated lengths of transition periods, the values of the log likelihood for restricted (no structural change) and unrestricted estimations, the chi-square (χ^2) statistics for likelihood ratio (LR) tests of the joint hypothesis of no structural change in regime probabilities, and the number of observations used in the analysis are shown at the bottom of Table 7.2. The plots of the value of log likelihood function for different lengths of transition period are given in Figure 7.1. The plots of the sizes of losses or gains from inefficient trade for selected maize market pairs are given in Figure 7.3.

7.2.1 Spatial Market Efficiency Prior to the Policy Changes

For the period before the policy changes, the probability of regime one (λ_1), where the spatial price differential is equal to transfer cost, is less than 1% and statistically significant at the 1% level for 3 of 7 selected maize market pairs. It varied from 20% to 34% for the other 4 of 7 selected market pairs. Thus, prior to the policy changes, the probability of the spatial price differential being equal to transfer cost, which is consistent with spatial market efficiency whether or not trade is actually occurring, is very low for most market pairs and, less than 35% for all market pairs.

On the other hand, the probability of regime two (λ_2), where the spatial price differential is less than transfer cost, is found to be large and statistically significant at the 10% level for all maize market pairs. For example, the probability of being in regime two prior to the policy changes are greater than 65% and statistically significant at the 1% level for 6 of 7 selected maize market pairs. Regime two can also be consistent with

spatial market efficiency if no trade is occurring between the markets. If trade does occur in regime two, then it is presumably conducted at a loss, which would be inconsistent with spatial market efficiency.

During the same pre-policy change period, the probabilities of regime three (λ_3), where the spatial price differential is greater than transfer cost, is found to be small but statistically significant in most cases. The only large and statistically significant probability of regime three is observed between Addis Ababa and Mekele, which has a 68% probability of regime three, which is statistically significant at the 1% level. Of course, regime three is spatially inefficient whether there is trade or not because there are arbitrage profits from potential trade.

In general, the period before the policy changes is characterized by large and statistically significant probabilities of the spatial price differential being less than transfer cost, while the probability of the spatial price differential being greater than or equal to transfer cost is generally small. This indicates that the probability of profitable spatial arbitrage opportunities (probability of regime one plus probability of regime three) for maize prior to the policy changes is very low for the selected maize market pairs. The fact that regime two dominates also indicates that there is a high probability that maize traders made losses during this period, if they engaged in actual trade.

The one exception to the above conclusion is Addis Ababa – Mekele, which was estimated to have a 68% probability of spatial price differential greater than transfer cost, indicating spatial inefficiency and potential gains from additional trade. This result is consistent with the observation of strict and persistent control on grain flows from Addis Ababa to the Tigray region, which might have created maize shortages in Tigray and

increased prices there. The purpose of the grain movement control was to raise tax revenue. The grain movement control was enforced through a roadblock raised at Alamata, a small town which is strategically situated on a major grain route connecting Addis Ababa to Mekele. It is a strategic location because grain traders who want to ship grain to Mekele from or via Addis Ababa do not have any better alternative route by which they can avoid this roadblock. Grain can also enter Tigray via Gonder in the North. However, this route involves longer distance and its costs may have exceeded the roadblock charge at Alamata. Thus, the ability of regional maize traders to take advantage of profitable spatial maize trade opportunities between Addis Ababa and the Tigray region is limited by this regional grain trade block.³⁰

With very large and statistically significant estimated probability of spatial price differential less than grain transfer costs, one would generally expect very low maize flow among these markets during this period, because spatial arbitrage would be unprofitable. In other words, the probability of market segmentation is very high. However, a close examination of maize flow data between these markets during this period shows that there have indeed been frequent maize flows between these markets. This would suggest maize traders were engaged in maize trade but were making losses which indicate spatial inefficiency.³¹

For example, based on the EGTE's grain flow data, maize trade flow between Jimma and Addis Ababa and Wellega and Addis Ababa occurred at least for 95% of the

³⁰ The roadblock charges are included in the computation of grain transfer costs. However, it is difficult to capture the whole magnitude of the roadblock charge from a few cross-section surveys. For example, the time wasted at the roadblock, the spoilage and quality deterioration, missed market opportunities can't be easily quantified from cross-section surveys.

³¹ This result might also be due to aggregation error in the prices and transfer costs which masks periods when trade was profitable.

months prior to the policy changes (Table 7.1). At the same time the probabilities of spatial price differential less than transfer cost is at least 75%. These results indicate there is high probability of spatial maize market inefficiency prior to the policy changes. Generally, Western maize producing regions like Jimma and Wellega have a limited export outlet for surplus maize production, and it is commonly observed that, even when prices are relatively low in Addis Ababa, maize exports to Addis continue from these regions. Hence, prices continue to fall in Addis Ababa. Grain traders in surplus producing regions have the option to sell their grain in their local markets when the price in Addis Ababa or other regional markets is not favorable. However, the surplus absorption capacities of local markets are limited.

There are several factors which might cause spatial inefficiency of maize markets in which there is high probability of making losses by maize traders. First, the lack of well-developed storage facilities in maize supply markets might force the continuous flow of grain to central or other deficit markets, even if maize prices are not favorable in these markets. The rationale for this might be to reduce further revenue losses because of waiting for better price which might lead to spoilage, quality deterioration, and maize prices in the maize destination markets might also further decrease while waiting. Second, liquidity constraints and shortage of working capital due to missing or imperfect credit markets for grain traders can also force maize traders to liquidate grain, even if it means a loss. It has been observed that grain traders in Ethiopia have poor access to formal credit and other forms of financial services. Author's personal observation of grain markets indicate that proceeds from current grain (e.g., maize) sales are used by grain traders for refinancing future grain purchases and settling other debts which

indicate that the opportunity costs of capital tied up in grain stock is very high when the grain traders have limited access to credit.

Third, regional maize wholesale traders might have difficulty matching profitable purchase and sale decisions due to inadequacy or unavailability of market information regarding future price movements and changes in supply and demand conditions in the source and destinations markets. Fourth, there may be too many maize traders but these traders might lack economies of scale in their operation contributing to higher cost of marketing. Fifth, maize traders might also be limited by their grain trading skills to adjust to the very dynamic grain marketing situations.

If inefficient (unprofitable) trades are taking place a natural question to ask is: how do maize grain traders survive in the long-run in the face of high probability of making losses? It is observed that the wholesale grain trade is not a specialized business in Ethiopia. Regional grain traders usually keep a diversified portfolio of business activities (grain and non-grain) and that might help to spread the losses. Regional grain traders also combine interregional grain trade activities with local grain trade activities. A lot of grain traders are also observed to operate without a license, while those with a license complain about the unfair competition from unlicensed grain traders (Dessalegn et al., 1998). Operating without a license might allow grain traders (experienced or new) to enter and exit out of the grain trade sporadically, depending on market conditions, and still avoid government tax payments, hence reducing their marketing costs.

The other possible reason why the grain traders might survive could be due to the offsetting or compensating effects of fewer but larger gains for many but smaller losses. In order to investigate this issue we have computed the size of losses or gains from trade

and plotted these for selected maize market pairs in Figure 7.3. The sizes of losses or gains from trade are computed as a proportion of the difference between spatial price differential and transfer costs to the cost of grain plus the transfer cost. The plots show a few episodes of unusually very high gains for most maize market pairs and there are also episodes of very high losses. However, in order to exactly determine the compensating effects of larger gains we need data on the total volume of grain transacted.

There are also indications that it might still be profitable for large scale wholesale grain traders to engage in spatially profitable arbitrage even when smaller wholesale grain traders find it unprofitable. Osborne (1997) argues that large and small wholesale grain traders in Ethiopia have different cost structures because of economies of scale. This means that large wholesale traders can sell at the same price as the smaller traders and still make a profit because of lower cost.

The standard deviations of “economic” profit from spatial arbitrage estimated for different trade regimes are statistically significant at the 5% level for 19 of 21 cases. For each market pair, the standard deviation estimated for regime three (σ_v) is found to be the largest. As regime three is unambiguously inefficient, this indicates that the variability in the “economic” profit from spatial arbitrage is higher when the market is inefficient. It is also observed that the standard deviations of regime two are higher than that of regime one in 5 of 7 cases. The other important observation regarding variance estimates is that the standard deviations for market pairs involving Addis Ababa and deficit markets are larger than the standard deviations involving Addis Ababa and surplus markets. This indicates that the degree of risk in trading maize is relatively higher between Addis Ababa and grain deficit markets than Addis Ababa and grain surplus markets.

