Essays in international trade and energy economics

by

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Abstract

This Dissertation consists of three empirical essays in international trade and energy economics.

Chapter 1 examines whether the food market of Turkey is cointegrated with the world food market. Using an error correction model, we analyze the response of producer prices of wheat, barley, maize, soybean and rice to changes in world market prices. Results show that the rice market of Turkey is not cointegrated with the world rice market, while the other commodity markets are weakly cointegrated. Results also show that pass-through of changes in the world prices to the domestic prices is relatively low both in the short run and in the long run, and that adjustment to the new equilibrium following a shock is slow. Government intervention policies both at the border and as domestic price supports seem to be underlying causes that have weakened the linkage between domestic and international markets. Fewer protectionist policies at the border and lower levels of government support policies are necessary to increase the domestic market integration with the international market.

Chapter 2 examines (i) whether the government interventions in the cotton market in the forms of border protection and as price support have weakened the integrations of domestic cotton markets with the world cotton market and (ii) how weak cointegration affects the world cotton trade. We address the first question by estimating price and exchange rates transmission elasticities using an error correction model and the second question by conducting a partial equilibrium model. Results indicate that the estimated elasticities are significantly smaller than unitary, which suggests that the cointegration is weak and the law of one price (LOP) does not

hold. Furthermore, when cointegration is weak, exchange rate movements have lower impact on exports, imports and prices than they do in the case of strong cointegration.

Chapter 3 examines whether retail gasoline prices in Turkey respond more quickly to increases in crude oil prices than to decreases. Using an asymmetric extension of Engle and Granger's two stage error correction model with daily data, we find three types of asymmetries: (1) asymmetry from crude oil price to gasoline price in the short-run (2) asymmetry in the speeds of adjustment, and (3) asymmetry in the lag length. We argue that the oligopolistic coordination theory is the most likely explanation for the observed asymmetric price transmission.

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List of Abbreviations

ARIP	Agricultural Reform Implementation Project
CAP	Common Agricultural Policy
EU	European Union
GOT	Government of Turkey
ICAC	International Cotton Advisory Committee
IGC	International Grains Council
IMF	International Money Fund
NCCA	National Cotton Council of America
OECD	Organization of Economic Coordination and Development
SEE	State Economic Enterprises
TL	Turkish Lira
URAA	Uruguay Round Agreement on Agriculture
USDA	United States Department of Agriculture
WTO	World Trade Organization

To my mother

Chapter 1: Turkey's grain market integration with the world grain market: An analysis of selected commodities

1. Introduction

Over the past two decades, many developing countries have liberalized their agricultural trade in order to integrate their domestic agricultural markets with world markets. Domestic market integration with the international market potentially increases countries' gain from trade due to comparative advantage and specialization and it stabilizes price volatility in domestic markets. A fundamental indicator of market integration is the extent to which domestic market prices respond to world price changes. This phenomenon is referred to as price transmission (or price pass-through). If a change in the world market passes through to the domestic market quickly and completely, there is a high transmission and thus markets are well cointegrated; otherwise there is a slow or no transmission and thus markets are weakly or not cointegrated. Hence, price transmission is crucial in understanding countries' economic integration with the world economy.

In this study, we assess market integration and price transmission of selected agricultural commodity markets (wheat, barley, maize, soybean and rice) of a developing country, Turkey, with the world market. To measure the degree of domestic market integration with the international market, we estimate price transmission elasticities. These elasticities help us address the following questions: (1) how much of a shock in world prices is transmitted to domestic prices? and (2) How long does it take for domestic prices to adjust to a shock from international price? For highly cointegrated markets, it is expected that domestic prices will be close to international prices and that shocks in world prices will be transmitted to domestic prices more completely and more quickly. Addressing these issues in Turkey's settings is particularly important because the country has been liberalizing its agricultural trade under World Trade Organization (WTO) agreement and on its way to integration with the European Union (EU). As mentioned in the following sections, although some significant steps have been taken towards free trade, several issues still exist. Thus, there is a crucial need to assess the effectiveness of trade liberalization policies on Turkey's agricultural market integration.

