

The Ethiopian Commodity Exchange and Spatial Price Dispersion: Disentangling Warehouse and Price Information effects

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Abstract

Agricultural commodity markets in developing countries are characterized by high transaction costs and risks that reduce trade flows among spatial markets. In this article, we examine whether institutionalized agricultural commodity exchange markets reduce transaction costs and hence spatial price dispersion using the introduction of the Ethiopian Commodity Exchange (ECX) as a quasi-experiment. We use a commodity level Difference-in-Difference identification strategy to compare the spatial price dispersion of cereals that are traded at ECX (maize and wheat) with a cereal traded only at the local market (*teff*). Results show that ECX significantly reduces the spatial price dispersion of maize and wheat compared to *teff*. This effect varies depending on crop type and the time length since the ECX started trading the commodity. The longer the duration, the larger the reduction in price dispersion. We also find that dissemination of price information is the main channel through which the commodity exchange affects spatial price dispersion.

Keywords: *Commodity Exchange, Difference-in-Difference, Ethiopia, Price Dispersion, Spatial market*

JEL Codes: O13, O18, Q12, Q13

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1 Introduction

Trade costs are considered to be one of the main barriers to trade between spatial markets. They include expenses associated with transportation, distribution, information, contract enforcement, legal and regulatory fees. These costs can be especially high in developing countries, where spatial markets are less integrated (Anderson and Van Wincoop, 2003). In Ethiopia, the agricultural markets have also been characterized by high risk and trade costs, such as lack of trust among market actors, incomplete contract enforcement, and absence of product grades and standards (Gabre-Madhin and Goggin, 2005; Gabre-Madhin, 2012; ECX, 2013; Meijerink et al., 2014; Belay and Ayalew, 2019). In efforts to help improve the quality of trade in the country, the ECX was established in April 2008 as a multi-commodity platform where buyers and sellers can come together to trade. Through the ECX system, market actors are able to access various product prices, obtain product quality assurance (certification), and receive improved market access (Belay and Ayalew, 2019). What began as the trade of coffee and sesame, the two main exportable cash crops in Ethiopia, expanded to include the two main domestic crops, maize and wheat, and haricot beans on the ECX trading floor in March 2010. The final commodity to be included in ECX, mung beans, were introduced at the beginning of January 2014. This study examines the impact of ECX on spatial market price dispersion of domestic crops, mainly maize and wheat using a Difference-in-Difference (DID) approach.

Following the seminal work of Stigler (1961), several empirical works have shown that access to information is a key element of market efficiency and price transmission. For example, Deichmann et al. (2016) show digital technologies (mobile phones and the internet) overcome information problems that hinder market access for many small-scale farmers. Jensen (2007) also point out that the introduction of mobile phones increased local fisherman's profits and reduced catchment waste and price dispersion in India. Aker (2008) and Aker (2010) examine the impact of providing mobile phones on grain market in Niger and find that introduction of mobile phones reduces spatial market price dispersion. Similar results have been documented for India (Goyal, 2010; Fafchamps and Minten, 2012; Mitchell, 2014; Mitra et al., 2015), Ethiopia (Tadesse and Bahiigwa, 2015), Uganda (Muto and Yamano, 2009; Svensson and Yanagizawa, 2009), and Rwanda (Futch and McIntosh, 2009).

Despite the extensive literature on the impact of information on spatial market efficiency, there is scant empirical evidence related to institutionalized commodity market in Africa. For example, Andersson et al. (2017) examine the impact of ECX on spatial price dispersion of coffee (export crop) in regional markets and find a substantial reduction in the average price spread of coffee in Ethiopia. Similarly, Katengeza (2009) finds an improvement in spatial rice market integration in Malawi.

This paper contributes to the existing literature in the following dimensions. First, most of the existing studies focus on informal private source of price information that may not be credible and accessible for most rural households, especially the poor. However, in this study, we use a formal, non-excludable, and reliable public price information disseminated through price display plasma screens run by ECX (Francesconi and Heerink, 2011; Meijerink et al., 2014).