7.2.2 The Effects of the Policy Changes

Likelihood ratio (LR) statistics are used to test the joint hypothesis of no structural change in trade regime probabilities due to the policy changes for selected maize market pairs, after having estimated the optimal adjustment path to the policy changes.³² The chi-square statistics for the LR tests are presented at the bottom of Table 7.2. The results show that there is no statistically significant joint structural change in trade regime probabilities for 4 of 7 maize market pairs (Jimma and Addis Ababa, Addis Ababa and Dessie, Nazareth and Dire Dawa, and Shashamane and Dire Dawa) at the 10% level. On the other hand, the joint structural change in trade regime probabilities is statistically significant at the 5% level in 3 of 7 maize market-pairs, which include Addis Ababa and Nekempte, Addis Ababa and Dire Dawa and Addis Ababa and Mekele.

To some extent, the variation in the responses of regional maize markets to the recent policy changes can be explained by the history of government market interventions which have varied from region to region and may have different effects on the levels of private sector grain development and grain traders' perceptions of risk and uncertainty. Generally, the markets where the policy change appears to have had little effect appear to be where the private sector grain trade already had been relatively more tolerated by the government marketing agencies during socialist regime (e.g., Nazareth and Shashamane).

During the socialist regime, it was observed that private grain trade in Southern Ethiopia was much more tolerated by government marketing agencies than in other regions of Ethiopia (Osborne, 1997). So the degree of risk and uncertainty perceived due

³² Optimal adjustment paths were chosen based on a likelihood maximization procedure, as discussed earlier. The optimal adjustment path estimates will be explained in more detail below.

to the presence of EGTE in these markets might have already been low and the recent policy changes might not bring significant change in the attitude and operations of private grain traders. On the other hand, the joint structural change in regime probabilities is statistically significant for trade between Nekempte and Addis Ababa. Nekempte is located in a maize surplus producing region and has historically been one of the major focuses of government marketing activities (private grain trade sector was highly suppressed). So in this case the changes in policy appear to have had an effect. Structural change is also significant for trade between Addis Ababa and Dire Dawa and Addis Ababa and Mekele markets. Dire Dawa and Mekele markets are also grain deficit areas where there had been heavy government intervention.

Of three maize market pairs with statistically significant joint structural change in trade regime probabilities, Addis Ababa and Nekempte and Addis Ababa and Mekele adjusted to the new policy changes gradually over a period of less than or equal to six months while the trade between Addis Ababa and Dire Dawa adjusted instantaneously (Table 7.2 and Figure 7.1). The variation in the length of transition period among market pairs indicates that the speed by which grain traders adjust to new policy regimes may depend on their location. The market pairs where the speed of adjustment is gradual appear to be where the marketing infrastructure, like road network and grain storage, is relatively less developed (e.g., Nekempte) and the destination market is far from surplus producing areas and drought affected (e.g., Mekele). On the other hand, where the adjustment is instantaneous (Dire Dawa) infrastructure is more developed with grain traders engaging in relatively larger purchases having more storage capacity, longer

experience in the grain trade, and better road networks connecting the markets with other regional markets.

For markets where there is statistically significant structural change as a result of policy changes, individual t-tests on the structural change parameters (δ 's) are evaluated to investigate the effect of the policy changes on trade regimes probabilities. With the policy changes, there is a large shift to regime three for Addis Ababa and Nekempte and Addis Ababa and Dire Dawa, which suggests unexploited spatial arbitrage opportunities have increased and spatial market efficiency has therefore declined. The probability of spatial price differential less than transfer cost also decreased for both market pairs but Addis Ababa and Nekempte experienced large a decrease which is statistically significant at the 5% level. However, the change in the probability of spatial price differential equal to transfer cost is not statistically significant at the 5% level for both market pairs.

For Addis Ababa and Mekele the probability of spatial price differential equal to transfer cost increased and the change is statistically significant at the 5% level. The probability of spatial price differential less than transfer cost also increased slightly but is not statistically significant at the 10% level. The probability of spatial price differential greater than transfer cost decreased considerably and this is statistically significant at the 5% level. The large decrease in the probability of spatial price differential greater than transfer cost, and corresponding large increase in the probability of spatial price differential equal to transfer cost, suggests an increase in spatial market efficiency.

7.2.3 Conclusions for Maize

In general, prior to the policy changes all the maize market pairs considered are spatially inefficient with high probability. It is observed that the probability of spatial price differential less than transfer cost is greater than 65% for 6 of 7 maize market pairs, while the frequency of trade flow observed for these market pairs appears to be significant. Together, these results indicate that grain traders were active but made losses during this period. In other words, too much trade was taking place relative to that which we would expect in a spatially efficient market. Policy changes had statistically significant effect on regime probabilities at the 5% level in 3 of 7 maize market pairs. However, as a result of the policy changes the spatial maize market efficiency has improved only for trade between Addis Ababa and Mekele, while for the other market pairs spatial efficiency either deteriorated (Addis Ababa and Dire Dawa) or was not affected (the rest of market pairs).

7.3 Empirical Results for Wheat

The empirical results for selected wheat market pairs are given in Table 7.3. The conditional maximum likelihood estimates of trade regime probabilities (λ 's), the change in trade regime probabilities (δ 's) due to the policy changes, and the standard deviations of profit for different trade regimes (σ 's) are shown at the top of Table 7.3. The estimated lengths of transition period, the values of the log likelihood for restricted (no structural change) and unrestricted estimations, the chi-square (χ^2) statistics for LR tests of the joint hypothesis of no structural change in regime probabilities, and the number of observations used are shown at the bottom of Table 7.3. The plots of the value of log

likelihood function for different lengths of transition period are given in Figure 7.2. The plots of the sizes of losses or gains from inefficient trade for selected wheat market pairs are given in Figure 7.4.

7.3.1 Spatial Market Efficiency Prior to the Policy Changes

For the period before the policy changes, the probability of spatial price differential equal to transfer cost is less than 1 % and statistically significant at the 1% level for all wheat market pairs. Thus, the probability of the spatial price differential being equal to transfer cost, which is consistent with spatial market efficiency whether or not trade is actually occurring, is almost zero in all wheat market pairs.

The probabilities of spatial price differential less than transfer cost are also found to be less than 1% and statistically significant at the 1% level for 5 of 7 wheat market pairs. The probability of spatial price differential less than transfer cost is greater than 80% and statistically significant at the 1% level only for Addis Ababa and Dessie, and the Dire Dawa and Nazareth market pairs. From EGTE flow data (Table 7.1), it is observed that the frequencies of wheat flow for the same market pairs are 100% which indicate strong trade flows even when the price differential does not cover transfer cost. This is inconsistent with spatial market efficiency.

However, prior to policy changes, the probabilities of spatial price differential greater than transfer cost are found to be very large and statistically significant at the 5% level in most of the cases. For example, in 5 of 7 selected wheat market pairs (Bale Robe and Addis Ababa, Hosanna and Addis Ababa, Addis Ababa and Dire Dawa, Addis Ababa and Mekele and Shashamane and Dire Dawa), the probability of spatial price differential

greater than transfer cost is found to be greater than 99% and statistically significant at the 1% level. For the period before the policy changes, a small probability of spatial price differential greater than transfer cost is observed only between the Addis Ababa and Dessie, and Nazareth and Dire Dawa wheat market pairs.

Thus, in the case of wheat, the period before the policy changes is characterized by large and statistically significant probability of spatial price differential greater than transfer cost, while the probability of spatial price differential less than or equal to transfer cost are, with few exceptions, very small and mostly not statistically significant. The very large probabilities of spatial price differential greater than transfer cost indicate that the wheat markets are spatially inefficient. This could be due to the lack of competition in wheat wholesale trade either in the production areas or consumption areas. This could also be due to shortages of wheat supply in these markets resulting from restrictions on grain movement such as through roadblocks at Alamata. The high probability estimates of regime three are consistent with the observations of high frequency of wheat flow between pairs of markets considered but the quantities supplied might not be sufficient to meet the local demand.

Prior to the policy changes, the frequency of wheat trade flow between Addis Ababa and Bale Robe is 89% while it is 100% between Addis Ababa and Hosanna (Table 7.1). However, given the normal or bumper harvests for most of the time before the policy changes, observing a high probability of spatial price differential greater than transfer cost is more consistent with lack of competition or due to restrictions in wholesale wheat trade than the shortages of wheat to be supplied to these markets. In this regard, a high concentration ratio of wheat wholesale trade is also observed for some

markets like Shashamane and Nazareth (Dessalegn et al., 1998). A high concentration ratio is one of the conditions for anti-competitive behavior in the market. Even though wheat grain traders made profit most of the time during the study period, there are also periods when wheat traders made very high losses (Figure 7.4). For example, for Addis Ababa and Mekele wheat market pairs a loss which is greater than 20% was observed.

The standard deviations of “economic” profit from spatial arbitrage estimated for different trade regimes are statistically significant at the 5% level for 16 of 21 cases. For each wheat market pair, the standard deviation estimated for regime three (σ_v) is found to be the largest in 5 of 6 cases. As regime three is unambiguously inefficient, this also indicates that the variability in the “economic” profit from spatial arbitrage is higher when the market is spatially inefficient.

