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The Ethiopian Commodity Exchange and spatial price dispersion[1]

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Abstract

In this article, we study the impact of an institutional intervention on market efficiency in Ethiopia. More specifically, we study whether regional warehouses that are connected to a national commodity exchange reduce transaction cost and price dispersion between regions. In order to identify the causal effect we take advantage of the fact that the warehouses that are connected to the Ethiopian Commodity Exchange were sequentially rolled out. Using retail price data and information about warehouse operation from 2007-2012, we find that the average price spread between market pairs is reduced by 0.86-1.775 ETB when both markets have an operating warehouse. This is a substantial reduction considering that the average price spread over the full period is 3.33 ETB.

Keywords: Coffee, Commodity Exchanges, Ethiopia, Price dispersion, Warehouses

JEL classification: D47, O10, Q11, Q13, Q18

1. Introduction

The questions asked in this paper relate to how exogenous institutional interventions contribute to increased efficiency of output markets for smallholder farmers in developing countries. More specifically, we analyze to what extent a recently introduced national commodity exchange and decentralized warehouse system in Ethiopia has resulted in a reduction in the spread of coffee prices between regional markets.

It is well known that many markets in developing countries are characterized by small trading volumes, incomplete competition and a high volatility in prices (i.e., by being 'thin'). Low trading volumes implies that the quantity and quality of information disseminated from trade is limited and therefore that the price discovery process (i.e., the process through which buyers and sellers arrive at a transaction price) is hampered (Tomek, 1980; Carter, 1989; Mattos and Garcia, 2004). A malfunctioning price discovery process is in turn associated with extensive price variability and inefficient markets.

Well-functioning agricultural exchange platforms disseminate relevant information to all decision makers and thereby facilitate price discovery and price risk management (Gonzalo and Figuerola-Ferretti, 2007; Kaur and Rao, 2012). Such institutions may therefore be of great importance for optimal resource allocation[2] (Easwaran and Ramasundaram, 2008; Shalini and Duraipandian, 2014).

However, the recently growing literature on price discovery in agricultural commodity markets in developing countries provides mixed evidence concerning whether commodity exchange systems have really contributed to improved efficiency (Matteo and Garcia, 2004; Shakeel and Purankar, 2014)[3]: while the introduction of spot and futures exchange systems have been found to increase efficiency in terms of price discovery in some regions of India (Roy, 2008; Shakeel and Purankar, 2014) and Malaysia (Azizan et al. 2007), the effects are less clear for other regions in India (Thomas and Karande, 2001; Kumar and Sunil, 2004; Karande, 2006; Praveen

[2] Contrary to an inefficient market, which is one under which different prices for same commodities exist, which bias decision making and resource allocation, an efficient market is characterized by a marketing system that generates price that fully reflects the available information and transmits that information throughout the marketing system in a timely manner (Working, 1942; Tomek, 1980; Sahi & Raizada, 2006; Mattos and Garcia, 2004; Kaur and Rao, 2012).

[3] Notable works in the study of the role of commodity markets in price discovery in the developed world generally show an effective role commodity markets play in price discovery and there by market efficiency. The price discovery mechanism is quite effective for most commodities, but may not be very effective for some commodities (e.g.. Gardbade and Silber (1983), Schroeder and Goodwin (1991), Oellermann et al. (1989), Brockman and Tse (1995), Zapata and Fortenberry (1997), Tucker and Koutmos (1996), Tse and Xiang (2005) y Zapata et al. (2005), Yang et al. (2001)).

and Sudhakar, 2006; Shihabudheen and Padhi, 2010; Kaur and Rao, 2012), and Brazil (Mattos and Garcia, 2004). Research on price discovery in the context of commodity exchange markets in Africa, where markets are notoriously thin (e.g. Gabremadhin, 2001; Fafchamps and Gabremadhin 2006), is very scant (Gabremedhin, 2008).[4] Exceptions include Katengeza et al. (2011), who find that the Malawi Agricultural Commodity Exchange (MACE) significantly improved spatial integration (i.e., that the tendency of prices to move together in spatially separated markets), Francesconi and Heerink (2011), who do not find significant effects of the Ethiopian Commodity Exchange (ECX) on commercialization levels of smallholder farmers in Ethiopia, and Hussein (2010) who find that ECX is weak-form inefficient but that traders can earn excess profit using the predictability in price series. Further analysis of the conditions under which commodity exchange institutions lead to market efficiency is therefore needed

The focus of the analysis below is on how physical infrastructure, in terms of local warehouses connected to a commodity exchange, affects market efficiency. The motivation for our focus is based on three arguments: 1) the availability of secure storage is crucial for seasonal smoothing of the supply and price of agricultural produce. 2) Unless reliable and up to date price information is available, market agents' ability to reap the benefits of seasonal and regional variation in prices is limited even in if storage facilities are available. 3) Geographic distance and transportation costs imply that unless traders that are separated geographically have access to reliable information on quality and sample sizes, trade is hampered. Taken together, a lack of with local warehouses offering services such as storage, sampling and certifying the quality of the produce, combined with incomplete price information and high transport costs are likely to give rise to thin markets with large price spreads between surplus and deficiency areas. Indeed, Fafchamps & Gabre-Madhin (2001) identify lack of grading and quality certification, the lack of organization between brokers and agents through a commodity exchange, and the presence of search and transport costs to be the main transaction costs and thus obstacles for improvements in efficiency in Malawi and Benin. Coulter and Onumah (2002) argues that regulated warehouse receipts reduce such transaction costs, since warehouse operators have access to and can disseminate information on demand, supply, inventories and quality of the goods. In addition, warehouse operators' ability to enter into contracts with local small-scale farmers and traders reduces the risks associated with deliveries and quality.

Ethiopia has a relatively long history of using decentralized warehouses for storage. However, with the liberalization of the economy, many warehouses fell in disuse due to non-

[4] Section 2 discusses the nature of commodity exchange markets in Africa in more detail.

profitability. The ones that remained active were located in a few urban areas.[5] The ECX has as a mission to gradually re-open local warehouses, and to homogenize standards for quality grading and certification. In addition, a major effort has been made to improve the infrastructure for price information.[6] The introduction of such a decentralized system of warehouses connected to a commodity exchange has the potential to improve efficiency through several channels: 1) via reduction in seasonal price variability, 2) via curtailed cheating on weights and measures, and 3) via improved access to finance at all levels in the marketing chain (Fafchamps & Gabre-Madhin, 2001; Coulter and Onumah, 2002; Bouquet et al., 2009).

Based on this, the purpose of the analysis conducted in this paper is to provide a formal evaluation of the effect of the ECX in general, and the local warehouses in particular, on market efficiency in Ethiopia. The reason that we focus the introduction of local warehouses is that, although the opening of the ECX was associated with an improved infrastructure for price information, high transport costs and lack of secure storage implies that the sole effect of the ECX on local markets is likely to have been limited. Our hypothesis is thus that the roll out of warehouses to local markets brought the ECX, and thereby the national and even international market closer to these markets and that this has improved efficiency.

We evaluate market efficiency by comparing price dispersion between market pairs where both markets have access to warehouses and market pairs where at least one part lacks access to a warehouse, on a dataset consisting of a sample where all markets eventually installed a warehouse. We thus use spatial price dispersion as a measure of market efficiency. As in Hussein (2010), our analysis is based on coffee prices. The motivation for using coffee prices as our main unit of analysis is that coffee was the first commodity traded at the ECX and that coffee is the by far most important export commodity in Ethiopia. However, our empirical analysis differs from Hussein (2010) in several important aspects. First and perhaps foremost, we have data on a longer time period since the introduction of the ECX and can therefore better estimate effects. Second, instead of closing prices on the ECX, we analyze how spread in prices between different regions in Ethiopia has been affected by the presence of warehouses linked to the ECX.