Second, instead of focusing only on a single commodity, we compare the spatial price dispersion of multiple crops using a Difference-in-Difference (DID) approach. Most of the existing literature on market integration uses time-series data (Ravallion, 1986; Abdulai, 2000; Goodwin and Piggot, 2001; Meyer, 2004; Tostão and Brorsen, 2005; Balcombe et al., 2007; Cirera and Arndt, 2008; Baulch et al., 2008; Moser et al., 2009; Tankari and Goundan, 2017; Pierre and Kaminski, 2019).¹ There are also studies that use a Difference-in-Difference (DID) approach to investigate spatial market integration for a single crop (see, eg., Jensen, 2007; Aker, 2008; Aker, 2010; Goyal, 2010). Unlike these studies, our study compares the spatial price dispersion of multiple crops using a Difference-in-Difference (DID) approach. In particular, we compare the price dispersion of cereals traded both at ECX and local markets (maize and wheat) with a cereal traded only at the local market (*teff*). We argue that since the observed characteristics are often common for these commodities, this approach provides a better estimate by removing confounding factors that could exist if we instead focused on a single commodity. These factors include road quality improvement, diesel price shock, and international food crises that could reduce spatial price dispersion.

Finally, improving on the closest work by Andersson et al. (2017), which only captured warehouse effects on coffee (mainly export crop), we decompose the main channels through which

¹ Market integration literature shows mixed results. For example, Abdulai (2000) and Moser et al., (2009) found well-integrated maize and rice markets in Ghana and Madagascar, respectively. On the other hand, Tankari and Goundan (2018) could not find market integration for millet markets in Niger.

the commodity exchange market affects spatial prices into price (information) dissemination and warehouse service for maize and wheat (mainly domestic crops). We believe that the decomposition of these mediators is key to design crop-specific programs to improve the level of integration of existing fragmented spatial markets in Ethiopia. This also adds new insight to the growing literature on an institutionalized commodity exchange.

Using a commodity level identification strategy, we estimate both binary and continuous treatment effects. Binary treatment is defined by classifying the cereals traded at ECX, maize and wheat, into the treatment category, and *teff*, traded only at the local market, as the control. Similarly, a treatment duration, which is measured as the number of months elapsed since the commodities were introduced at ECX's trading floor, is used to estimate the continuous treatment effect. Results from the binary and continuous treatment models indicate that ECX reduces the spatial price dispersion of maize and wheat compared to *teff*. The continuous treatment model also shows that longer treatment duration is associated with a larger reduction in spatial price dispersion. The other interesting finding of this study is that price information dissemination through plasma screens is found to be the main channel through which ECX reduces price dispersion. We also run robustness checks and the results remain the same.

The rest of the paper is organized as follows. Section two presents the background of agricultural commodity exchange in Ethiopia and the ECX. The data and identification strategy are presented in section three. Section four discusses the main findings and section five concludes.

2 Agricultural Commodity Exchange in Ethiopia

The ECX was established in April 2008, pursuant to the Federal Democratic Republic of Ethiopia (FDRE)'s proclamation number 550/2008, with a capital of 250 million Ethiopian Birr (ETB). It is an institutionalized response aimed at transforming Ethiopia's primitive marketing system into a modern, transparent, and efficient one. It is a platform where buyers and sellers come together to trade and are assured of quality, delivery, and payment. Through the ECX system, market actors are able to get product quality assurance and certification, access various real-time product price information in a minute-by-minute basis, loan access guarantees, and warehousing services. ECX offers market surveillance to mitigate risks, training to improve awareness and build member's capacity, and daily clearing and settling of contracts. It also provides advice to sellers and buyers on ways to hedge against price risk and a trading system where buyers and sellers can

coordinate in a seamless way on the basis of standardized contracts (Dawit and Meijerink, 2010; Paul, 2011; ECX, 2011, 2013, 2015).