7.3.2 The Effects of the Policy Changes

Likelihood ratio (LR) statistics are used to test the joint hypothesis of no structural change in trade regime probabilities due to the policy changes for selected wheat market pairs. The chi-square statistics for the LR tests are presented at the bottom of Table 7.3. The results show that there is no statistically significant joint structural change in trade regime probabilities for 6 of 7 wheat market pairs, at the 10% level. On the other hand, the joint structural change in trade regime probabilities is statistically significant at the 5% level for just 1 of 7 wheat market pairs.

Structural change due to the policy effect is significant only for Addis Ababa and Mekele, which also shows instantaneous adjustment to the policy changes. For this market pair, with the policy changes there is no change in the probability of spatial price

differential equal to transfer cost. However, the probability of spatial price differential less than transfer cost increased and is statistically significant at the 5% level. The probability of spatial price differential greater than transfer cost also decreased and this decrease is statistically significant at the 5% level. This result is consistent with the decrease in trade flow between Addis Ababa and Mekele which changed from 92% prior to the policy changes to 66% after the policy changes (Table 7.1). In general, as result of policy changes, the trade between Addis Ababa and Mekele changed from a situation of too little trade (high probability of regime 3) to too much trade (high probability of regime 2). Under these conditions it seems that traders made losses while the consumers in Mekele market might have gained from the wheat price decrease. In most of the cases, the Addis Ababa and Mekele market is observed to behave differently from other market pairs, which might be because of the roadblock charges and control on grain going to Tigray.

7.3.3 Conclusions for Wheat

Prior to the policy changes, all the wheat market pairs considered are spatially inefficient most of the time. In 5 of 7 market pairs, the probability of spatial price differential greater than transfer cost is statistically significant at the 5% level. This is inconsistent with spatial market efficiency. On the other hand, the probability of spatial price differential less than transfer cost is greater than 80% for 2 of 7 wheat market pairs, where high frequency of wheat trade flow was also observed for these market pairs. This is also consistent with spatial market inefficiency, as grain traders would have lost money if they actually traded during this period. The structural change is significant only for

Addis Ababa and Mekele market pair, where the nature of spatial inefficiency changed from high probability of making excessive profit to high probability of making losses. Thus, following the policy changes wheat markets are still spatially inefficient.

7.4 Conclusions

Prior to the policy changes, both maize and wheat markets appear to be spatially inefficient most of the time. The likelihood ratio test shows that there is statistically significant joint structural change in trade regime probabilities in 3 of 7 maize market pairs and in 1 of 7 wheat market pairs as a result of the policy changes. However, the policy changes did not bring any significant improvement the spatial efficiency of maize and wheat markets except in the case of Addis Ababa and Mekele where the spatial efficiency of the maize market improved after the policy changes, and in the case of Addis Ababa and Dire Dawa where the spatial market efficiency deteriorated for the maize market following the policy changes. Thus, maize and wheat markets are also spatially inefficient for most of the time after the policy changes.

However, it is observed that the nature of spatial inefficiency is different for maize and wheat markets. In the case of maize, spatial inefficiency is mostly due to the fact that there is high frequency of grain flow while there is high probability of spatial price differential less than grain transfer cost. In this case, if the grain traders are actually trading they are making losses. In the case of wheat the spatial market inefficiency is mostly due to high probability of spatial price differential greater than transfer cost. This is consistent with spatial market inefficiency whether or not there is trade, but indicates too little trade is occurring rather than too much.

The fact that the nature of spatial market inefficiency observed for maize and wheat is different implies that the two commodities probably require a different policy response in order to improve spatial market efficiency. One of the possible reasons for the observed differences in the nature of spatial inefficiency between maize and wheat might be due to the difference in their market structures. The geographic locations of surplus maize and surplus wheat producing regions are different. Maize is produced mainly in the Western regions of Ethiopia while wheat is grown in central regions of the country. The marketing infrastructure, particularly the road network, is relatively more developed in the central regions. Among other things, this might have attracted investment in storage and other marketing facilities in the wheat areas, which encouraged the development of relatively larger wholesale grain traders which can influence wheat prices. The analysis of the structure and conduct of wholesale grain trade in Ethiopia by Dessalegn et al. (1998) also indicates that the wheat markets are more concentrated. On the other hand, the marketing infrastructure in the Western region is less developed and the grain traders are expected to be smaller sized and maybe numerous compared to the central regions.

Finally, as with empirical studies of spatial market efficiency, it is important to keep in mind that data and estimation methods have inherent weaknesses. For example, the results are sensitive to the accuracy of transfer cost estimated from the survey and the distributional assumptions made. Therefore it is always important to interpret the empirical results with caution and think critically about the implications of the results for the design and implementation of public policy.

Table 7.1 Minimum Observed Months of Trade Flows for Selected Maize and Wheat Market Pairs

Market pairs	1996:08 to 1999:09		1999:10 to 2002:08		1996:08 to 2002:08	
	Maize	Wheat	Maize	Wheat	Maize	Wheat
Addis & Bale Robe	--	23(89)	--	34(97)	--	57(93)
Addis & Dessie	22(85)	26(100)	35(100)	31(89)	57(93)	57(93)
Addis & Dire Dawa	15(58)	26(100)	13(37)	35(100)	28(46)	61(100)
Addis & Hosanna	--	26(100)	--	35(100)	--	61(100)
Addis & Jimma	26(100)	--	35(100)	--	61(100)	--
Addis & Mekele	18(69)	24(92)	4(11)	23(66)	22(36)	47(77)
Addis & Wollega	25(96)	--	35(100)	--	60(98)	--
Dire Dawa & Nazareth	4(15)	26(100)	0(0)	35(100)	4(7)	61(100)
Dire Dawa & Shashamane	23(89)	10(39)	35(100)	34(97)	58(95)	44(72)

Note: *The maximum possible number of monthly observations for the period before and after the policy change is 26 and 35, respectively and figures in parenthesis are percentages of months with trade flows.

Table 7.2 Conditional Maximum Likelihood Estimates of EPBM Parameters for Selected Maize Market Pairs (1996:08 to 2002:08)

EPBM Parameters	Market pairs						
	Jimma & Addis	Nekemte & Addis	Addis & Dessie	Addis & Dire Dawa	Addis & Mekele	Nazareth & Dire Dawa	Shashamane & Dire Dawa
Regime probabilities							
λ_1	0.001 ^a	0.236	0.001 ^a	0.326 ^c	0.001 ^a	0.201	0.339
λ_2	0.872 ^a	0.763 ^a	0.889 ^a	0.673 ^a	0.315 ^a	0.798 ^a	0.660 ^c
λ_3	0.127	0.001 ^a	0.110	0.001 ^a	0.684 ^a	0.001 ^a	0.001
Structural changes							
δ_1	+0.997 ^a	+0.133	0.000	-0.325 ^c	+0.662 ^b	+0.588 ^b	-0.196
δ_2	-0.871 ^a	-0.762 ^a	+0.110	-0.233	+0.022	-0.796 ^a	+0.009
δ_3	-0.126	+0.629 ^a	-0.110	+0.558 ^a	-0.684 ^a	+0.208	+0.187 ^c
Standard deviations							
σ_e	5.181 ^a	4.854 ^a	2.498 ^a	4.456 ^a	6.475 ^a	10.100 ^a	7.265 ^a
σ_u	3.159 ^c	8.945 ^a	5.706 ^a	15.764 ^a	10.658 ^a	8.572 ^b	15.112 ^a
σ_v	6.512	10.540 ^a	10.007 ^b	16.961 ^a	18.621 ^a	30.651 ^a	31.534 ^a
Transfer costs							
β_0	29.774 ^a	21.240 ^b	25.502 ^a	64.368 ^a	56.603 ^a	58.452 ^a	85.934 ^a
β_1	-0.686 ^a	-0.042	-0.390 ^a	-0.840 ^a	-0.414 ^b	-0.970 ^a	-1.094 ^a
Transition period (θ)	0	6	35	0	5	0	0
Log likelihood							
Restricted	-231.612	-259.456	-224.630	-297.220	-293.538	-292.277	-296.697
Unrestricted	-230.150	-251.988	-223.589	-289.548	-285.519	-289.469	-292.484
LR Test							
$\chi^2(3)$ Statistics	2.90	14.936 ^a	2.08	15.344 ^a	16.038 ^a	5.618	1.74
Observations	73	73	73	73	73	73	72

Note: Trade is more than 99% uni-directional, the first and second market in the list of market pairs being the source and destination market, respectively. Note also that ^a, ^b and ^c indicate statistical significance at 1%, 5%, 10%, respectively. The possible values of θ range from 0 to 35.