The empirical approach used for analysis in this paper is most closely related to the work of Jensen (2007), Aker (2008, 2010) and to Svensson and Yanagizawa (2009) who all analyze effects of an improved information infrastructure on market efficiency. Utilizing a quasi-experimental setting caused by a gradual roll-out, Jensen (2007) shows that the introduction of

[5] Agricultural Growth Program (AGP) and USAID: http://ethioagp.org/agp-amde-ethiopia-warehouse-receipt-system-and-regulation-a-case-for-expansion/. Visited in 2015-08-05.

[6] ECX provides price information via e.g., interactive voice recordings and short text messages (SMS) and electronic tickers in rural markets.

mobile phones in the Indian region Kerala increased local fishermen's profits and reduced catchment waste and price dispersion. Aker (2008; 2010) similarly evaluates the effect of mobile phones on market efficiency, but for the grain market in Niger. Utilizing a market and trader panel dataset[7], Aker employs a difference-in-differences approach to allow for heterogeneity temporally and spatially. The results of the empirical analysis are in accordance with Jensen (2007), but the panel structure of Aker's dataset also allows her to identify effects on price dispersion both across markets and within years. Perhaps the most prominent result found is that the magnitude of the effects of improved information increases with transportation costs (either due to poor road quality or long distance from markets). Finally, Svensson and Yanagizawa (2009) analyse how the introduction of a Market Information Service (MIS) project[8] in Uganda affected farm gate prices. Similar to Aker (2008; 2010) and Jensen (2207), Svensson and Yanagizawa (2009) utilize the natural experiment characteristic of access to the MIS, in this case in terms of exogenous differences in access to radio broadcasts. The results of the study suggest that improved access to information about prices is associated with a significant increase in farm gate prices (radio access in a MIS district was associated with a 15% increase in farm-gate prices).

Similarly to the above-described studies, we utilize what may be seen as a quasi-experimental setting. More specifically, we use that warehouses connected to the ECX were gradually implemented across regions in Ethiopia, and analyze differences in difference between regions with and without access to these warehouses. As Aker (2010) and Jensen (2007), we use price spreads between markets as a measure of market efficiency. However, in contrast to Jensen (2007), Aker (2008; 2010) and Svensson and Yanigizawa (2009), our focus is not solely on information but rather on the compound effect of warehouses and the presence of a centralized commodity exchange. To the best of our knowledge, this is the first paper that evaluates the effects of commodity exchanges in developing countries.

The rest of the paper is outlined as follows: In section 2, we give a brief description of the Ethiopian coffee market and the ECX. This is followed by a description of the conceptual framework used in the paper in section 3. In section 4, a discussion of the warehoursing system under the ECX is presented. The data and empirical methodology is presented in section 5. Section 6 presents the results of the empirical analysis. Finally, the paper is concluded in section 7.

[7] Covering 42 domestic and cross border markets and 35 markets and six regions respectively

[8] An initiative by two agricultural research organizations IITA and ASARECA in association with the National (Ugandan) Ministry of Trade, Tourism and Industry , initiated in 2000 and covered 21 of Uganda's 56 districts, reaching 7 of Uganda's 24 million population in eight languages

2. Essential features of commodity markets, the Ethiopian Commodity Exchange Market and Coffee Trading

2.1. Market Imperfections, liberalization and the emergence of commodity exchange in Africa

As mentioned above, the main cause of market thinness in developing countries is the presence transaction costs caused by poor transport and information infrastructure and lack of efficient market institutions (North, 1990; World Bank, 2002; Kydd and Dorward 2004; Dorward et al., 2005). These transaction costs imply that farmers are often effectively prevented from taking advantage of price difference between markets, and have insufficient information about the final demand and value of their produce.

In response to the failure of agricultural markets in developing countries there has been aggressive liberalization of agricultural systems since the late 1980s. However, the results of such policy interventions have, in general, been disappointing. For example, in spite of liberalization reforms, the emergence of a common price and commercialization of subsistence farmers has been limited (Sadoulet and de Janvry, 1995; Shiferaw et al., 2010), and there appears to the persistent barriers to trade. As a consequence, price volatility is high, and investments remain constrained (Reinganum, 1979; Stahl, 1989; Dercon, 1995; Negassa and Jayne, 1997). Akiyama et al (2001) argues that one reason for the failure is that most policy interventions were rushed piecemeal and generally ill-suited. The reforms also focused primarily on removing state interventions (World Bank, 1997), placing little emphasis on developing institutions to help the private sector succeed in expanding its marketing activities (Jayne and Argwings-Kodhek, 1997; Akiyama et al., 2001; Coulter and Onumah, 2002).

The above-described problems are especially prominent for small-scale farmers. The failure of agricultural markets for smallholder farmers often result from lack of access to information and information asymmetry between the farmers and buyers (Kydd and Doward, 1889; Poulton et al., 2006; Shiferaw et al, 2006; Barrett, 2009). A consequence of these failures is that smallholder farmers tend to sell their produce in local poor-paying markets or at the farm-gate rather than travel to distant better-paying markets (Fafchamps and Hill, 2005).

In addition to lack of information and the lack of inventory credit limits the capacity of traders to store and discourages producers from holding inventories. Instead, farmers are compelled to sell the bulk of their output immediately after harvest at a sub-optimally low price to meet the cash needs of the household. Lenders tend to be reluctant to provide inventory finance partly because of lack of transparent systems of price discovery as well as institutions and instruments for managing price risk (Onumah, 2002).

The foregoing discussion suggests that innovations that facilitate market exchange by reducing transaction costs and imperfect information will benefit the agricultural trade in Africa (Coulter and Onumah, 2002). One such innovation is commodity exchanges.[9] Following the sweep of market liberalization across the globe, the presence of such exchanges has increased rapidly to fill the gap left by marketing boards and fixed price systems in many developing countries, and today over 100 exchange institutions are active.[10] Most of these exchanges have been created since 1992 (Gabre-Madhin, 2008). While exchange infrastructure, consisting of the trading, delivery and payments systems, are no panacea to some of the factors contributing to inefficiency in agricultural markets in most African countries, they may be able to reduce transaction costs, improve storage and ease access to trade finance (Onumah, 2002).

The establishment of commodity exchange markets in Africa is a relatively recent phenomenon. Pioneers include the Uganda Commodity Exchange (UCE) and the Kenya Agricultural Commodities Exchange (KACE), the Zimbabwe Agricultural Commodities Exchange (ZIMACE) and the South Africa Futures Exchange (SAFEX), all established in the 1990's. The Ethiopia Commodity Exchange (ECX), which was launched in 2008, is the most recent Spot/Cash exchange in Africa.

2.2. The Ethiopian Commodity Exchange Market

Like most markets in developing countries, the agricultural market in Ethiopia is plagued by market imperfections caused by thin markets: low density and high cost of transport[11], inadequate market information about prices, supplies, and inter-regional grain flows in other markets, inadequacy of storage facilities, weak bargaining power of producers, imperfections in the marketing chain, inadequate enforcement of contracts and lack of universally applicable and enforceable product standards (RATES, 2003; Assefa, 1995; Holden & Shiferaw, 2003; Osborne, 2005; Jaleta, 2007). As a consequence, the level and growth in agricultural productivity is low even in comparison to sub-Saharan Africa, (RATES, 2003) in spite of Ethiopia's relatively high agricultural potential.[12]

[9] We define a commodity exchange as a market institution that provides a physical or virtual (electronic) venue which brings together buyers and sellers to trade usually through a group of registered brokers. Trading in this marketplace may be in physical commodities or in derivatives, which are financial contracts/instruments, whose values are derived from the value of an underlying asset, which can be commodities, equities (stocks), mortgages, bonds, interest rates and exchange rates or indices such as stock market and consumer price indices. They are usually used to manage the risk of unexpected reduction in the value of the underlying asset (Rashid et al. 2008).