To trade through ECX, a product owner needs to deliver his/her commodity to the nearest ECX warehouse. Then, the warehouse weighs, samples and grades the product, and issues an electronic certificate to the seller. The certificate, which represents the identity of the commodity, is used as a basis of the transaction on the ECX trading floor. After receiving a certificate, the seller can proceed to make an offer to sell the product either on his/her account if he is a member at ECX or on account of others, otherwise.² Similarly, a buyer should deposit a minimum of 500,000 ETB in his/her account at a recognized bank.³ Once ECX has received a direct financial report from the bank, the buyer is allowed to offer a bid. At any time, multiple actors can simultaneously make multiple offers and bids based on yesterday's closing price and forecast of the international prices using market references. The function of the exchange is to match these offers and bids as they come in. Once the deal is done, the deal is recorded and the deal price is automatically disseminated electronically to all trading parties. ECX disseminates real market information to all market actors and the public on minute-by-minute and on a daily basis through its English and Amharic homepage *www.ecx.com* or *www.ecx.com.et*, across 90 electronic display boards across country, an automatic Short Message Service - SMS (934) and toll-free IVR (Interactive Voice Response-929), and various print and electronic media (TV/Radio). Once the deal has been made, the process of product delivery and fund transfer is put into effect (ECX, 2015).

In the first 1000 days of ECX establishment, the Exchange has registered significant success. Table 1 shows the volumes of trade, values of transaction and number of clients in the ECX from 2008 to 2011. The volume of trade, which stood 138 thousand metric tons in 2008/09 increased to 508 thousand metric tons in 2010/11, which represents a more than thrice growth rate. Similarly, between 2008/09 and 2010/11, the value of commodity transacted has also increased from 293 million dollars to 1.1 billion dollars (ECX, 2011). Despite the low share of wheat and maize traded at ECX compared to the total maize and wheat production in the nation, small-scale farmers benefit

² ECX works based on membership. Only those who have bought a membership seat are allowed to trade at ECX trading floor. According to the ECX's rule number 2/2009, producers, cooperatives, unions, domestic trades, exporters, processors, public enterprises and commercial or state farms are entitled for membership. A member is allowed to transfer, inherit, or sell his/her seat for the third party. Nonmembers can only trade in ECX through the agency of an ECX member. An ECX member who trades only on his/her account can be classified as trading member and one who trades either on his/her account or on behalf of a clients are called intermediary members. At the end of June 2014, ECX has 346 full members and 15,400 clients (ECX, 2015).

³ Since most of buyers are exporters or merchants, 500,000 ETB is relatively a small amount to deposit.

greatly from the Exchange.⁴ Among the ECX members, 12 percent are farmer co-operatives that are representing 2.4 million smallholder farmers who produce 95 percent of Ethiopia’s agricultural output in Ethiopia. Even if the majority of smallholder farmers do not trade directly through the exchange, because of the transparency around the pricing, all the farmers in the country are now using the ECX price as the reference price. For example, ECX getting 1.2 million calls and 888,000 texts per month for market prices off the market data server, of which 70% come from rural areas. This could reduce the spatial price dispersion of commodities trade at the Exchange (ECX, 2013).⁵

Table 1: The volumes of trade, values of transaction and number of clients at ECX

Years	2008/09	2009/10	2010/11
Volume of trade (Thousands of metric tone)	138	222	508
Value of transaction (Millions of USD)	293	558	1113
Number of clients	2407	3499	7914

3 Data and Empirical Strategy

This section presents a description of the datasets and empirical strategies employed in the analysis section.

3.1 Data Description

In our analysis, we use three different data sets. First, to construct the absolute price difference between market pairs, we use the Monthly Retail Price Survey (MRPS) data, collected by the Ethiopian Central Statistics Agency (CSA) in 119 selected markets. The data covers the prices of about 400 major agricultural and industrial goods and services from open markets, kiosks, groceries, butcheries, pharmacies, and supermarkets. More specifically, it includes the prices of food, drinks, tobacco, clothing and foot wares, contraction materials, transportation, education,

⁴ During our sample period, the percentage of wheat and maize traded at the ECX was below 10 percent. However, small-scale farmers, who widely produced wheat and maize, greatly benefited from commodities traded at ECX. Even if they do not directly trade their commodities at ECX, they used ECX prices as a reference price to sale maize and wheat at the local market (Vasu, 2018).

⁵ <https://www.theguardian.com/global-development/2012/dec/13/africa-commodity-exchange-ethiopia-economy>

energy, household equipment, medical care, farm equipment, hotel services, etc. In this study, we only focus on the prices of maize, wheat, and *teff* for 119 markets from July 2009 to July 2011.