1.1. Why price transmission is important

As Zorya et al. (2014) point out, a high price transmission is important particularly for developing countries for several reasons. First, a high price transmission is an indication of a strong integration of economies with the world market. If transmission is poor, domestic prices deviate from international prices which will likely cause a reduction in the gains from trade. Second, generally prices in developing countries are more volatile than world price volatility. Through a strong co-integration with the international market, high price volatility in the domestic market can be more stable. Third, price transmission from world to domestic prices is critical for comparative advantage-based agricultural production. For most price-taking developing countries, world prices are deemed as opportunity costs. When the prices deviate from each other, opportunity cost increases, which affects comparative advantage-based production. Hence, international prices play a crucial role in an efficient distribution of domestic resources. Fourth, when world price changes are not transmitted perfectly to domestic prices, consumers and producers make decisions based on domestic prices which do not represent their real costs and benefits. Fifth, because world prices signal global shortage or surplus, a strong price transmission helps increase international markets' responsiveness to shocks. Sixth, there are many empirical evidences (Dawe 2009; Timmer 2004) showing that deviation of domestic prices from international prices leads to substantial sub-optimality in domestic market and slow economic growth. Lastly, price transmission elasticities are useful for forecasting purposes (Osborne, Liefert , 2004).

1.2. What factors affect market integration?

The extent to which domestic market prices reflect world market changes depends on several factors including border policies, price support mechanism, transfer costs, exchange rate and market structure.

Border policy instruments such as import tariffs and export subsidies, export bans, export taxes and non-tariff barriers insulate the domestic market from international markets and impede the complete transmission of price signals coming from world prices. If a high level of import tariff is imposed, the world price changes would partly, if at all, pass through to the domestic prices which would cause the international and domestic prices move independent of each other (Rapsomanikis et al. 2003).

In domestic markets, the implementation of price support policies, such as floor price, deficiency payments or any other supports can cause domestic and international prices to move independently.

Transfer cost also may cause weak cointegration or no cointegration at all. Delivery costs of commodities from producers to the border for export can be high due to high transfer costs, which cause high marketing margins that insulate markets from each other. Particularly, in developing countries, transportation costs are high due to poor infrastructure. High transfer costs and large marketing margins impede price transmission.

Exchange rate is also important. When local currency appreciates (depreciates) against the US dollar, an increase in the commodity price in the local currency would be less (more) than an increase in the international price in dollars. Hence, prices deviate from each other.

Market structure can hinder market integration. In non-competitive markets, for example, high prices in the world market may not be transmitted to the domestic consumer or producer prices.

It is important to note that in the case of partial or no market integration we are not able to distinguish which of the above-mentioned factors insulate the domestic markets from world markets.

The remaining of the paper is organized as follows. The next section gives information about the Turkish economy, its agricultural market, and steps taken (and not taken) towards market integration. Section three gives literature review of selected studies. Section four introduces econometric methods and data used. Section five presents the results and discussion, and the final section concludes.

2. Overview of the Turkish Economy

Turkey is an upper-middle-income country in Eastern Europe with its population of 79.8 million and Gross Domestic Product (GDP) of $856 billion (or GDP per capita of $10,807) in 2016 (World Bank, 2016). The country is the 17th largest economy in the world. Since 2001, the country's economy shows positive GDP growth rate ranging from 3 to 9 percent except the year of 2009. After 2009, the growth rate has experienced fluctuations from 9.2% in 2009 to 2.1% in 2012 and from 4.2% in 2013 to 2.9% in 2014, showing Turkey's vulnerability to capital inflows and shortage in agricultural output due to unfavorable weather conditions. In addition, the current geopolitical crisis in the region caused an inflow of about three million refugees the country which puts more challenges on sustained economic growth of the country.

Turkey has a relatively young population. The population has grown with an annual population growth rate of 1.5 percent. Its main economic activities are centered in western Turkey, which have led to high rates of immigration from rural areas, particularly from eastern and southeastern rural areas to major cities. As a result of this immigration, almost two-third of the population lives in major cities like Ankara, Istanbul and Izmir where over 75% of total value-added is produced.