[10] 28 in Latin America, more than 20 in Asia, 3 in Africa, 4 in Eastern Europe, and several in Russia.

[11] 66 percent of marketing cost of grain

[12] The agricultural sector in Ethiopia grew at a rate below the population growth between 1962 and 2002 (Taffese, 2005).

For the grain market in particular, Gabre-Madin (2001a) finds that traders tend to engage in suboptimal searches due to insufficient access to brokers. Gabre-Madhin and Goggin (2005) argues that the introduction of a commodity exchange in Ethiopia could potentially remedy some of the above mentioned market inefficiencies and produce a more integrated agricultural market. More specifically, Gabre-Mahdin and Goggin (2005) argue that the introduction of an exchange is justified from a bottom-up perspective, since farmers and traders' demand for a better-organized domestic and regional market, and for improved agro-processing. In addition, a commodity exchange could potentially produce a more efficient and integrated agricultural market by providing actors with better information about market prices, quality controls and product standards as well as a legal framework to reduce the risk of default. However, the success of a commodity exchange depends critically on the economic order and the linking of institutions such as market information systems, quality certification, regulatory frameworks and legislation, arbitration mechanisms and producer and trade associations.

Partly as a consequence of the work by Gabre-Mahdin (2001a) and Gabre-Mahdin and Goggin (2005), the Ethiopian Commodity Exchange (ECX) was opened in 2008. The ECX is a modern auction for agricultural commodities located in Addis Abeba. The exchange is associated with a comprehensive system for disseminating information about market prices to more peripheral regional markets in the country. In addition, a number of warehouses connected to the ECX have been established in surplus areas. The warehouses provide services in terms of information, storing facilities and quality controls. More specifically, the availability of ECX warehouses in surplus areas implies that commodities are now controlled, graded and stored locally until they have been sold through an electronic system in Addis Abeba (ECX, 2010). This implies that traded commodities no longer need to be brought to the auctions centers in Addis Abeba or Dire Dawa for sales. In an attempt to shorten the supply chain, primary transaction centers have been established as designated trading places where smallholder producers and cooperatives on the one hand and coffee suppliers (*agrabies*) on the other hand trade red cherry and sun dried coffee (Council of Ministers Regulation No. 159/2008; Berhe, 2010; Adinew, 2010).[13]

[13] It should be noted that Adinew (2011) finds that in the area for the study, the primary collectors still operates and perform their previous duties. It may also be noted that all coffee still has to pass through the auctions/ECX. Only coffee rejected for export due to poor quality can be sold on the domestic market. However, the mandatory pass through only concerns coffee destined for non-growing areas, in coffee growing areas licensed traders were allowed to sell directly to the market (Dercon and Ayalew, 1995).

The establishment of the ECX has also contributed to a substantial improvement in the information infrastructure for commodities traded at the exchange: traders can now receive market information via SMS, Interactive Voice Response, Internet, other media (radio, television and newspaper), or via electronic tickers placed in rural markets that display real time prices of all commodities traded on the platform. Finally, the ECX has a comprehensive legal framework and an advanced system for clearing and settlement of contracts in order to guarantee payment and delivery, for example by requiring all trading members to have prepaid credit accounts. However, the ECX has not only been embraced as a positive phenomenon. The exchange was initiated mainly to overcome shortcomings in the trade of grains, and not for coffee. Some critical voices have therefore been raised that the ECX therefore contributed to further complicating the problems facing coffee growers. Most importantly, critics argue that the coffee market is inherently different than markets for other agricultural commodities. Mezlekia (2009) for example, argues that since coffee is a global commodity and since the international coffee market is characterized by fierce competition between numerous supplying countries selling to a few multinational buyers,[14] it would be beneficial for Ethiopian farmers to engage in direct trade and to create a niched market (i.e., by selling profiled high quality coffee). However, the Ethiopian government's requirement that all coffee should pass through the ECX effectively eliminate such direct trade and niching of the product. In addition, Coulter and Onumah (2002) note that the warehouse system faces challenges in regards to scale economies, the policy environments, legal limitations, banker confidence, lack of regulatory system and insufficient smallholder involvement. Consequently, to what extent the ECX has actually contributed to increased efficiency remains an open question since very few formal evaluation has so far been implemented. To the best of our knowledge, there is to date only one study that makes an attempt to estimate the effect of ECX on efficiency. Hussein (2010) evaluates if price movements of coffee traded at the ECX follow a random walk process.[15] The results of the empirical analysis suggest persistent and strong dependencies in the price series, and therefore that traders can still excerpt excess profits by using predictability in the price series. However, Hussein (2010) notes that this result may be a consequence of the short time span between the introduction of the exchange in 2008 and the evaluation in 2010.

[14] Nestlé, Philip Morris, Procter and Gamble, Sara Lee, and Kraft Foods buy about 70% of the world's coffee.
[15] Hussein (2010) employs the Augmented Dickey-Fuller (ADF) test, the variance ratio test and the Brock-Dechert-Scheinkman (BDS) test on weighted average washed and unwashed coffee prices at the ECX

2.3. Coffee trading in Ethiopia

Ethiopia is often believed to be the origin of coffee Arabica and the country is probably also the oldest exporter of coffee in the world (Aregay, 1988). In 2012, coffee accounted for about a quarter of Ethiopia's export value and over 4 million of Ethiopia's smallholder farming households were estimated to grow coffee (CSA, 2013). At the international level, Ethiopia is the fifth largest coffee producer in the world after Brazil, Vietnam, Indonesia and Colombia. However, coffee is not only an important export commodity; Ethiopia is one of the few coffee producing countries that also have a large domestic consumption. About half of the coffee produced in Ethiopia is consumed locally (CSA, 2013) and the coffee ceremonies are an important part of the cultural tradition.

Coffee is mainly produced in the regions of Oromia and Southern Nations, Nationalities and People's Republic (SNNPR). The taste and the quality of coffee differ depending on the geographical location of the production and vary in the dimensions of farming system (forest coffee, semi-forest coffee, garden coffee and semi-modern plantation) and processing method (dry and wet). During the past three decades, the Ethiopian coffee market has undergone a number of structural changes.[16] Many of these reforms have had a gradual effect on the market (Petit, 2007) and a large share of the market structure characteristics still stem from the historical legacy (Love, 2001), with two significant milestones: The first important mark in the country's history of Coffee Trading Policy is the beginning of a more liberalized coffee market following the downfall of the Derg military regime in 1991, while the second was the introduction of the Ethiopian Commodity Exchange.