Descriptive statistics of the average summary statistics of maize, wheat and teff absolute price difference between market pairs from 2009 to 2011 is summarized in Table 2. The average absolute price dispersion between market pairs are relatively higher for *teff* and lower for wheat. The absolute price dispersion of teff ranges from around 0 to 11.5 ETB, with a mean of 3.50 ETB in the study period. Similarly, the absolute maize price dispersion ranges from 0 to 11.0 ETB, with a mean of 3.26 ETB. The price dispersion of wheat is relatively lower than maize and teff price dispersions, with a mean of 2.22 ETB.

Table 2: Average maize, wheat and teff absolute price dispersion (in ETB) between market pairs

Commodity	Mean	St. dev.	Min	Max
Maize	3.26	2.77	0	11.0
Wheat	2.22	1.89	0	9.51
Teff	3.50	2.41	0	11.5

Second, the data on the geo-spatial location of each ECX warehouse and price display plasma screens comes from the ECX office. Figure 1 indicates the location of plasma display boards and warehouses in 2011. During the sample period, among the 119 major markets, only 17 markets provide a warehouse service and 28 markets have an active plasma display board that disseminates the prices of commodities traded at ECX on a minute-by-minute basis.

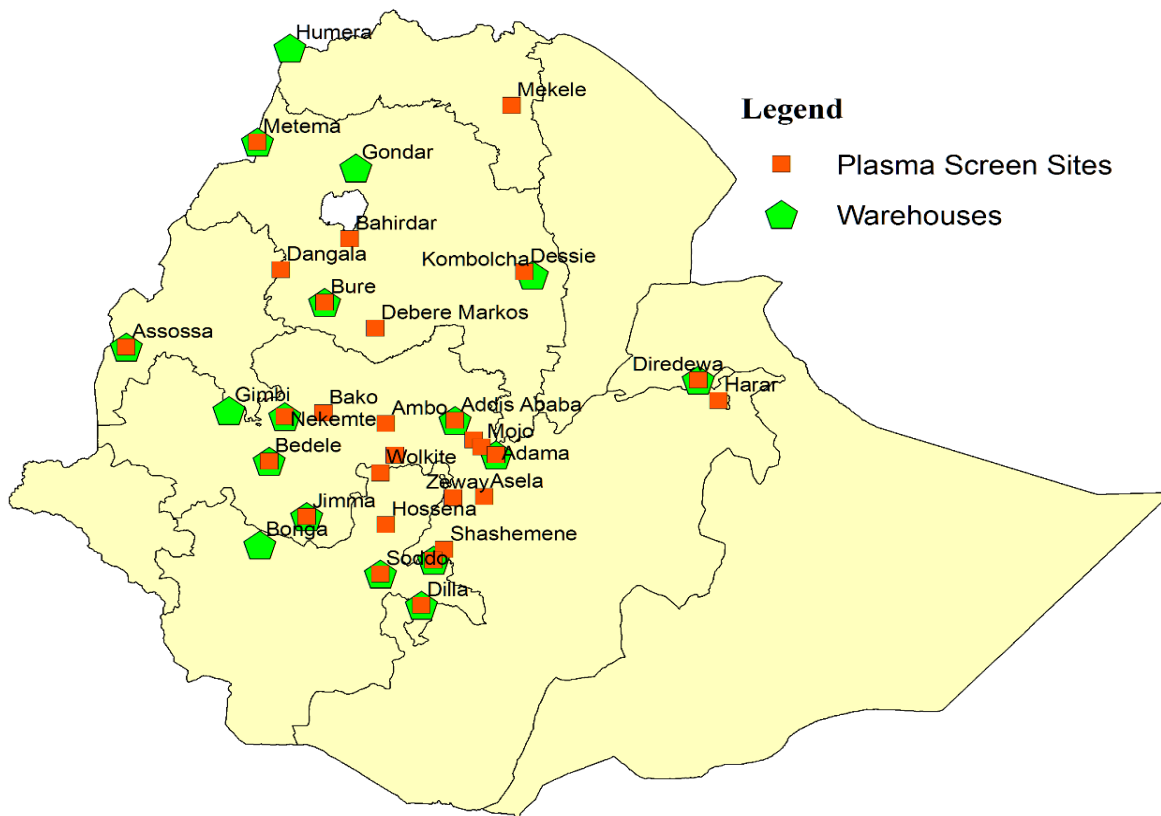


Figure 1: ECX warehouses and plasma screen sites in 2011

3.2 Identification strategy

In order to examine the effect of ECX on spatial price dispersion, we use a commodity level identification strategy. Instead of looking at the price dispersion of a single commodity, we use multiple commodities traded at ECX and local markets. More specifically, we compare the price dispersion of commodities traded at ECX with similar commodities that are only traded at the local market. In this study, we only focus on maize and wheat cereals, which are traded at ECX as the treatment, and a comparable cereal, *teff*, which is only traded at the local market is considered as the control group.⁶

⁶ *Teff*, wheat and maize are the most widely traded cereals that are used to prepare Injera, which is the staple food of Ethiopia. We assume households have the same demand function for these commodities.

As we consider markets with wider geographic distances, we follow an approach similar to Aker (2010) and Andersson et al. (2017) and use the price dispersion between market i and j , i.e., $Y_{c,t}^{ij} = \log|Price_i/Price_j|_{c,t}$ to measure the market performance for commodity c . Thus, in order to establish the impact of ECX (warehouses and price information through display boards) on price dispersion, we estimate the following fixed effect DID model:

$$Y_{c,t}^{ij} = \beta X_{c,t}^{ij} + \delta_t + \gamma_p Post_t + \gamma_P^D Post_t \times D_c + u_c + v^{ij} + \Gamma + \varepsilon_{c,t}^{ij} \quad (1)$$

Where, $Y_{c,t}^{ij} = \log|Price_i/Price_j|_{c,t}$ is the absolute value of the log price difference between market i and j for commodity c at time t , D_c is a treatment indicator which takes a value of $D_c = 1$ if the commodity is traded at ECX and $D_c = 0$ otherwise. $Post_t$ is an indicator variable which takes a value of one if the time period is after the commodity started to be traded at ECX and zero otherwise, and $X_{c,t}^{ij}$ represents different control variables, such as average price level, drought, etc. v^{ij} denotes a market pair fixed effect which reflects time-invariant covariates which could be correlated with price dispersion, δ_t and u_c represents time and commodity fixed effects, respectively. Γ captures the interaction of different fixed effects, for example, time and crop fixed effect, market-pair and time fixed effect, etc. $\varepsilon_{c,t}^{ij}$ correspond to the market pair-year error terms. The impact of the program between treated and control commodities is captured by a homogeneous treatment effect parameter, γ_P^D .

The main identification assumption is that in the absence of treatment, the average spatial price dispersion would have been the same for both the treatment and control groups. Applying DID on equation (1) gives us a better estimate by removing confounding factors associated with road quality improvement, diesel price shock and international food crises that could exist if we only use one commodity. Since any improvement in the above confounding factors would likely affect the spatial price dispersion between markets for both the treated and control groups, any difference between the two groups is associated with the introduction of ECX.

In addition to the above mentioned binary treatment effect model, we also estimate a continuous treatment effect model. This enables us to capture heterogeneities on the average treatment effect based on the extent of treatment duration. Treatment duration is measured by the number of months elapsed since the commodity was introduced at ECX.

4 Results

This section presents results supporting the argument that commodity exchange reduces spatial market price dispersion. First, we present the main results of the program on spatial price dispersion of maize and wheat, compared to *teff*. We then show the mechanism through which the ECX reduces spatial price dispersion. Finally, we demonstrate different internal validity checks.