2.1. Turkey's Agricultural sector

Due to Turkey's diverse climatic and topographic conditions, geographical location and fertile lands, a variety of agricultural commodities can be produced in the country. Turkey has 38.4 million hectares of agricultural land used for cultivation, 14.6 million hectares for pasture and grazing, and 21.5 million hectares for forestry (WTO, 2016). Small size farms are predominant in the country with an average size of 6 hectares. The major factor for small farm size is the Turkish inheritance law (Burrell and Kurzweil, 2007).

Turkey is the world's seventh largest agricultural producer. The agricultural sector has been an important driver of GDP growth and employment in the country. The sector constituted approximately 9% of GDP and 21% of employment in 2014.

Although Turkey's total trade shows deficits, the country enjoys an agricultural surplus. In 2014, the surplus was $3 billion with the export value of $17.6 million and import value of $14.6 billion (WTO, 2016). Turkey imports mostly raw materials including cotton, wheat, maize and soybeans, and exports mostly processed goods including textiles, flour and tobacco products. Table 1 and table 2 present the export and import of agricultural products from 2010 to 2014.

Along with many other products, nuts (mostly hazelnuts), fresh vegetables and dried fruits are the main exported products while cotton, wheat and other raw products are major imported products. Both export and import values have increased over time. The EU is the main destination for Turkey's hazelnut export; Iraq for flour, sunflower seed oil and chicken meat; and The Russian Federation for citrus fruits. As for imports, cotton is imported from the United States; wheat and maize from Russia; soya beans from Paraguay and Brazil.

Agricultural policies

The government of Turkey (GOT) has supported the agricultural sector for decades. Along with high border protection, output price supports and input subsides are used as the main policy instruments.

Since 1930s, the government has regulated the agricultural market through the State Economic Enterprises (SEEs) that carry out manufacturing and commercial activities on behalf of the government. They influence supply and demand by purchasing and stockpiling commodities, supplying input to farmers and importing or exporting agricultural commodities, thus, influencing market prices (OECD, 2011).

In the agricultural sector, there are several SEEs including TMO (established in 1930s) for grains ; TSFAS for sugar ; TEKEL(1940s) for tobacco, alcohol and salt; TZDK (1940s) for fertilizer and other inputs; the EBK (1950s) for meat fish and poultry; YEMSAN(1950s) for feed industry; SEK(1963) for milk and CAYKUR(1971) for tea. Because these SEEs are acting on behalf of the state, their trading loss or capital needs are given from public funds. From the years of 1991 to 1995, the annual average losses of TMO, TEKEL and TSFAS were $622 million, which later increased to $1.7 billion in the years of 1996 to 2001. Furthermore, the government wrote off the debt of SEEs in the mid-1990s, an average annual write off of the debt during the years of 1996 - 2001 was $550 million dollar for TMO, TEKEL, TSFAS and CAYKUR (OECD,2011).

After 2001, the government initiated an agricultural policy reform, The Agricultural Reform Implementation Project (ARIP), which aimed, *inter alia*, to gradually reduce the government's role in the agricultural market by privatizating the SEEs. As part of ARIP, Turkish Sugar Company (TURKSEKER) and state-owned tobacco company, TEKEL, were privatized, while TMO's intervention in the grain market has been restructured.

2.1.1. Domestic agricultural policies: An overview of main policy developments since 2000

The Agricultural Reform Implementation Project (ARIP)

In 2001, the government launched ARIP and implemented it over the period of 2001-08. The main purpose of ARIP was to align the agricultural market of Turkey more with the World Trade Organization (WTO) and European Union's Common Agricultural Policy (CAP) by doing the following : First by reducing the SEEs' output intervention purchases; second by phasing out government subsidies and replacing them with less distorting system of Direct Income Support (DIS); third, by terminating the state involvement in production, processing and marketing; and lastly, by implementing a new support system that will increase productivity of the agricultural market (OECD, 2011 and World Bank, 2005). The project was carried out and funded by the World Bank and was a pre-condition to receive IMF support for the economic stabilization program.

Under ARIP, price and input subsidy supports were replaced with DIS payments which were given to the producers conducting agricultural activities regardless of the type of crop. DIS payments benefitted around 90% of total farmers. Additionally, several SEEs were privatized, and most Agricultural Sales Cooperative Unions (ASCUs) were transformed under the scope of ARIP. The government privatized the sugar sector SEE of TURKSEKER and the tobacco sector's SEEs TEKEL. ASCUs were transformed from government purchasing agencies to financially autonomous and sustainable cooperatives that function much like private firms considering the benefits of farmers.