Throughout the Derg regime that started in 1975, the Ethiopian Coffee Market Cooperation (ECMC) controlled about 80 per cent of the internal and external marketing of coffee. During this era, domestic coffee prices were set by the Ministry of Coffee and Tea, while export minimum prices were set by the Central Bank (Petit, 2007). Farmers were obliged to supply certain quotas of coffee to the government (Gemech and Stuthers, 2007) and only licensed collectors (*sebsabies*), and suppliers (*agrabies*), were allowed to trade coffee at the auctions in Addis Ababa and Dire Dawa where all coffee was priced. After the end of the military Derg regime in 1991, the parastatal Ethiopian Coffee Marketing Corporation (ECMC) was closed down and export price control as well as farm gate price floors were gradually removed. However, although license fees related to trade of coffee were reduced, the supply chain through primary collectors, suppliers and auctions remained (Petit, 2007). In addition, although the

[16] For an excellent review of structural changes at the international level see Petit (2007).

deregulation of the coffee market led to an improvement in the transmission of price signals from the world market to the domestic market, farmers' and traders' (akrabies and sesabies) insufficient access to market information and credit, along with high transaction costs and uncompetitive markets, substantially limited the effect (Love, 2001; Worako et al., 2008; NBE, 2001).

3. Warehouses of the ECX in Ethiopia

Within the ECX warehouses play a pivotal role. Warehouses store commodities in surplus across Ethiopia to facilitate exchange to those in demand of these goods (ECX). It is within warehouses that the commodities are graded and sorted based on quality and quantity (Onumah, 2010). It is there that commodities are sampled, weighted and graded using specified grading and weighing equipment (ECX). This is done on a First-In-First-Out principle that is in line with international standards of inventory management (ECX). While all trade is conducted using Addis Ababa prices, to reflect the variation in locations of the warehouses, a location differential is applied using a frequently updated, public table (Mezui et al., 2013).

Depositors are issued an Electronic Goods Received Note and a signed print copy as evidence of the deposit (Onumah, 2010); however, this does not constitute a transferable, negotiable or legal title to the commodity, which requires an issue from the ECX Central Depository (ECX). The ECX acts as the regulatory body of warehouses, with the jurisdiction over their licencing and regulation (Gabriel 2012). Theoretically the public jurisdiction of the ECX is intended to ensure that warehouses are both credible and capable of providing fair and secure services (Gabriel, 2012). They have been, thus far, rented by the ECX from private owners and the Ethiopian Trade Enterprise (EGTE) (Bacha, 2014).

In effect, warehouses serve as the managers of the collateral of trading (Antonaci et al., 2015). Warehouses are required to insure against loss or damage of those goods stored within them at maximum coverage (ECX). As such operators of warehouses are required to meet various criteria including minimum capital requirements and adequacy ratios, insurance and performance bonds so as to protect against fraud and mismanagement (Coulter et al., 2002), and either own or hold a long term lease on the physical infrastructure, appropriate equipment that has been properly calibrated and a bank reference (Gabriel, 2012). They are fully liable for the safe custody of the goods therein stored, regardless of fire or any other catastrophe (Onumah, 2010). However, warehouses hold not means of benefiting from such insurance, legally or financially, as in the event of such loss have no recourse themselves to insurance funds, other

than in the case of outstanding storage costs (Onumah, 2010). Additionally, in consolidating warehousing, the system benefits smaller wholesales that would be unable to bear the costs of independently storing their goods at required capacity (Quattri et al., 2011). However, given warehouse demand there are substantial fees associated with its use that often do restrict small traders and producers who are unable to pay high monthly fees (Onumah, 2010).

There have been many recognized limitations of Ethiopia's implementation of the warehouse component of the ECX system. As of 2013, there has been an intention to segment the warehousing operations into its own distinct and separate entity (Mezui et al., 2013). According to the Ministry of Trade Kebede Chane, this new entity would be responsible and have the authority for the construction of new warehouses, as well as the management of the 60 existing and employ an Inventory Warehouse Management System to reflect lessons taken from the South African and Columbian experiences (Bacha, 2014). The proposed separation comes after issues of warehouse mismanagement where quality stated and quality upon delivery have diverged, accusations of the siphoning of higher grade goods being replaced with lower grades (Tadesse, 2014; Bacha, 2014). Furthermore, the Rockefeller Foundation has commented upon the delays within the existing warehouse management system, siting poor infrastructure including internet connections and road access increase delays and paperwork, these are being reportedly addressed by the ECX through the introduction of V-SAT technology (2013).

When the ECX was initiated in April 2008, just one warehouse was in use (Mezui et al., 2013); however, this figure quickly rose to include ten warehouses (Francesconi and Herrink, 2011). By 2010/2011 this figure had risen to 55 warehouses in 16 locations, growing to 57 in 2013 (Mezui et al., 2013) and 60 in 2014 (Tadesse*, 2014)*. While this figure is substantial, the concentration of warehouses in just 16 locations reflects an important lack of spatial dispersion. It has been recommended that the warehouse system in Ethiopia be expanded not only in terms of number of warehouses, but more importantly to reach areas of the country not currently served via areas, such as Dessie in the Amhara district, that act as the key transit points for the drought prone areas of the North (Quattri et al., 2011). This proposal and recommendation is considered to be important for the supporting of crop movement from the moisture reliable to the drought prone so as to lessen the severity of droughts and prevent the onset of famines (Quattri et al., 2011). As of 2014, an Ethiopian reporter stated that warehouses would expand to include the regional towns of Adama, Hawassa, Jimma, Gonder and Humera (Tadesse, 2014).

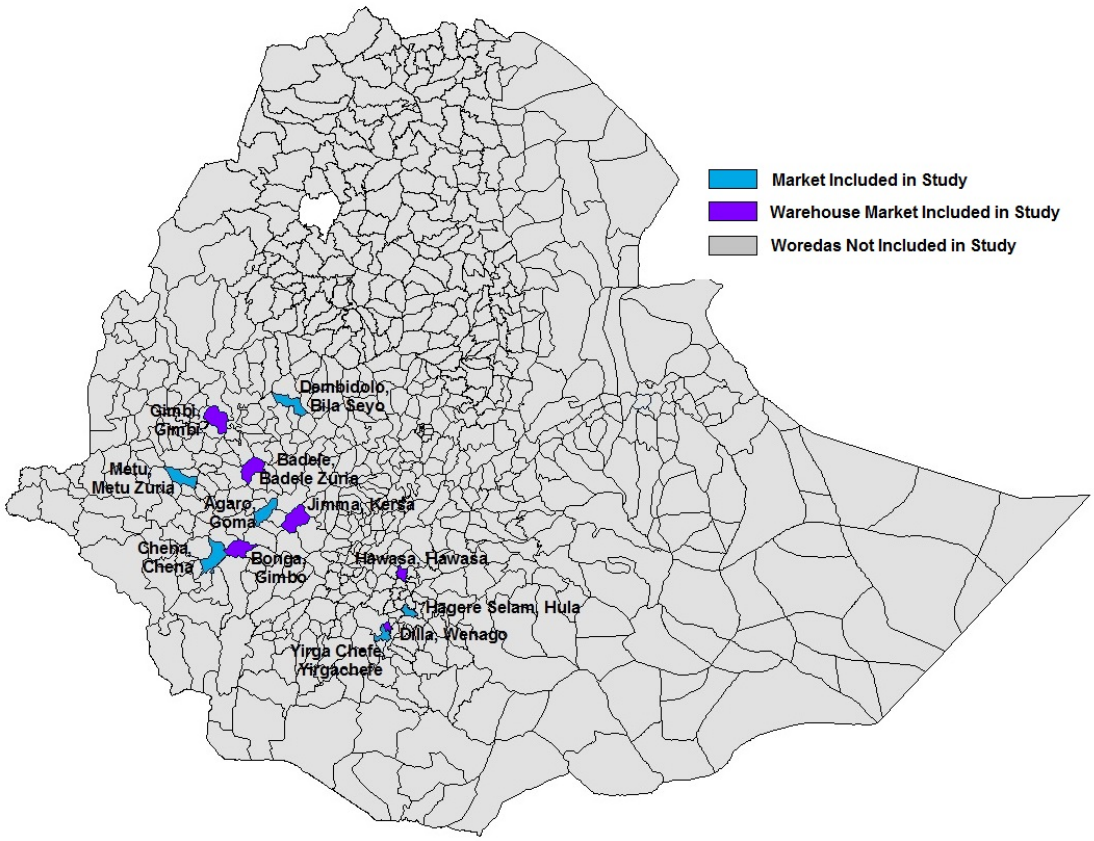

Figure 1: Locations of Warehouses under the ECX

It may be noted that, even after the introduction of the ECX, farmers still do not interact directly with warehouse managers. Instead, the produce is collected locally by primary collecting centers. However, within the new system,