4.1 Effect of ECX on Spatial Price Dispersion

Table 3 present the effect of ECX on spatial price dispersion of maize and wheat compared to *teff*. The first two columns compare the spatial price dispersion of maize and *teff* using binary and continuous treatment indicators respectively, whereas column 3 and 4 present wheat and *teff*. Compared to *teff*, on average, the introduction of ECX reduces the spatial price dispersion maize by 6 percentage points. This effect increases to 9 percentage points if we compare wheat and *teff*. The rationale behind the crop-specific effect of the program on spatial price dispersion could be associated with the difference in the production of commodities. Since there is a higher production of maize compared to wheat, the transaction cost wheat between market pairs is higher than maize. This could explain the higher reduction of price dispersion of wheat than maize. In addition to the binary treatment effect model, we estimate the continuous treatment effect model for maize and wheat in columns 2 and 4, respectively. On average, an extra one-month treatment duration reduces the spatial market price dispersion of maize and wheat by 2 and 1 percentage points, respectively. The interaction between the treatment and duration square points out the existence of non-linearity effect of the treatment.

Table 3: Effect of ECX on spatial log price dispersion of cereals

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment x post	-0.06*** (0.02)		-0.09*** (0.01)		-0.05** (0.02)	-0.07*** (0.01)
Post	-0.23*** (0.03)		-0.26*** (0.01)		-0.24*** (0.03)	-0.27*** (0.01)
Average price level	0.14*** (0.02)	0.03 (0.02)	0.07*** (0.00)	-0.03** (0.01)	0.14*** (0.02)	-0.04*** (0.01)
Treatment duration		-0.02*** (0.00)		-0.01*** (0.00)		
Duration		0.02** (0.01)		-0.01*** (0.01)		
Treatment duration square		0.00*** (0.00)		0.00*** (0.00)		
Duration square		-0.00*** (0.00)		0.00 (0.00)		
Treatment x post						
x one market has a plasma					-0.04*** (0.01)	-0.04*** (0.01)
x both markets have a plasma					0.02 (0.03)	-0.06*** (0.02)
x one market have a warehouse					0.02 (0.01)	0.01 (0.01)
x both markets have a warehouse					0.06 (0.05)	0.01 (0.02)
Post						
x one market have a warehouse					0.02* (0.01)	-0.00 (0.01)
x both markets have a warehouse					-0.06 (0.04)	-0.01 (0.01)
x one market has a plasma					0.03*** (0.01)	0.02*** (0.01)
x both markets have a plasma					-0.02 (0.02)	0.00 (0.01)
Number of Observations	124255	124255	138739	138739	124255	138739

The dependent variable is log absolute price dispersion between market-pairs. In column (1), (2) and (5), the data is restricted to maize and *teff* observations and in column (3), (4) and (6) to wheat and *teff*. In all estimations, we control for time, crop, market and market-pair fixed effects. We also interact crop and time fixed effects, crop and market fixed effects, crop and market-pair fixed effects, market and time fixed effects, market and market-pair fixed effects, market-pair and time fixed effects, crop, market and market-pair fixed effects, crop, market-pair and time fixed effects, and crop, market and market-pair fixed effects. Robust standard errors, clustered at the market and market-pair level, are reported in parentheses. Statistical significance at 1% ***, 5% **, and 10% * levels.

The reduction in spatial market price dispersion could be due to a reduction in trade costs associated with market information asymmetry and limited market access. More specifically, ECX reduces trade costs of maize and wheat between market pairs by disseminating market prices on a minute-by-minute basis via Television, Radio, plasma display boards, IVR and SMS, and by creating extra market access through warehouse servicing. For example, before the establishment of ECX, sellers who were living in the northern part of Ethiopia would spend a lot to sell their commodities in the south. However, ECX reduces this trade cost through warehouse services. That is, sellers can now deposit their product to the nearest warehouse and get an electronic receipt, which states the amount and quality of the commodity deposited at the warehouse. Then, they can sell their product to buyers, who deposited their money in a bank that is known by ECX. Once the buyers and sellers agree on the prices, ECX transfers the money to the seller and the buyer can withdraw the same quality of the commodity in the nearest warehouse.