Table 7.3 Conditional Maximum Likelihood Estimates of EPBM Parameters for Selected Wheat Market Pairs (1996:08 to 2002:08)

EPBM Parameters	Market pairs						
	Bale & Addis	Hosanna & Addis	Addis & Dessie	Addis & Dire Dawa	Addis & Mekele	Nazareth & Dire Dawa	Shashamane & Dire Dawa
Regime probabilities							
λ_1	0.001 ^a	0.001 ^a	0.001 ^a	0.001 ^a	0.001 ^a	0.001 ^a	0.001 ^a
λ_2	0.001 ^a	0.001 ^a	0.998 ^a	0.001 ^a	0.001 ^a	0.811 ^a	0.001 ^a
λ_3	0.998 ^a	0.998 ^a	0.001 ^a	0.998 ^a	0.998 ^a	0.188	0.998 ^a
Structural changes							
δ_1	0.000	0.000	0.000	0.000	0.000	+0.998 ^a	0.000
δ_2	0.000	+0.109	0.000	0.000	+0.711 ^a	-0.811 ^a	0.000
δ_3	0.000	-0.109	0.000	0.000	-0.711 ^a	-0.187	0.000
Standard deviations							
σ_e	6.234 ^a	2.583 ^b	9.886 ^a	16.465 ^a	11.212 ^a	15.017 ^a	17.583 ^a
σ_u	0.001 ^a	2.275	0.452	0.001 ^a	12.620 ^a	11.917 ^b	0.001 ^a
σ_v	19.843 ^a	19.214 ^a	23.491	2.231	27.393 ^a	23.096 ^b	10.321
Transfer costs							
β_0	16.445 ^a	52.707 ^a	32.040 ^b	105.399 ^a	147.938 ^a	123.428 ^a	127.981 ^a
β_1	0.438 ^a	-1.362 ^a	-0.542 ^c	-1.462 ^a	-1.672 ^a	-1.822 ^a	-1.557 ^a
Transition period (θ)	0	0	3	2	0	4	0
Log likelihood							
Restricted	-289.931	-279.268	-71.106	-308.244	-33.041	-315.703	-312.793
Unrestricted	-289.931	-278.385	-71.106	-308.244	-20.799	-313.480	-312.753
LR Test							
$\chi^2(3)$ Statistics	0.000	1.766	0.000	0.000	24.484 ^a	4.446	7.818
Observations	73	73	73	73	73	73	72

Note: Trade is more than 99% uni-directional, the first and second market in the list of market pairs being the source and destination market, respectively. Note also that ^a, ^b and ^c indicate statistical significance at 1%, 5%, 10%, respectively. The possible values of θ range from 0 to 35.

Figure 7.1 Maize Log Likelihoods for Different Time Lengths of Transition Period

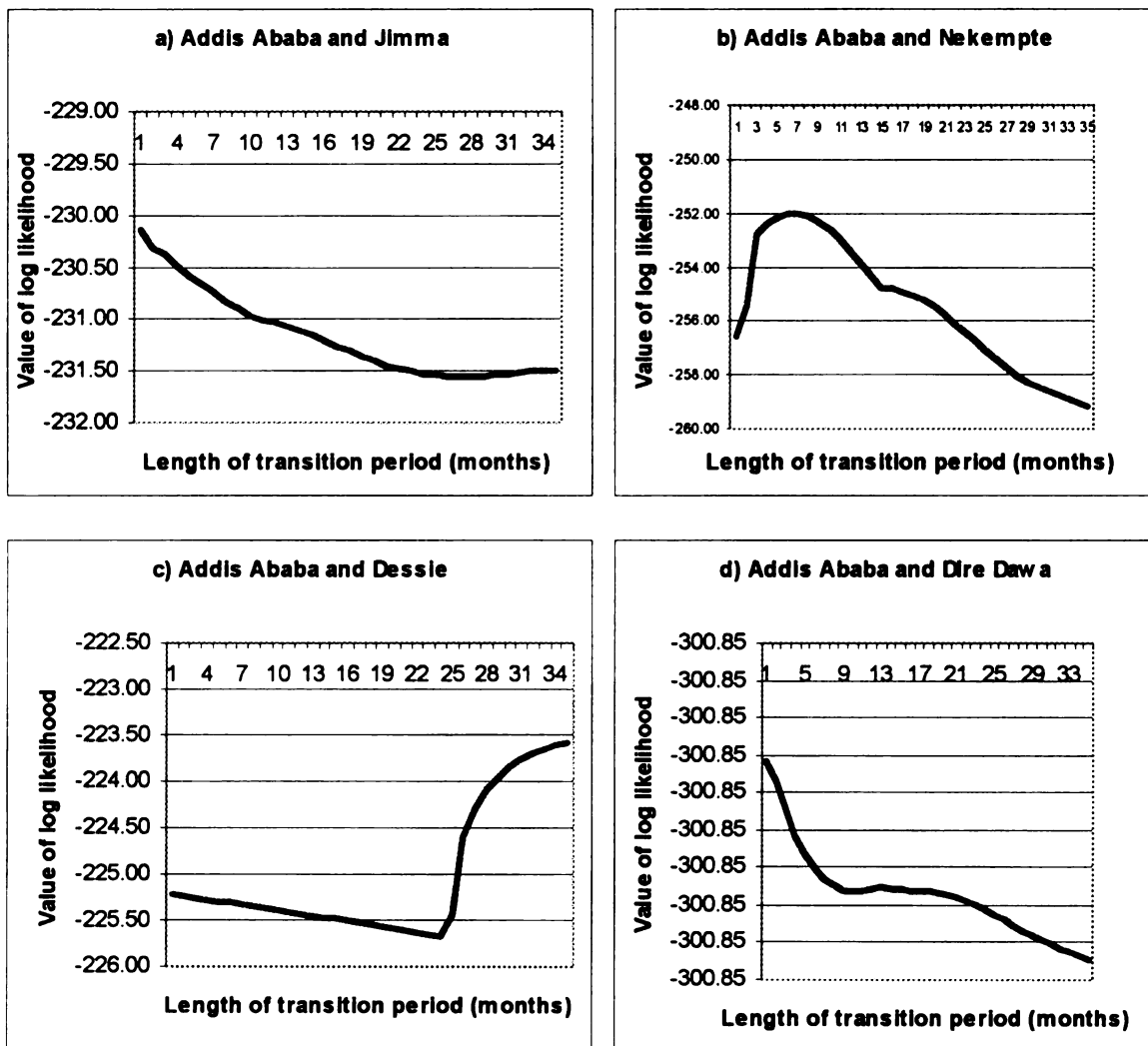


Figure 7.1 (Continued)

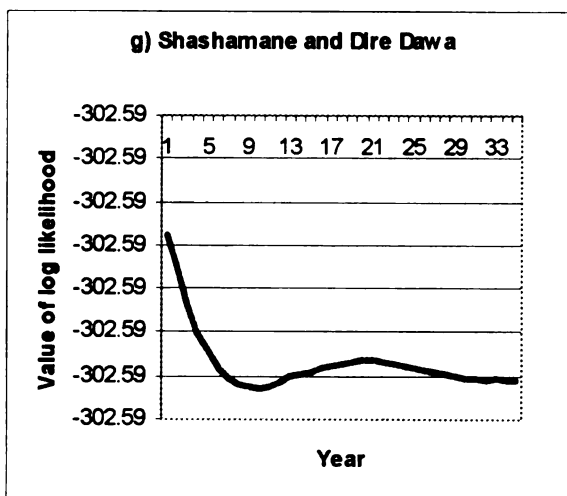
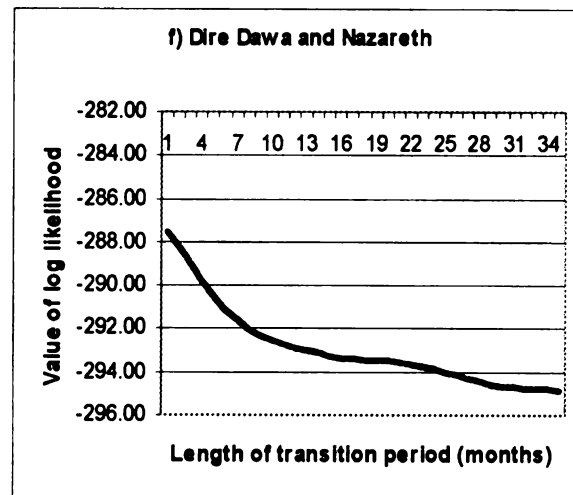
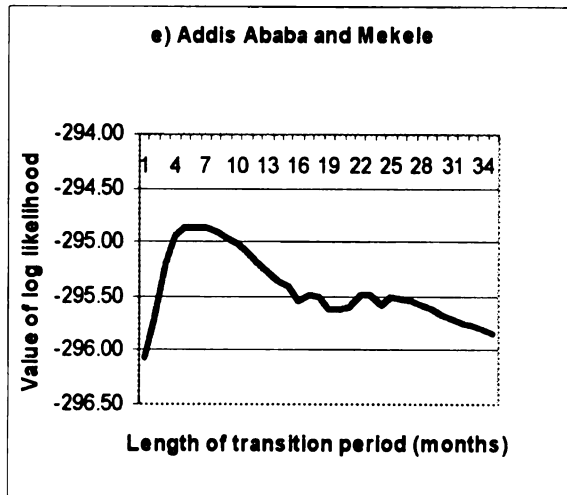