4. Conceptual framework

In this paper, we use price dispersion as a measure of market efficiency. According to the Enke-Samuelson-Takayama-Judge (E-S-T-J) models, two markets are in a long run spatial equilibrium when the marginal return to arbitrage is equal to zero (Enke, 1951; Samuelson, 1952; Takayama and Judge, 1971). Spatial arbitrage is defined as the opportunity to reap excess profit by transporting the good from one market to the other. This implies that the equilibrium condition for an efficient market is given by Equation (1) below.

$$P_{jt} \leq \tau_{jkt} + P_{kt} \qquad (1)$$

where is *j* and *k* indicates two spatially separated markets and *t* is a time index. P is the price of the traded good and τ is the cost of transfer between the markets. Transfer costs may include

costs related to e.g., transportation, information and transaction (Chowdhury et al 2005). Transport costs may include posts like e.g., fuel cost, road tariffs and time cost associated with embarking and disembarking,[17] while information costs often relates to search for the most favorable price for a specific good or service (Stigler, 1961). Finally, transaction costs may refer to the costs associated with drafting and negotiating contracts as well as the costs related to monitoring and enforcing agreements (Coase, 1937; Faminow and Benson, 1990).

In the absence of trade, the constraint in Equation (1) is not binding and in such cases there need not be any correlation between price differentials and transaction cost. However, when trade occurs, the constraint in Equation (1) is binding, causing transaction costs and price differentials to move in the same direction and with the same magnitude (Barrett and Li, 2002).

In general, the ECX has the potential to reduce many of the transfer costs described in the E-S-T-J-model. More specifically, an increase in the availability of adequate and timely market information should reduce search costs, while an improvement in the legal framework and reduced risk of defaults should reduce transaction costs. In addition, the system of warehouses and thereby the reduced need for transport should reduce transport costs. Finally, the reorganization of the value chain may increase competition.

The main link between the local ECX warehouses and retail price dispersion between coffee growing areas is most likely via the exchange's impact on export prices. The reason for this is that the going price for exported coffee from a particular region is likely to function as a benchmark for coffee sold on local markets in that region. More specifically, an increase (reduction) in export prices should intuitively increase (reduce) incentives to sell coffee via that channel (i.e., export), thus reducing (increasing) supply on the local market and thereby putting an upward (downward) pressure on local retail prices. In addition, if the connection between warehouses and the ECX implies an improvement in access to information and a reduction in the risk associated with supplying coffee to the export market, this should narrow the gap between the export price of coffee from the different regions. To see this, note that traders at the ECX should be well informed about the going price from previous contracts. Local storage of coffee in warehouses and quality assessments by warehouse operators effectively reduces transport costs. Taken together, this suggests that ECX, if functioning as intended, should reduce noise in the price signal, and that any arbitrage possibilities in exported coffee from different regions should immediately be displayed and exhausted. This further implies that any remaining differences in export prices should reflect differences in quality of coffee from the different regions. Thus, by

[17] The original models were only specified in terms of transportation costs

reducing the dispersion of export prices between regions, and reducing the dispersion between export prices and local retail prices, the exchange can reduce retail prices between coffee growing areas.

5. Data and identification

5.1 Data

To estimate the effect of warehouses on price dispersion, we use three sources of data: 1) information regarding the location of each ECX warehouse and dates for when the warehouses became fully functional. 2) Monthly coffee retail price data and, 3) time series of the world market price for coffee.

The information on location and opening date for ECX warehouses was retrieved via interviews with ECX officers. By October 2012, ECX had 56 warehouses operating at 17 different locations; 9 of these locations had warehouses for coffee trade. The first ECX warehouses for coffee started to operate in July 2008 followed by three warehouses 2009, three warehouses in 2010 and two warehouses in 2011.

Monthly retail prices were retrieved from Central Statistical Agency (CSA) in Ethiopia. The main variable of interest from this data set is average monthly price per kg for whole (unprocessed) coffee. The retail price data was collected by SCA from selected urban market places such as open markets, kiosks and supermarkets. The data was mainly obtained through interviews with traders and contains a maximum of three price observations from different retailers during the same day for each month and location. Retail price data is available from all of the nine towns with ECX warehouse. However, only three towns had a sufficient number of observations to be useful in the analysis. In order to increase the number of observations we also include towns within the same zones as the warehouse towns. This leaves us with price information from 9 different locations in total.

We limit our timeframe to the period between January 2007 and December 2012, i.e. three years before and three years after the first ECX warehouse in our sample became fully functional.

Finally, our measure of the world market price of coffee is based on the Global Economic Monitor (GEM) commodities provided by the World Bank. More specifically, we use International Coffee Organization indicator price (in nominal dollar price per kg) for Arabica coffee based on an average from the New York and Bremen/Hamburg markets.

Figure 2 below describes the retail price, the world market price and the starting dates for the ECX warehouses considered in our sample. From the graph, we can see that the world market price was relatively stable in the period December 2006- December 2009. However, beginning in late 2009 we see a clear and strong trend in increasing coffee prices that lasts until the end of 2010, where we instead see a sharp reduction in the world market price. The individual dots in the graph represent local retail prices in Ethiopia. The trend in local prices seems to follow the world price relatively well. However, the graph also suggests that there are substantial differences in retail prices between local markets. The figure also displays the sequencing out of warehouses between the years 2009 and 2011.

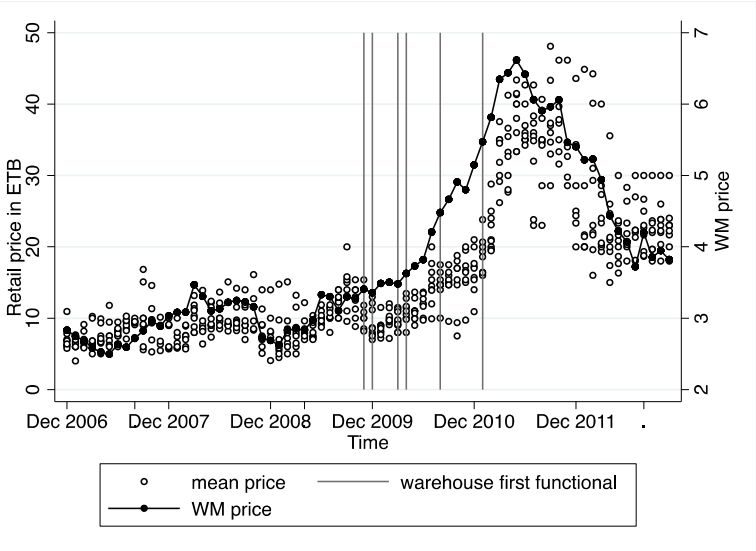

Figure 2. Retail prices in ETB and world price in USD

As can be seen in *Figure 2,* local coffee prices tend to follow the world market price, at least in terms of trend. However, a closer look at the individual years show that how well local prices follow the world price differ substantially between local markets and between time periods. *Figure 3* depicts the price trend on local markets for each year (2007-2012), along with the world market price (each dashed line represents a local market). Although the picture is not completely clear, the graphs seem to suggest that coffee prices on local markets follow the world price more closely in the period from 2010 and onwards.