Although ARIP has lessened the government support, the level of support to agriculture in Turkey has remained above the OECD average. As a result of these supports, the domestic prices have been on average 31% higher than world prices (OECD, 2017). The following instruments are provided to support the agricultural market and influence prices.

Deficiency payments (premium payments)

The GOT pays premiums for the products that are in supply shortage. The payment covers the difference between market price and target price which is estimated considering the costs of production and marketing. Deficiency payments are provided to producers of oilseeds, cotton, olive oil, cereals, tea and pulses. Similarly, organic farming, good agricultural practices, and certified seeds receive deficiency payments which are made in the form of a lump sum every year.

Input subsidies

Input supports include improving farm production capacity by providing payments for soil improvement, land consolidation, and drainage. Input subsidies are also provided in the form of interest rate concessions. The state-owned bank (Ziraat Bank) and Agricultural Credit Co-operatives (ACC) offer concessional loans at various interest rates (from 25% to 100%)

depending on type of agricultural activity (good farming practices, organic production etc.)(OECD, 2017).

Purchasing prices policy

The relevant SEEs set floor prices for cereal, sugar and tobacco taking into consideration the world prices and domestic market conditions. This causes some problems for producers because generally prices are not announced on a regular basis which causes uncertainty on farmers' production plans.

Other domestic price support policies include area payments for hazelnuts, agricultural insurance payments, livestock supports, compensatory payments and interest concessions.

2.1.2. Agricultural trade policies

Tariffs

Since the mid-1980s, significant steps have been taken towards trade liberalization in industrial products, yet the liberalization of the agricultural sector has been carried out at a slow pace. Under the terms of the Uruguay Round Agreement on Agriculture (URAA) in 1994, the agricultural trade liberalization requires reduction of protectionism and replacing price supports with direct income support.

Tariffs, which are mostly imposed in *ad valorem* form, are Turkey's main policy instrument in trade. In general, tariffs on agricultural commodities are substantially higher than non-agricultural commodities. The average m.n.f. tariffs applied in agricultural products was 59% in 2007 while it was 47.9% in 2011 and 49% in 2015 (Table 3).Tariff rates on meat products and dairy products were higher than 100%, other commodities including sugar, cereals, fruits and nuts have relatively high tariff rates, while live animals, cotton, raw hides and skins are duty-free. Along with the URAA, Turkey established the Custom Union (CU) agreement with the EU in 1996. Turkey has a common tariff on non-agricultural products (all industrial products and industrial part of agricultural products) with the EU Common Custom Tariffs. Turkey and the EU have agreed to extend the agreement to cover basic agricultural products with a quota limit. With an update in 2006, all *ad valorem* tariffs were abolished, while restrictions were introduced in the form of quota limits. Since then, several products have been exported with duty exemption or with tariff quotas. (OECD, 2011).

Export Support measures

Turkey aims to develop its export potential using export subsidy policies. These subsidies are provided in the form of export credits with very low interest rates and in the form of deductions in tax payments.

Turkey's Grain market

In Turkey, 74 % of the agricultural land is used for grain production. Of the grain land, 67% is used for wheat production, 24% for barley, 6% for maize and 3% for others including rice, oat and rye (Graph 1).

As shown in Figure 1, according to The International Grains Council (IGC), Turkey's total grain production was about 37 million tons (mt) in 2015, nearly 6 mt was imported, and total consumption was about 38 mt.

Although selfsuffciency rate of wheat is high in Turkey, nearly 20% of the wheat is imported because Turkey is a major exporter of flour (Figure 2). In 2015, 22.1 mt of wheat was produced, 4.2 mt was imported while 21.3 was consumed, the rest was exported.

Though the selfsufficeny rate is the highest in barley (Figure 3), Turkey is import-dependent of maize, rice and soybean (Figures 4-6).