Figure 7.2 Wheat Log Likelihoods for Different Time Lengths of Transition Period

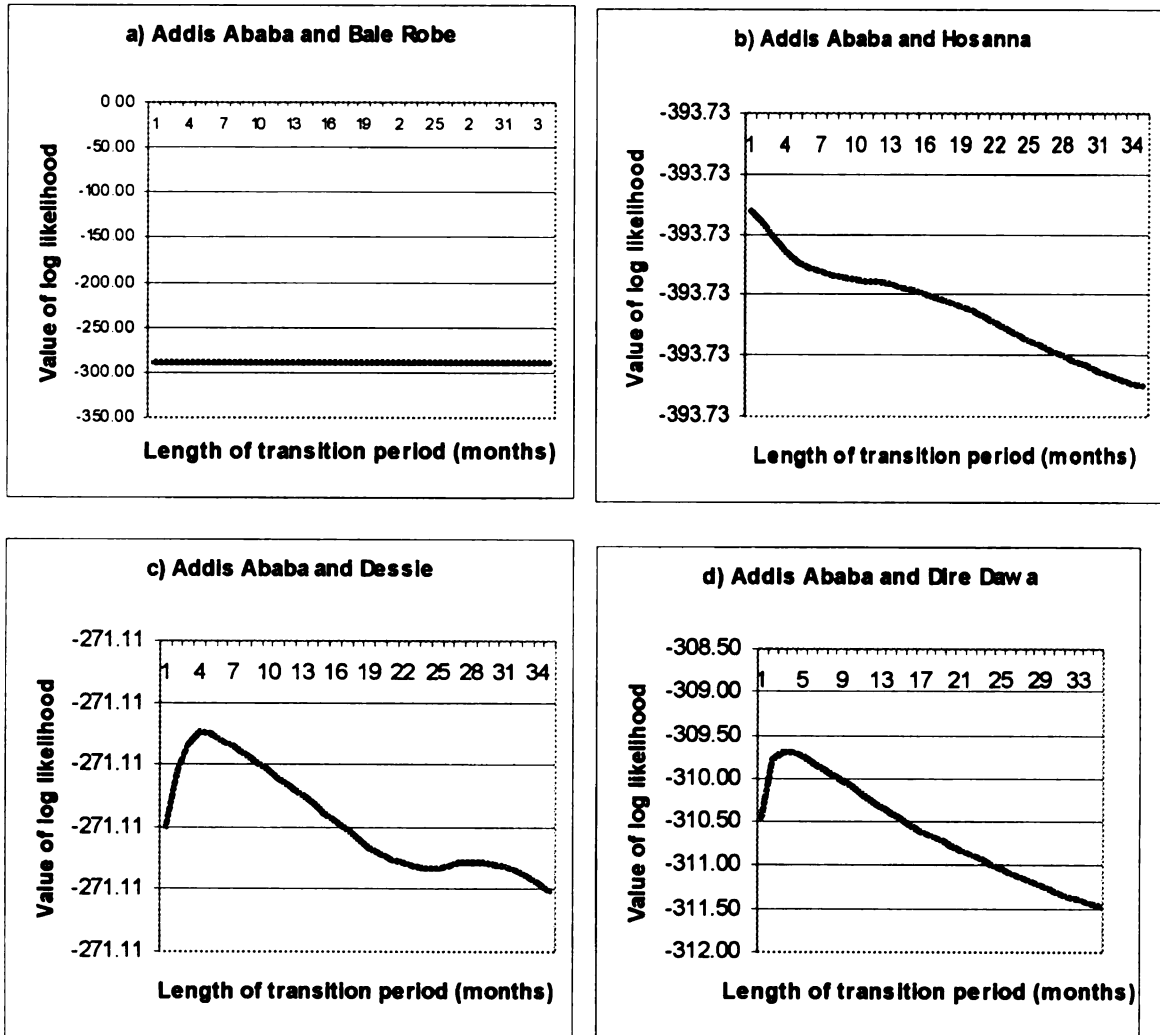


Figure 7.2 (Continued)