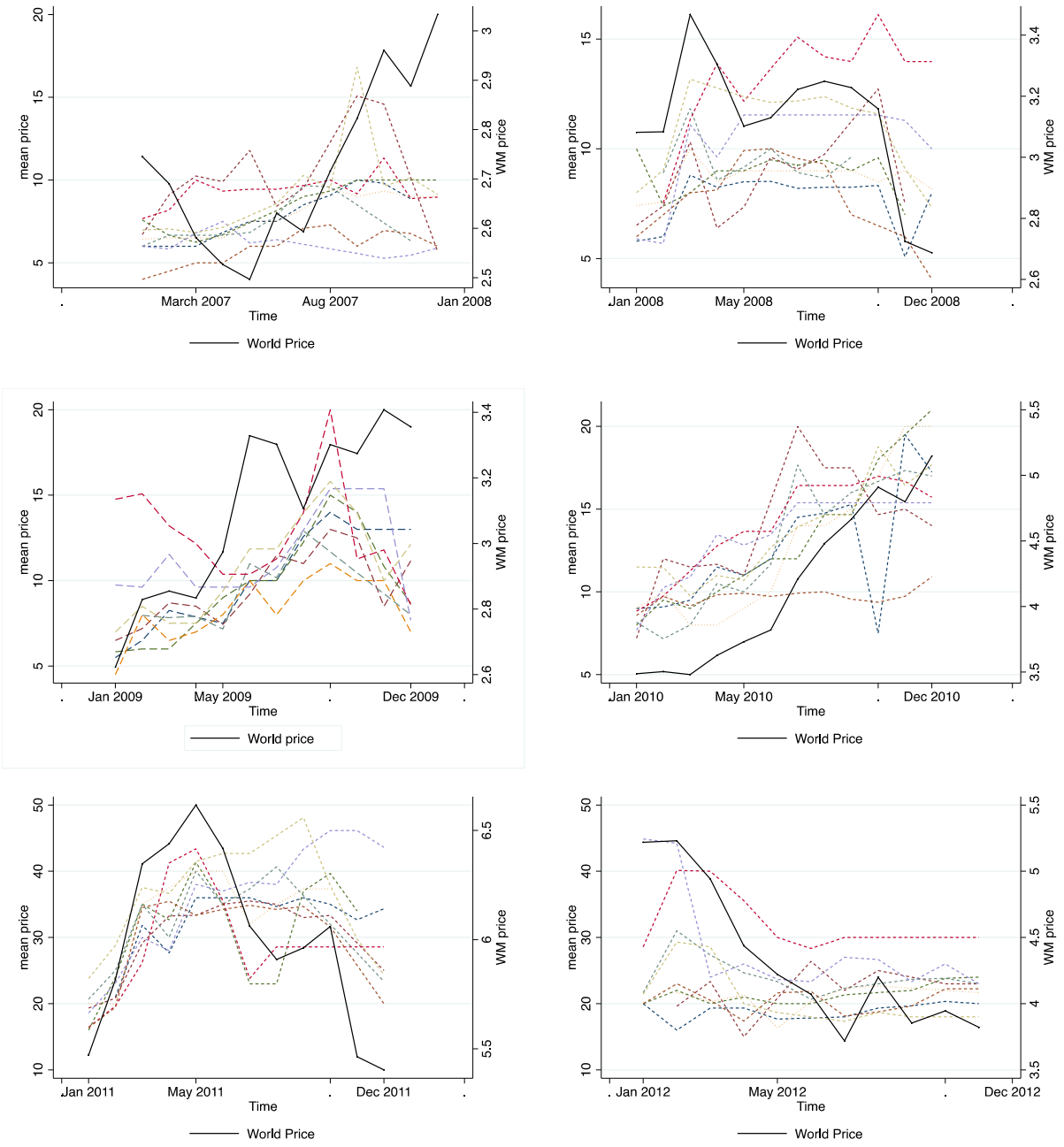

Figure 3: Local coffee prices and world market price of coffee 2007-2012

Figure 3 also suggests that there is a substantial variation in coffee prices between different local markets. *Figure 4a* depicts the pair-wise difference in prices between local markets, calculated as the percentage of the highest price, and *Figure 4b* shows the average percentage difference between local markets for each year.

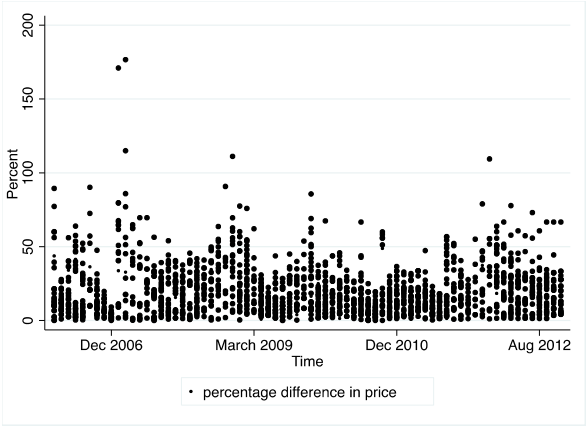

Figure 4a. Pair-wise percentage difference in coffee prices between local markets

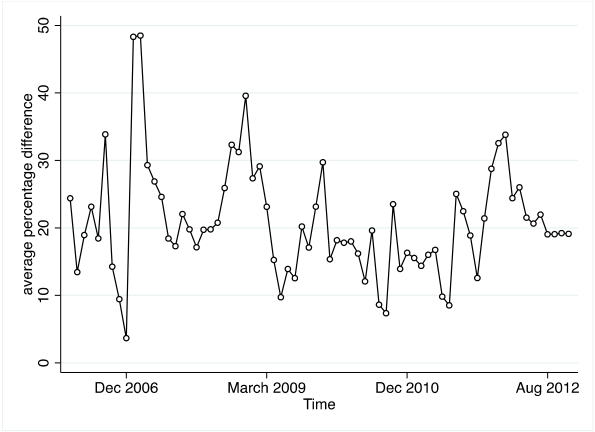

Figure 4b. Average pair-wise percentage difference in coffee prices between local markets

Figure 4a shows a significant variation in prices between local markets during the entire time period surveyed. However, *Figure 4b* suggest a slight trend towards stabilization of the spread between markets around 20 percent.

5.2 Method and Identification

In order to assess the impact of the warehouses on price dispersion, we follow an approach similar to Aker (2010) and estimate the following model:

$$\left|p_{jt} - p_{kt}\right| = \alpha + \beta_1 warehouse_{jk,t} + \beta_2 world\ market\ price_t + \alpha_{jk} + \theta_t + \mu_{jk,t} \quad (2)$$

where $\left|p_{jt} - p_{kt}\right|$ is the difference in price between market *j* and market *k* in period *t*, $warehouse_{jk,t}$ is a dummy variable equal to one if both markets in the market pair had an ECX-warehouse at time *t* and zero otherwise, α_{jk} is a pair fixed effect and θ_t is the trend variable.