Turkish Grain Board, *Toprak Mashulleri Ofisi* (TMO) in Turkish, is the SEE in the grains markets. It is a quasi-autonomous state enterprise that regulates Turkish grain market: wheat, barley, maize and rice.TMO intervenes in the market to stabilze prices at a level that allows production sustainability for producers and supply security for producers. Furthermore, TMO regulates grain trade in case of a shortage or surplus to protect consumers and producers.
The GOT provided support to farmers in the forms of diesel, fertilizer and soil analysis (Table 4). In the year of 2016 total a 1.6 of billion Turkish Lira (TL) was granted to farmers under scope of diesel, chemical fertilizer and soil analysis supports (USDA, 2017). The GOT also supports grain producers through production premiums (Table 5). In 2016, the government provided nearly 3 billion TL premiums for grain producers (USDA, 2017).

The GOT applies a 130 % tariff on wheat, barley and corn, while it applies an average of 40% tariffs for rice to protect the domestic market (Table 6). As a result of these supports and tariff protections, domestic prices have been higher than international prices (Figures 7-11).

3. Literature Review of Selected Studies

The concept of price transmission has been analyzed within the context of law of one price, market integration and/or reform policy evaluation following implementation of structural adjustment programs (Rapsomikis, et al., 2006). There is a large body of research on market integration and price transmission. A set of studies has focused on vertical price transmission along the supply chain (Wholgenant, 1985; Kinnucan and Forker, 1987; Goodwin and Holt, 1999; Vavra and Goodwin, 2005 and Brosig 2011) while another set of studies has analyzed spatial price transmission, pass-through from the world price to the domestic price, (Mundlak and Larson, 1992; Quiroz and Soto, 1996; Abdulai, 2000; Sharma, 2002; Baquedano et al., 2011; Sekhar, 2012 and Baquedano,2014). Some selected studies on spatial price transmission and market integration are provided here.

Mundlak and Larson (henceforth ML) (1992) measure price transmission from the world to domestic producer prices using FAO's annual data and a static model for 58 countries' 5-10 agricultural commodity markets. They find very high price transmission elasticities (between 0.74 to 1.24) for all countries analyzed, implying almost a full transmission of price movements from the world market to domestic markets. They also find high R-squares. Quiroz and Soto (1996) question ML's method and findings because during the years when greater government interventions occurred, a high price transmission was not expected. They estimate the price transmission elasticities for 58 countries using the same static method used by ML and a different dynamic approach. For the static model, they find autocorrelation to be the key estimation problem in the ML method. They re-estimate price transmission elasticities using a dynamic error correction model and find that most countries have low or no pass through. They also find that the speed of adjustment following a change is very low for all countries analyzed. Several studies have adopted and developed the dynamic model used by Quiroz and Soto and found low, moderate and high price transmission depending on the agricultural commodities studied, the time period covered, and the countries analyzed. Abdulai (2000) examines principal maize markets in Ghana and finds that major maize markets are well integrated in Ghana. Baffes and Gardner (2003) focus on price transmission and market integration of ten agricultural commodities for eight developing countries (Chile, Mexico, Argentina, Ghana, Madagascar, Indonesia, Egypt and Colombia) using an error correction model. They find that the domestic markets of Mexico, Chile and Argentina are highly cointegrated, whereas remaining countries (Colombia, Egypt, Ghana, Madagascar and Indonesia) have low or no cointegration. Sharma (2002) estimates eight Asian countries' wheat, maize and rice price transmission and finds low cointegration. Campa and Golberg (2005) use cross country time series for 23 OECD countries to analyze the extent of exchange rate pass-through into import prices. They find countries with higher rate of exchange rate volatility have higher pass-through elasticities. Janvry and Sadoulet (2010) estimate price transmission for Guatemala and find modest transmission. Minot (2011) examines degree of market integration for 11 Sub-Saharan African countries' staple food markets. Using error correction model and monthly data for the global food crisis years of 2007-2008, he finds low or no transmission. Baquedano and Liefert (2014) examine market cointegration of developing countries for four goods, wheat, rice, maize and sorghum. Using consumer price monthly data and a single equation error correction model, they find consumer markets in developing countries are cointegrated with the world market with a low transmission.

There are a few studies (Koc, 2010 and Brogis et al., 2010; and Bor et al. 2013) analyzing price transmissions along the supply chain in the domestic market of Turkey. Brosig et al. (2011) studies the Turkish wheat price transmission across supply chain using bivariate threshold vector error correction model accounting for transaction costs. They find that transaction costs affect price transmission more on smaller markets than larger ones.