4.2 Mechanisms

The binary and continuous treatment effect models, presented in the above section, suggest that the introduction of ECX reduces spatial price dispersion between market pairs. The next step is to decompose this effect into different mechanisms, specifically into warehouse and price (information) dissemination channels. Price dissemination via plasma screens and warehouse services are among the major services offered by ECX. The last two columns of table 3 show the decomposition of the effects of ECX on spatial price dispersion into price dissemination via plasma screens and warehouse services. Column 5 compares the effect of the program between maize and *teff*, whereas column 6 presents the DID estimates between wheat and *teff*. In both cases, the dissemination of market prices through plasma screens reduces the spatial price dispersion of maize and wheat. Having plasma display boards for one of the market pairs reduces the spatial price dispersion of maize and wheat by 4 percentage points. Compared to *teff*, the existence of plasma screens in both markets reduces the price dispersion of wheat by 6 percentage points. Though the sign of the coefficient is as we expected, the effect is not statistically significant for maize. On the other hand, there is no systematic difference in spatial market price dispersion between those markets with and without warehouses. This indicates that warehouse services are not the main channel by which ECX reduces price dispersion of maize and wheat compared to *teff*.

Rather, the dissemination of price information through the plasma boards is a more effective intervention for better market efficiency.

4.3 Robustness Checks

The binary and continuous treatment effect models presented in sections 4.1 and 4.2 assume that in the absence of the treatment the average change in spatial price dispersion for the treated commodities, maize and wheat, is the same as the observed average change in price dispersion for the control commodity, *teff*. Using the pre-treatment panel data, July 2009 and February 2010, we examine whether or not the control and treated groups have the same trend in spatial price dispersion over time.

Table 4 examines whether or not the spatial price dispersion of maize and wheat is equal to the price dispersion of *teff* before the introduction of maize and wheat in the ECX trading floor. Using a placebo treatment, we did not find any evidence against the parallel trend assumption. Column 1 compares the change in spatial price dispersion between maize and *teff* in the pre-treatment period (before ECX started trading maize in March 2010), whereas column 2 shows the DID spatial price dispersion between wheat and *teff* during the pre-treatment period. In both cases, we did not find a systematic difference between average price dispersion of maize and wheat compared to *teff*. This could be used as evidence in favor of our parallel trend assumption. Figures 2 and 3 also indicate the presence of the same trend between treatment and control commodities during pre-treatment periods, before March 2010.

Table 4: Effect of ECX on spatial log-price dispersion of grains: parallel trend test

	(1)	(2)
Treatment*Post	0.00 (0.03)	0.00 (0.02)
Post	-0.02 (0.04)	-0.00 (0.02)
Average Price level	-0.00 (0.04)	-0.00 (0.03)
Number of Observations	35802	39927

The dependent variable is log absolute price dispersion between market-pairs. Column (1) compares the change in spatial price dispersion between maize and *teff*, whereas column (2) presents the DID estimates of wheat and *teff* during the pre-treatment period. In all estimations, we control for time, crop, market and market-pair fixed effects. We also interact crop and time fixed effects, crop and market fixed effects, crop and market-pair fixed effects, market and time fixed effects, market and market-pair fixed effects, market-pair and time fixed effects, crop, market and market-pair fixed effects, crop, market-pair and time fixed effects, and crop, market and market-pair fixed effects. Robust standard errors, clustered at the market and market-pair level, are reported in parentheses. Statistical significance at 1% ***, 5% **, and 10% * levels.

In addition to the parallel trend assumption, we test whether there is a substitution in the production of treatment and control commodities after the intervention or not. In order to do that, we examine the allocation of land to the treated commodities before and after the introduction of maize and wheat at the ECX trading floor. Tables 5 and 6 show the share of inputs allocated to maize and wheat between 2009/10 and 2010/11. Results from both tables indicate that there is no significant systematic difference in the allocation of land for maize and wheat between 2009/10 and 2010/11.

Table 5: Input allocation for maize between 2009/10 and 2010/11

	Land	Fertilizer	Irrigation	Improved seed
Year=2011	0.01 (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Household Size	0.01* (0.01)	0.00* (0.00)	0.00 (0.00)	0.00 (0.00)
Education (Highest Grade)	-0.01 (0.01)	-0.00* (0.00)	-0.00 (0.00)	0.00 (0.00)
Age of the household head	-0.00*** (0.00)	-0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)
Farm Size	0.02** (0.01)	0.00 (0.00)	-0.00 (0.00)	0.00*** (0.00)
Number of Observations	1627	1627	1627	1627

The dependent variable in column (1) is the percentage share of land allocated to maize. Similarly, the dependent variables in columns (2) to (4) are the percentage share of fertilizer, irrigation and improved seed used in maize production respectively. Robust standard errors, clustered at the district level, are reported in parentheses. Statistical significance at 1% ***, 5% **, and 10% * levels.