Note that our estimations are based on data for local markets that opened up ECX warehouses during the study period. This means that all locations are eligible for an ECX warehouse and that our identification strategy is based on *differences* in the opening date (i.e., the date when each warehouse is defined as fully functional). To estimate the effect of warehouses on price dispersion, we compare the price differences between market pairs where both markets had a functional ECX warehouse at a particular point in time, to the price difference between markets pairs where at least one market did not yet have an operating ECX warehouse. To control for unobserved differences between market pairs and time effects, we include time-specific and market pair-specific effects. We further run a number of different specifications varying the specification of time specific effects, time trends and lag structures of the explanatory variables to

test our model specification. OLS estimates using various specifications are presented in *Table 1*, time and pair fixed effects estimates are presented in the first two columns of *Table 2*.

When running an OLS regression there is always a risk that the estimates are biased due to omitted variables. For example, as emphasized in the theoretical model, market pairs that are located closer to each other are likely to have smaller price dispersion than market pairs that are located further away from each other. In order to avoid such types of omitted variable bias, we include market pair specific fixed effects.

There is also a risk that the price dispersion depends on the time period; it may vary between years and agricultural seasons, or exhibit some other type of time trend. We therefore test if the main results are robust to various specifications of time-specific effects.

Finally, full realization of the warehouse effect may take time. To allow for adjustment over time, we estimate a number of models with different lag and evaluate the robustness of the results.

Since a large share of Ethiopian coffee is exported, the world market price of coffee is most likely an important determinant of domestic coffee prices in Ethiopia. Domestic coffee prices, in turn, should intuitively be positively correlated with price dispersion between market pairs. We therefore hypothesize a positive correlation between the world market price of coffee and price dispersion between market pairs. Again, we want to make sure that the main result is not affected by the choice of the lag structure of this variable and we therefore use a number of model specifications. The OLS estimates of these models are presented in *Table 1*, whiel time and pair fixed effects estimates are presented in the first two columns of *Table 2*.

Another set of complications will occur if the error terms have different variances across panels, if an exogenous shock affects all market pairs at a specific period in time, or if a shock that affects a certain market pair have lasting effects over several time periods. In order to correct for such heteroscedasticity across panels, contemporary correlation across panels and first order serial correlation in the disturbance term (which generally makes inference about standard errors incorrect) we also use Panel Corrected Standard Errors (PCSE) and Prais-Winsten parameter estimates. With this estimation procedure, parameter estimates are conditional on estimates of

the autocorrelation and the disturbance covariance matrix is estimated with FGLS.[18] Prais-Winsten (PCSE) estimates are presented in *Table 2* column 3-6.

As the price difference may exhibit some dynamic structure, we also formulate a model with a lagged dependent variable on the right hand side of the equation. However, the lagged dependent variable is by definition correlated with the error term and therefore produces biased estimates (shown in Nickell, 1981). We therefore follow the approach as first suggested by Anderson and Hsiao (1982) and more generally described by Wooldridge (2010) and transform the equation (2) to a first difference equation. To instrument for the lagged dependent variable, we use further lags of the dependent and explanatory variables. If we define the change in the pair-wise difference in prices as: $\Delta y_{it} = |p_{jt} - p_{kt}| - |p_{jt-1} - p_{kt-1}|$, and Δz is the change in the independent variables given above, the model can formally be described by equation (3) below.

$$\Delta y_{it} = \alpha + \beta \Delta z_{it} + \beta_2 \Delta y_{it-1} + \mu_{jk,t} \tag{3}$$

where the instruments are coming from $(\Delta z_{t-3}, \Delta y_{t-3})$ Note that, since there may be some autocorrelation in the error term, y_{t-2} is not included as an instrument. Finally, we use heteroskedasticity and autorcorrelation consistent (HAC) standard errors in the first differenced instrumental variable regression.[19] Estimations using this procedure are presented in *Table 2* column 7-8.

One could argue that the roll out of warehouses was not made in a random order; perhaps towns with more favorable characteristics were connected to the ECX earlier than other towns. In order to see if there are any "placebo effects" we test if the price difference for a market pair is different from that of other market pairs 6 and 12 months before both of them have a fully functional ECX-warehouse. The model can be described as

$$|p_{jt} - p_{kt}| = \alpha + \beta_1 warehouse_{jk,t+n} + \beta_2 world\ market\ price_t + \alpha_{jk} + \theta_t + \mu_{jk,t} \tag{4}$$

where n=6, 12 months.

Estimations for these models are presented in *Table 3*.

[18] This is implemented in Stata with the xtpcse command

[19] This is implemented in Stata using the xtivreg28 command developed by Schaffer (2012)

6. Results

All estimation results are presented in *Table 1* and *2*, below. As can be seen in the tables, the joint presence of warehouses in two markets has a significantly negative impact on the price dispersion between these markets. Our OLS results are very robust to changes in specification and suggest that if two markets have access to ECX warehouses, the average spread is reduced by 0.86 – 1.14 ETB, with all four OLS models significant at either the 1% or 5% levels. These findings are also robust to the use of lags, where lagging the effect of both markets having ECX access by one month is associated with a reduced spread of 0.97 ETB and by 1.5 ETB when lagged by two months, significant at the 5% and 1% levels respectively. This is an interesting result, as it suggest that the impact of warehouses stronger after some period of time.

Applying Fixed effects and Prais-Winsten (PCSE) estimates we find that in three of the four additional models there are statistically significant reductions in average spread by between 0.89 (significant at 10%) and 1.14 (significant at 1%). Then applying a lag of two months we find larger effects ranging between 1.33 and 1.78 ECX, significant at either the 1% or 5% levels. Considering that the average spread over the full period is 3.33 ETB, this is a substantial reduction in price dispersion. The insignificant results for warehouse-effects 6 and 12 months before their implementation presented in *Table 3* suggest that there are no problems with placebo effects. We do find evidence of time trends in our OLS estimates as in three of the forth models were significant at the 5% level for increases ranging between 1.41 ETB and 1.62 ETB; however squaring the time effect we found statistically significant, but extremely small, negative impacts on ETB, ranging from reductions of just 0.006 and 0.008 ETB.

Regarding the effect of world market price on the local price, we find market prices are significantly associated with an increase between 0.75 ETB and 1.66 ETB in the OLS models 1 through 4. When lagged by one month, the effect of world price on these models is found increase ETB by 0.73, significant at the 10% level and when lagged by two months the effect increases to 0.91 ETB, significant at the 5% level. Using Fixed effects and Prais-Winsten (PCSE) estimates we find an increase in local price ranging from 0.90 ETB and 1.42 ETB due to the world market price. Lagging these effects by two quarters we still find significant results as the world market price is shown to increase local price between 1.07 ETB and 1.23 ETB. We do however find potential issues of placebo effects regarding world market price as shown by the significant results of *Table 3*.

Table 1. OLS estimates, various model specifications.