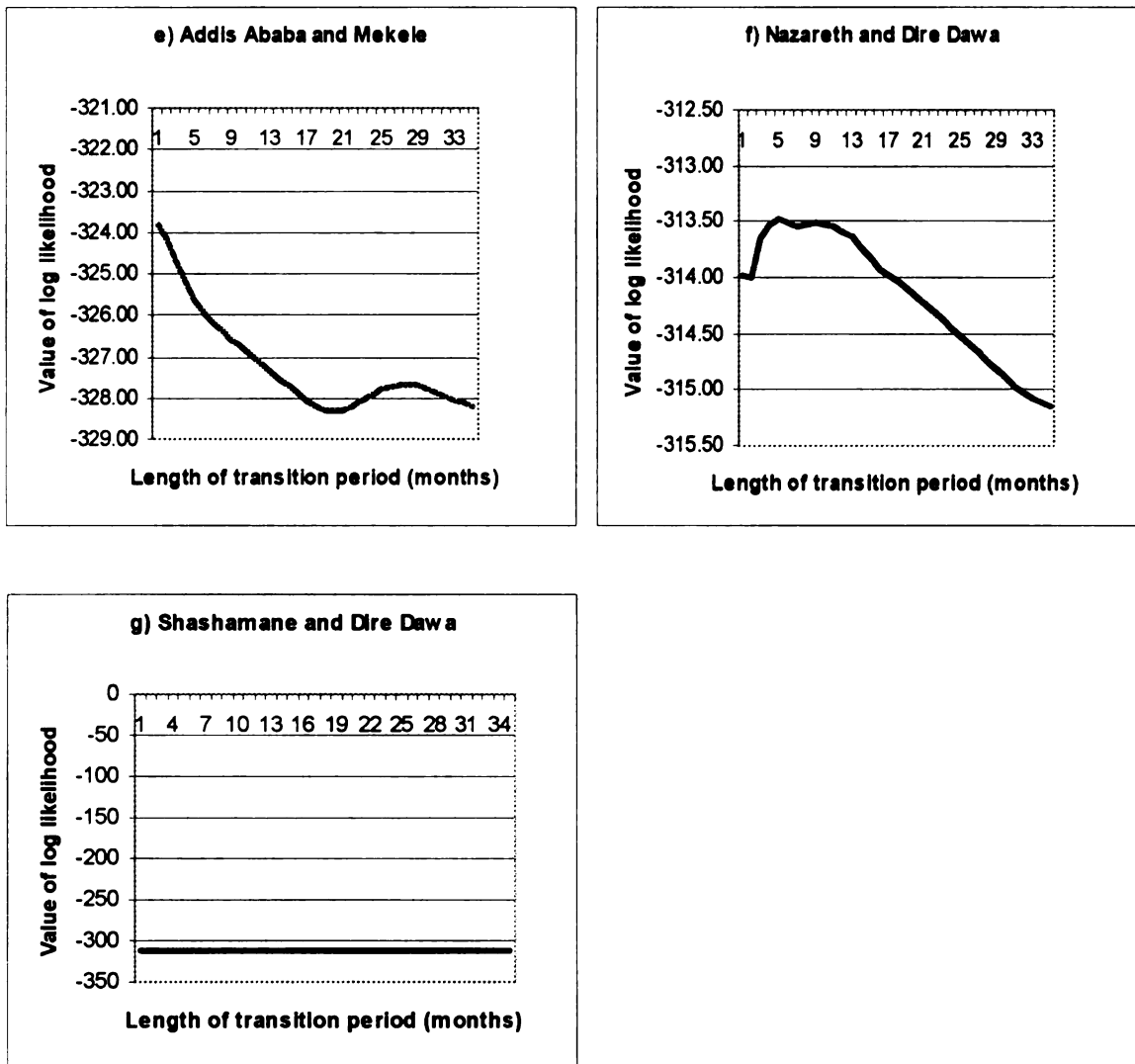


Figure 7.3 Magnitudes of Losses and Gains from Inefficient Trade for Maize

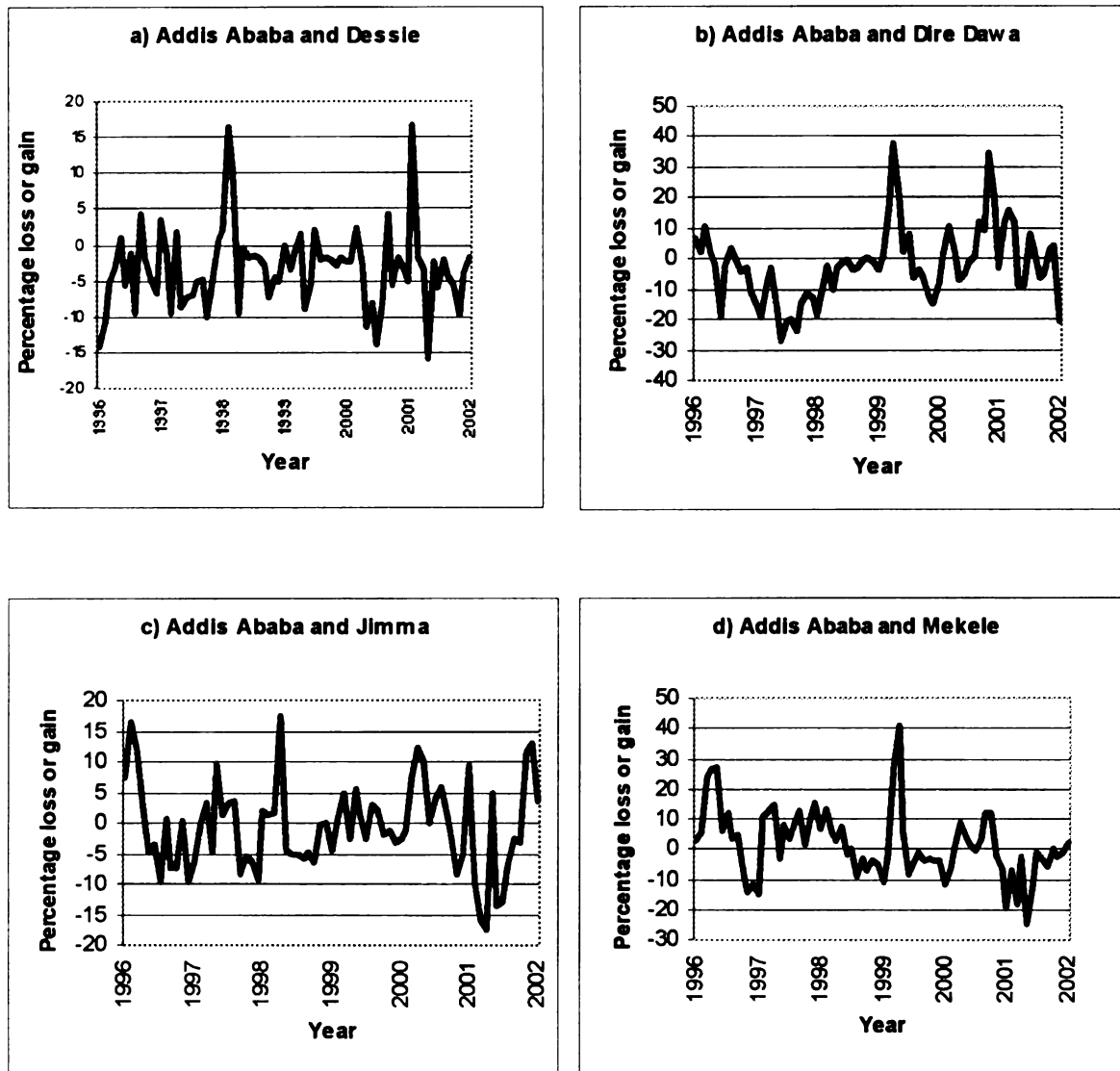


Figure 7.3 (Continued)