Table 6: Input allocation for wheat between 2009/10 and 2010/11

	Land	Fertilizer	Irrigation	Improved seed
Year=2011	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Household Size	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00* (0.00)
Education (Highest Grade)	0.01** (0.00)	0.00** (0.00)	0.00 (0.00)	0.00** (0.00)
Age of the household head	0.00** (0.00)	0.00* (0.00)	0.00** (0.00)	0.00 (0.00)
Farm Size	0.00 (0.00)	-0.00 (0.00)	-0.00* (0.00)	-0.00 (0.00)
Number of Observations	1627	1627	1627	1627

The dependent variable in column (1) is the percentage share of land allocated to wheat. Similarly, the dependent variables in columns (2) to (4) are the percentage share of fertilizer, irrigation and improved seed used in wheat production respectively. Robust standard errors, clustered at the district level, are reported in parentheses. Statistical significance at 1% ***, 5% **, and 10% * levels.

5 Discussions and Conclusions

High trade costs and segmented spatial markets are argued to be the main factors that reduce trade, thus creating huge spatial market dispersion and market inefficiency. Agricultural markets in Ethiopia have been characterized by a lack of trust among market actors, incomplete contract enforcement, the absence of product grades and standards, and high risk and transaction costs. Most rural households often trade with merchants they know in markets close to them, with very little information at hand. They are also unable to negotiate for better prices or reduce their market risk. In addition, the absence of product quality or quantity assurance limits trade to something conducted solely based on visual inspection, which may lead to an increase in uncertainty in farm-gate prices.

To transform this backward marketing system into a modern, transparent and efficient one, the Ethiopian government, with financial assistance from the World Bank, established the ECX. The study examines the effect of the ECX on the spatial price dispersion in 119 markets using monthly retail price data.

In doing so, the paper estimates both binary and continuous treatment effect models. In the binary treatment model, maize and wheat, which are traded at ECX's trading floor are considered to be treatment commodities, and *teff* which is only traded at local markets, is used as a control commodity. Compared to *teff*, the introduction of ECX, reduces the spatial price dispersion of maize and wheat by 6 and 9 percentage points, respectively. The continuous treatment effect is also estimated by taking the number of months that each commodity has been traded at ECX as a measure of treatment duration. Estimated results point out that one month of additional treatment duration is associated with a reduction of maize and wheat treatment duration by 2 and 1 percentage points respectively. We also find a non-linear effect on treatment duration implying convergence in price dispersion over time between treatment and control commodities.

Finally, we decompose the spatial price dispersion effects of ECX into two main channels: price transmission via plasma display boards and warehouse services. ECX provides different services to market actors, such as warehouse services, quality certification, price dissemination through the internet, SMS, IVR, plasma display screens, radio, television, and magazines. However, because of data issues, we only managed to decompose the effects of warehouse service and price dissemination via plasma boards. Estimated results indicate that minute-by-minute price

dissemination through plasma screens is the main channel by which ECX reduces spatial price dispersion of maize and wheat. However, we did not find any supporting evidence for warehouse services. Although the two interventions may not be directly comparable, our result indicates that the dissemination of price information through the plasma boards could be a more effective intervention for better market efficiency among the indicated commodities. It is not possible to show why the price information and not the warehouse service that contributed more to reduction of spatial price dispersion. However, one could argue that our finding for the primacy of access to price information over warehouse services may be due to the nature of the commodities considered in our paper, i.e., both the treatment commodities, *maize* and *wheat*, and control commodity, *teff* are mainly domestic crops often traded locally, unlike coffee, an export crop considered in Andersson et al. (2017), which found a significant (ECX) warehouse effect on spatial price dispersion of coffee. This finding supports previous arguments for commodity-specific interventions (that consider the nature of commodity, e.g. perishable vs less-perishable or domestic vs export) to promote market efficiency for a given commodity (Muto and Yamano, 2009)

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