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
	coef/se	**coef/se**	**coef/se**	**coef/se**	**coef/se**	**coef/se**
Both locations have a warehouse at time t	-0,861**	-1,142***	-1,097**	-1,024**		
	(0,338)	(0,340)	(0,341)	(0,341)		
Both locations have a warehouse at time t-1					-0,967**	
					(0,339)	
Both locations have a warehouse at time t-2						-1,495***
						(0,356)
World market price at time t	1,660***	0,901**	0,983**	0,748*		
	(0,172)	(0,409)	(0,413)	(0,419)		
World market price at time t-1					0,728*	
					(0,418)	
World market price at time t-2						0,907**
						(0,418)
Pair specific effects	yes	yes	yes	yes	yes	yes
Year specific effects	yes	no	no	no	no	no
Quater specific effects	no	yes	yes	yes	yes	yes
Time trend			-0,119	1,141**	1,463**	1,615**
			(0,077)	(0,411)	(0,454)	(0,519)
Time squared				-0,006**	-0,008***	-0,008***
				(0,002)	(0,002)	(0,002)
Constant	yes	yes	yes	yes	yes	yes
Number of observations	2 191	2 191	2 191	2 191	1 885	1 612
Adjusted R2	0,282	0,360	0,361	0,363	0,378	0,415

Note: Dependent variable: absolute difference in retail prices between market pairs. Quarters are calculated as Jan-March –1 st quarter; April-June-2nd quarter; July-September- 3rd quater and October-Decmber- 4rth quarter (and main harvesting monts)

Our sensitivity analysis suggests that the results are relatively robust. Note that our regression of first differences in Model 13, *Table 2* produces a positive non-significant effect of ECX warehouses on prices dispersion, while the result in column 8 depicts a negative and significant coefficient. These results suggest that the effect of warehouse access on price dispersion may not be linear, and that the downward pressure on dispersion may grow over time.

Table 2. Fixed effects, Prais-Winsten and First difference results

	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14
	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se
Both locations have warehouses at time t	-1,142***		-0,893*		-1,027**		0,451	
	(0,340)		(0,478)		(0,463)		(0,445)	
Both locations have warehouses at time (t-2)		-1,579***		-1,509**		-1,775***		-1,330**
		(0,358)		(0,461)		(0,523)		(0,626)
World market price at time t	0,901**		0,946*		1,130**		1,142**	
	(0,409)		(0,563)		(0,528)		(0,473)	
World market price at time (t-2)		1,237**		1,130**		1,112**		1,072**
		(0,398)		(0,531)		(0,477)		(0,468)
Difference in retail prices in period (t-1)							-0,309	-0,301
							(0,357)	(0,361)
Quarter specific effects	yes	yes	yes	yes	yes	yes	yes	yes
Pair specific fixed effect	yes	yes	no	no	no	no	no	no
Prais-Winsten (PCSE) estimates using general AR(1) disturbance	no	no	yes	yes	no	no	no	no
Prais-Winsten (PCSE) estimates using panel specific AR(1) disturbance	no	no	no	no	yes	yes	no	no
First difference iv-regression	no	no	no	no	no	no	yes	yes
Constant	-0,877	-1,543	-0,908	-1,195	-1,431	-1,125	-0,362***	-0,303***
	(1,131)	(1,202)	(1,628)	(1,652)	(1,523)	(1,498)	(0,095)	(0,090)
Number of observations	2 191	1 612	2 191	1 612	2 191	1 612	1 168	1 168
Adjusted R2	0,294	0,322					0,199	0,201

Note: In model 13 and 14, the instruments used in this regression are the third lag of the dependent variable and the third lag of the world market price. Using the Hansen J statistic, we cannot reject that the instruments are valid and correctly excluded from the equation. Furthermore, using the Anderson (1984) canonical correlations test we can reject the hypothesis that the equation is under identified

Table 3: Test for placebo effects

	Model 15 coef/se	Model 16 coef/se	Model 17 coef/se	Model 18 coef/se	Model 19 coef/se	Model 20 coef/se
Both locations have warehouses attime (t+6)	-0,276	-0,201	-0,164			
	(0,324)	(0,335)	(0,335)			
Both locations have warehouses attime (t+12)				-0,334	0,080	0,119
				(0,326)	(0,332)	(0,333)
WM price	1,575***	0,711*	0,813**	1,545***	0,704*	0,810**
	(0,174)	(0,406)	(0,410)	(0,165)	(0,406)	(0,410)
Pair specific effects	yes	yes	yes	yes	yes	yes
Year specific effects	yes			yes		
Quarter specific effects		yes	yes		yes	yes
Time trend			-0,138*			-0,142*
Constant	-3,582***	-1,686	8,253	-3,501***	-1,666	8,564
	(0,634)	(1,189)	(5,696)	(0,617)	(1,189)	(5,695)
Number of observations	2 191	2 191	2 191	2 191	2 191	2 191
Adjusted R2	0,281	0,357	0,358	0,281	0,357	0,358

Note: .p<0.001 - ***; p<0.05 - **;p<0 .1 - *;

7. Conclusions

The efficiency-enhancing feature of the ECX is based on its potential to reduce many of the transfer costs associated with trade of coffee in Ethiopia. More specifically, an increase in the availability of adequate and timely market information should reduce search costs, while an improvement in the legal framework and reduced risk of defaults should reduce costs associated with transaction. The reduced transfer costs are likely to reduce price dispersion between exported coffee from different regions, as well as price dispersion between the export price and local retail price within regions.

Exploiting the unique feature that the warehouses connected to the commodity exchange in Ethiopia were rolled out sequentially, this paper use a number of models exploring the relationship between local warehouses and regional coffee price dispersions. Based on data on local and retail prices for coffee and starting dates of warehouse operations, we find that the average price spread between market pairs is reduced by 0.86-1.14 ETB when both markets have an operating warehouse when using OLS estimates. These estimate hold up to both lags of one month and by two months, with average price spread estimated to be reduced by 0.97 ETB for a lag of one quarter and by 1.5 ETB for lags two quarters. This is a substantial reduction considering that the average price spread over the full period is 3.26 ETB. The result is stable between model specifications, whereby the use of Fixed effects and Prais-Winsten (PCSE)

estimates is found to reduce the average price spread by between 0.89 and 1.14 ETB across the three models with statistically significant results and at either the 10% and 5% levels is found to reduce spread by 1.33 – 1.78 ETB when lagged two months. Furthermore, these reductions in average price spread are not found to be due to placebo effects

While the evaluation exercise carried out in this paper is one of very few such studies, and is particularly rare in its use of data from the developing world, the analysis of the impact of such interventions could be improved in many ways. First, as the commodity exchange has mainly been operating in a period when world market prices have been falling longer time series are required for more generalizable results. Second, the current analysis does not delve into details of what types of costs the ECX actually contributes to reducing. Indeed, anecdotal evidence suggests that ECX operations are associated with big costs of assessments where assessment costs at ECX centers are mostly driven by long queues and issues with moisture testing etc. rather than the transport costs to reach a warehouse. If this is the real cost, the possible changes in transport costs might be partially offset. Further examination of the nature of the costs possibly reduced by the ECX would support not only improved ECX operations, but also the evaluation of the corresponding welfare gains from reducing alternative cost components. It should also be noted that we do not evaluate all the four functions stated in section 2 - we only evaluate the role of warehouses on export prices. In other words, our analysis does not provide answers to the question of how the introduction of the ECX has affected the welfare of small-scale farmers. The results of our analysis suggest that local markets that are connected to the ECX via local warehouses experience less price dispersion. We can only speculate that this reduction in price volatility trickles down to local coffee producers. A proper poverty analysis, such as that found with the Madagascar study, would be an interesting addition based on consumption to see which types of households benefit from such interventions. An important task for future research is therefore to find and use information local producer prices to evaluate the effect of warehouses and the ECX on the welfare of local farmers.

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International Journal of Managment, IT and Engineering Year : 2014, Volume : 4, Issue : 2 First page : (87) Last page : (95) Online ISSN : 2249-0558. Commodity derivative markets in India: Issues and concerns. Ms. Shalini H. S.*, Dr. Duraipandian R.** *Assistant Professor, Department of MBA, Surana College-PG Department, Bangalore, India **Professor and Head of the Department, Department of MBA, PESIT, Bangalore-South Campus, India

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