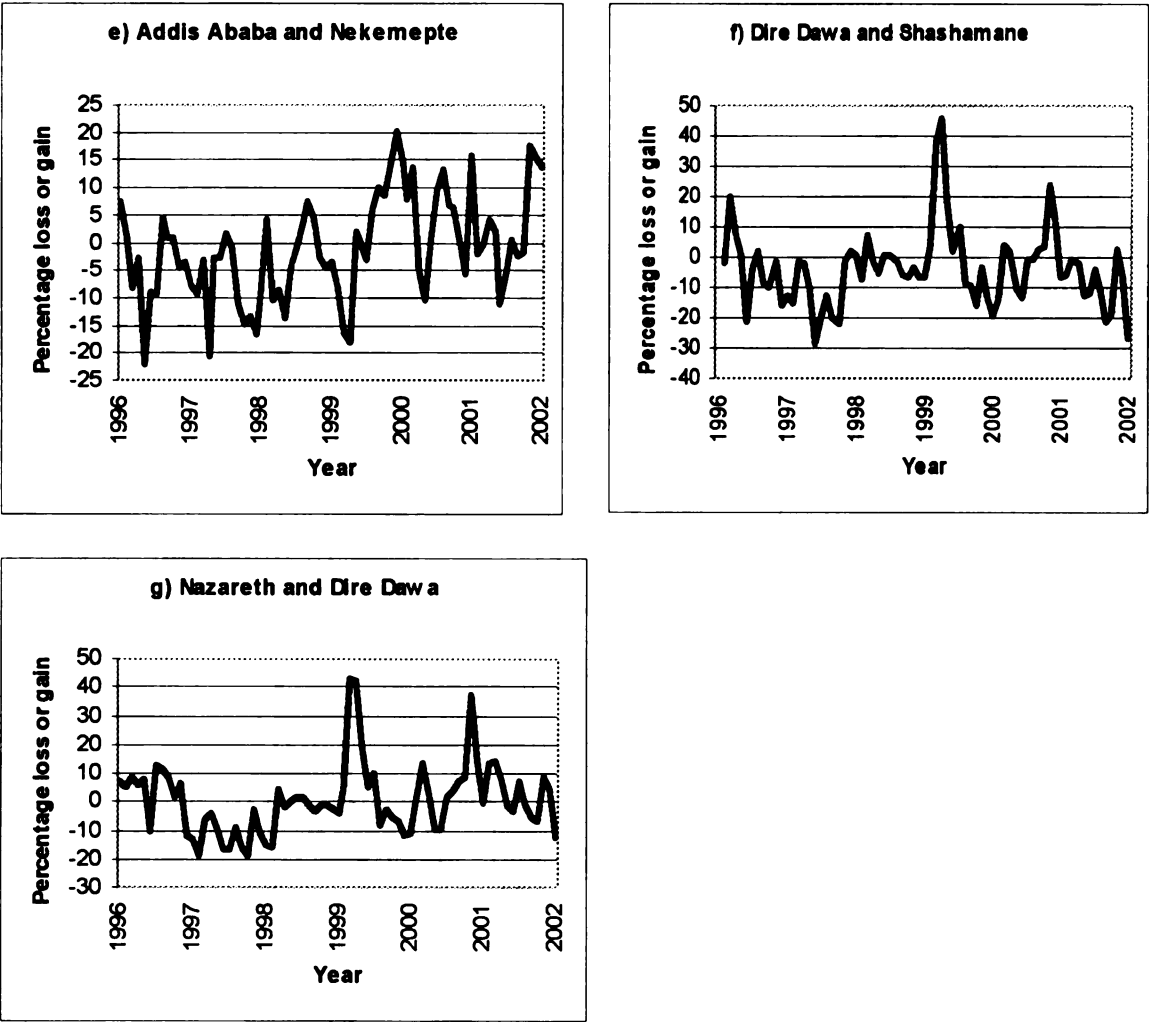


Figure 7.4 Magnitudes of Losses and Gains from Inefficient Trade for Wheat

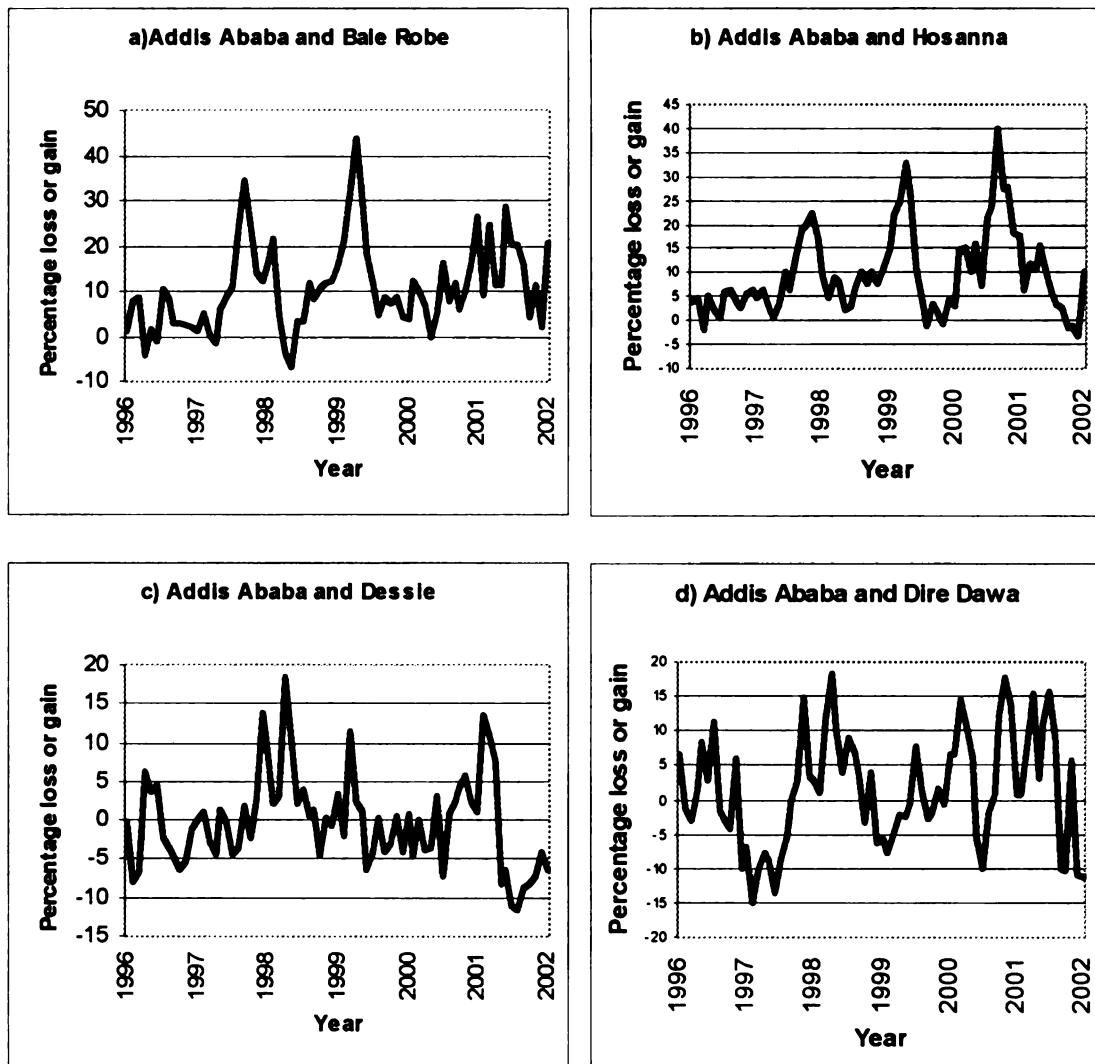
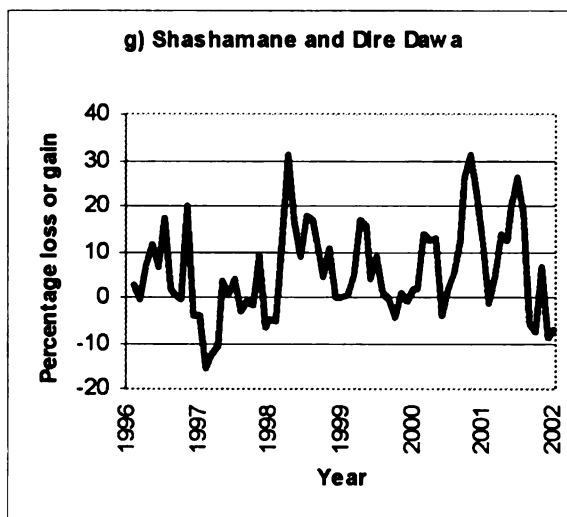
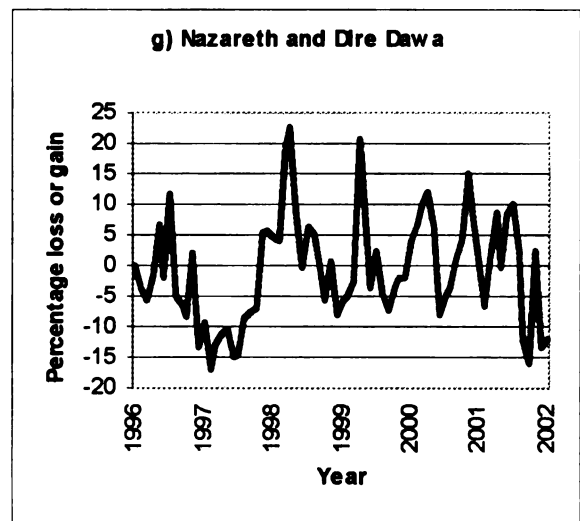
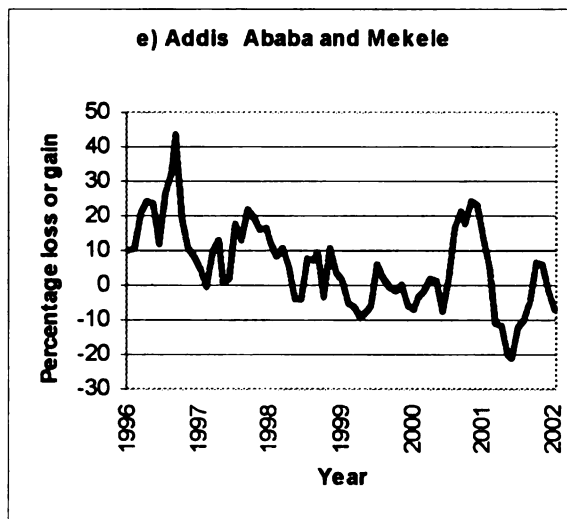


Figure 7.4 (Continued)



CHAPTER 8

SUMMARY AND CONCLUSIONS

In recent years, the Ethiopian government has embarked on various market reform measures aimed at improving grain market performance. Research is needed to improve understanding of the operation of grain markets and the effects of policy changes on grain market development. As discussed in Chapter 3, the various conventional methods which have been used to study spatial market efficiency and/or spatial market integration depend on an assessment of the co-movement of prices, or the long-run relationship between prices. These methods assume stationary spatial marketing margins, stationary transfer costs, and/or that markets are linked by a constant trade pattern (uni-directional and continuous). However, these assumptions are often violated and so the resulting test of market integration may be misleading and have adverse consequences on policy decisions.

The standard parity bounds model (PBM) represents one of the recent developments which attempt to overcome some of the weaknesses of the conventional methods discussed in Chapter 3. The PBM allows for transfer costs and explicitly incorporates spatial arbitrage conditions in a test for spatial market efficiency. However, in the context of on-going market reform and policy changes in developing countries, the standard PBM needs further improvements in order to properly assess the effect of policy changes on spatial market efficiency. This is because the standard PBM has been used mostly to analyze spatial market efficiency within a given constant policy regime. In cases where it has been used to analyze the effects of policy changes on spatial market efficiency, the effect of policy changes is assumed to be instantaneous. However, the

PBM is mis-specified and the results and policy implications might be misleading if the actual effects of policy changes on spatial market efficiency are gradual and move through a transition period, as might be expected in many cases.

Therefore, there are two major objectives for this study: (1) to provide an improved modeling approach for analyzing the adjustment paths and the extent of structural change in spatial grain market efficiency in response to policy changes; and (2) to provide empirical evidence on the adjustment path and extent of structural changes in spatial market efficiency for maize and wheat in Ethiopia as a result of recent grain marketing policy changes implemented in October 1999.

In Chapter 4, building on the standard parity bounds model, a stochastic gradual switching model with three trade regimes was developed to analyze the effects of policy changes on spatial market efficiency. The extended parity bounds model (EPBM) improves the standard parity bounds model in two ways. First, it traces the time path of the effects of policy changes on spatial efficiency regime probabilities. Hence, the model allows the effects of policy changes to be instantaneous or gradual and, if they are gradual, the model also allows estimation of the length of time required for the full effects of policy changes to be realized. Thus, the EPBM allows a better understanding of the nature of transition from old to new policy regimes. Second, it allows formal statistical tests to be undertaken for structural change in the probabilities of different trade regimes due to policy changes.

The EPBM is estimated using maximum likelihood and utilizes data on observed grain transfer costs and wholesale grain prices for several regional markets in Ethiopia. One of the problems with implementing the PBM empirically is that time series data on

transfer costs are rarely available, particularly in developing countries like Ethiopia. As a result, most empirical PBM studies have assumed transfer costs are constant over time for a given policy regime. However, this assumption is very restrictive, particularly when the PBM is used to analyze the effects of policy changes. This is because if transfer costs are assumed to be constant when they actually fluctuate considerably over time, then the PBM may misinterpret spatial price deviations as evidence of inefficiency when they are actually just a rational response to changes in transfer costs. Thus, there is a need to go beyond the constant transfer cost assumption and find better ways of using data that are available to construct more appropriate inferences about historical movements in transfer costs. Chapter 6 discusses the data sources and the steps followed in the construction of grain transfer costs based on two cross-sectional surveys of grain traders in Ethiopia and time series truck shipment freight rate data. The spatial efficiency interpretations of trade regime probabilities estimated by EPBM are also guided by the EGTE grain flow data.

Monte Carlo experiments were conducted to assess the performance of the EPBM. The design and the results of Monte Carlo experiments are discussed in Chapter 5. The results show that the EPBM estimates the level and the changes in trade regime probabilities with high accuracy, even in relatively small samples, conditional on zero time length required for transition between policy regimes. However, the EPBM estimation of the optimal time length is biased downward and the size of the bias increases with the actual time length required for transition from old to new policy regime. Thus, caution must be used in interpreting results when the transition period is very long, for example, more than a year.

The EPBM is applied to examine the effects of Ethiopian grain marketing policy changes implemented in October 1999 on spatial efficiency of maize and wheat markets and the results are presented in Chapter 7. Prior to the policy changes, all the maize market pairs considered are spatially inefficient with high probability. However, the nature of observed spatial inefficiencies varies among maize market pairs. On one hand, it is observed that the probability of spatial price differential greater than transfer cost is about 68% for Addis Ababa and Mekele. This is inconsistent with spatial market efficiency whether or not there is actual trade. The result indicates that too little maize trade was taking place relative to that which we would expect in a spatially efficient market. One of the reasons for this spatial inefficiency may be due to the restriction of grain movement between Addis Ababa and Mekele which is enforced through a roadblock at the town of Alamata. This might restrict trade flow into Mekele market and thus increase maize prices in that region.

On the other hand, it is observed that the probability of spatial price differential less than transfer cost is greater than 65% for 6 of 7 maize market pairs (Addis Ababa and Jimma, Addis Ababa and Nekempte, Addis Ababa and Dessie, Addis Ababa and Dire Dawa, Nazareth and Dire Dawa, and Shashamane and Dire Dawa), while at the same time the frequency of maize trade flow observed for these market pairs appears to be significant. Together, these results indicate that maize traders were active but made losses during this period. In other words, there was too much maize trade relative to that which we would expect in a spatially efficient market.

There are several factors which might cause spatial inefficiency of maize markets in which there is high probability of making losses by maize traders. First, the lack of

well-developed storage facilities in maize supply markets might force the continuous flow of grain to central or other deficit markets, even if maize prices are not favorable in these markets. The rationale for this might be to reduce further revenue losses from waiting for a better price, which might lead to spoilage, quality deterioration, and lower maize prices in destination markets. Second, liquidity constraints and shortage of working capital due to missing or imperfect credit markets for grain traders can also force maize traders to liquidate grain, even if it means a loss. It has been observed that grain traders in Ethiopia have poor access to formal credit and other forms of financial services. As a result, proceeds from current grain (e.g., maize) sales are used by grain traders for refinancing next grain purchases and settling other debts which indicate that the opportunity costs of capital tied up in grain stock is very high when the grain traders have limited access to credit.

Third, regional maize wholesale traders might have difficulty matching profitable purchase and sale decisions due to inadequacy or unavailability of market information regarding future price movements and changes in supply and demand conditions in the source and destinations markets. Fourth, there may be too many maize traders but these traders might lack economies of scale in their operation contributing to higher cost of marketing. Fifth, maize traders might also be limited by their trading skills to adjust to the very dynamic grain marketing situations following market reform.

If inefficient (unprofitable) maize trades are taking place a natural question to ask is: how do maize grain traders survive in the face of high probability of making losses? It is observed that the wholesale grain trade is not a specialized business in Ethiopia. Regional grain traders usually keep a diversified portfolio of business activities (grain

and non-grain) and that might help to spread the risks. Regional grain traders also combine interregional grain trade activities with local grain trade activities. A lot of grain traders are also observed to operate without a license, while those with a license complain about the unfair competition from unlicensed grain traders (Dessalegn et al., 1998). Operating without a license might allow grain traders (experienced or new) to enter and exit out of the grain trade sporadically, depending on market conditions, and still avoid government tax payments and hence reduce their marketing costs.

Grain marketing policy changes had statistically significant effects on maize trade regime probabilities at the 5% level only in 3 of 7 market pairs (Addis Ababa and Nekempte, Addis Ababa and Dire Dawa and Addis Ababa and Mekele). Of those 3 market pairs, 2 of them (Addis Ababa and Nekempte and Addis Ababa and Mekele) adjusted gradually over six months or less while Addis Ababa and Dire Dawa adjusted instantaneously. However, as a result of the policy changes spatial efficiency of maize markets appears to have improved only for trade between Addis Ababa and Mekele. For all the other market pairs, spatial efficiency either was not significantly affected (Addis Ababa and Jimma, Addis Ababa and Dessie, Addis Ababa and Nazareth and Dire Dawa and Shashamane and Dire Dawa) or deteriorated (Addis Ababa and Dire Dawa).

In the case of wheat, prior to the policy changes, all the wheat market pairs considered are spatially inefficient most of the time. Similar to maize markets, the nature of spatial inefficiency of wheat markets also varied among wheat market pairs. In 5 of 7 wheat market pairs, the probability of spatial price differential greater than transfer cost is statistically significant at the 5% level; this is inconsistent with spatial market efficiency irrespective of actual trade flows. On the other hand, the probability of spatial price

differential less than transfer cost is greater than 80% for 2 of 7 wheat market pairs. In these cases, high frequency of wheat trade flow was also observed. This is also inconsistent with spatial market efficiency as grain traders would have lost money if they actually traded during this period. There is statistically significant joint structural change in wheat trade regime probabilities only for Addis Ababa and Mekele with instantaneous adjustment. For this market pair, the probability of spatial price differential greater than transfer cost decreased by about 71% while the probability of spatial differential less than transfer cost increased by the same magnitude.

There are several possible reasons for the high frequency of spatial price differential being greater than transfer cost in the case of wheat. First, it could be an indication of lack of competition in the wheat marketing system, lack of information on profitable spatial arbitrage opportunities, and wheat traders' inability to take advantage of arbitrage opportunities for several reasons (e.g. weak institutions and infrastructure supporting spatial grain markets and barriers to interregional trade). Second, the high frequency of spatial inefficiency could also be an indication of high risk inherent in the wheat marketing system. Generally, when risks are high traders require higher margins to compensate for the risk in the marketing system. In the Ethiopian context, some of the risks faced by grain traders could be due to unforeseen changes in policies affecting grain markets, food aid and commercial imports of grains and changes in supply and demand for grain.

It is also important to note that the nature of spatial market inefficiency observed for maize and wheat is different and this might require a different policy response for the two commodities. In the case of maize, in most of the cases there is high probability of

spatial price differential less than transfer cost while there is also high probability of trade flow between these markets. So the maize market is more often characterized by too much trade rather than too little. In the case of wheat, in most of the cases there is high probability of spatial price differential greater than transfer cost. In general, the wheat market is more often characterized by too little trade rather than too much.

One of the possible reasons for the observed differences in the nature of spatial inefficiency between maize and wheat might be differences in maize and wheat market structures. The geographic locations of surplus maize and surplus wheat producing regions are different. Maize is produced mainly in the Western regions of Ethiopia while wheat is grown in the central regions of the country. The level of marketing infrastructure is relatively more developed in the central regions. Among other things, this might have attracted investment in storage and other marketing facilities in the wheat areas which encouraged the development of relatively larger wholesale grain traders which can influence wheat prices. The analysis of the structure and conduct of wholesale grain trade in Ethiopia by Dessalegn et al. (1998) indicates that the wheat markets are more concentrated. On the other hand, the marketing infrastructure in the Western region is less developed and grain traders are expected to be smaller sized and more numerous compared to the central regions.

The results indicate that there are spatial inefficiencies in maize and wheat markets in Ethiopia both before and after the policy changes. This shows that resources are being misallocated in transferring maize and wheat from surplus producing regions to grain deficit regions. The implication of these results is that maize and wheat markets are characterized by periodic gluts and shortages which can undermine the welfare of

producers, grain traders and consumers. In most of the cases, the effect of past policy changes on spatial grain market efficiency is not significant. However, in cases where significant structural change occurred the markets adjusted to the policy changes either gradually or instantaneously. Thus, an instantaneous response to the policy changes cannot be taken for granted but should be tested empirically.

Finally, as with all empirical studies of spatial market efficiency, it is important to keep in mind that the data and estimation methods have inherent weaknesses. For example, the results are sensitive to the accuracy of transfer costs estimated from the cross-sectional survey of grain traders and time series truck shipment freight rate data. Results are also sensitive to the distributional assumptions made in implementing the EPBM. Therefore it is important to interpret the empirical results with caution and think critically about the implications of the results for the design and implementation of public policy. The other limitation of this study is also that it only assesses the degree of spatial efficiency of grain markets and does not provide actual evidence on why the markets are not spatially efficient.

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