On the other hand there is no study, to our knowledge, that examines the transmission of border prices to domestic prices. This study contributes to the existing literature in two ways. First, this study is the first to analyze Turkey's agricultural price transmission from world market to domestic market. Second, this is the first study that analyzes a large range of commodity market integration with world market.

4. Model and Data

Our model is based on the law of one price, which postulates that once adjusted transport and transaction costs, the price for a homogenous commodity in two spatially separated markets should be the same. We develop an error correction model from this relationship to estimate both short and long run price transmission elasticities and the speed at which domestic price adjusts to international price changes.

The relationship between domestic price and world price is represented as follows:

$$P_{it}^{d} = \beta P_{it}^{w} + u_t \qquad (1)$$

Where P_{it}^{d} and P_{it}^{w} are the natural log of the domestic price and the world price respectively in real term for commodity *i* at time *t*.

According to Engle and Granger (1987) if the residuals, $\widehat{u_t}$, of equation (1) are stationary, then there is a long-run equilibrium between the series. Hence, one can conclude that domestic prices follow world price movements in the long run. In other words, domestic prices and world prices are co-integrated. These residuals are inserted in equation (2) as an Error Correction Term (ECT) to correct the deviation from equilibrium in the last period.

A simple Error Correction Model (ECM) that captures the interaction between international price and domestic price is represented as the following form.

$$\Delta p_t^{d} = c + \gamma \Delta p_t^{w} + \delta \underbrace{\left(P_{t-1}^{d} - \beta P_{t-1}^{w}\right)}_{\text{Error correction term}} + \varepsilon_t \qquad (2)$$

Where p_t^{d} is the domestic price, p_t^{w} is the world price and c, γ, and δ and β are parameters to be estimated. The main advantage of the ECM is that it separates out the long-run and short-run variables. γ represents short-run transmission elasticity[1] for the world price. The key parameters in ECM are β which measures how domestic price reacts to changes in world price in the long run (long run price transmission elasticity) and δ which adjusts deviation from long-run equilibrium (also called error correction term, adjustment parameter, and/or speed of adjustment parameter). If domestic and world prices are cointegrated, then δ must have negative sign and must be statistically significant. If this is the case, any deviation from equilibrium will adjust back to long-run equilibrium. A large value of δ implies that deviations are corrected rapidly while small value implies slow speed of correction. The error correction term can be interpreted based on the frequency of the data used for estimation. For example, a $\delta = 0.5$ estimated with annual data implies that the 50 percent of the deviation from the long-run equilibrium is corrected within one year. With monthly data the same value would imply that 50 percent of the deviation is adjusted within one month (Greb et al. 2016). Finally, ε_t is mean zero and *iid* error term. Equation (2) suggests that changes in the domestic prices stem from two sources. First, changes in world price. Second, changes in error correction term, deviation from the equilibrium in the last period. Equation (2) may contain more lags of changes in domestic prices and world prices which we decide using Akaika Information Criteria (AIC).

Figure 12 outlines steps how to assess price transmission and market integration. The first step is to determine whether domestic and world price series are both non-stationary (also referred to as 'integrated' or I (1)) by conducting Augmented Dickey Fuller test (Dickey and Fuller, 1979) or other unit root tests. If the prices are not in the same order, they are not

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[1] Because prices are logarithmic form, β and ϒ can be interpreted as short-run and long-run price transmission elasticities.

cointegrated. If they are both in order I (0), i.e. stationary in level, Autoregressive Distributed Lag (ARDL) can be used for estimation. If price series are of order I (1), the null hypothesis that the prices are not cointegrated can be tested using two stage Engle-Granger OLS (Engle and Granger, 1987) or Johansen tests (Johansen, 1988). If the null is rejected, (i.e. if there is cointegration) then error correction model is used to assess dynamics and speed of adjustment. Lastly results of short and long run elasticities and speed of adjustment are interpreted. Our transmission estimates may understate the degree of actual transmission because we do not adjust domestic prices for transportation and transaction costs since data is not available.

We use monthly price and exchange rates data over the period from January 2005 to March 2015. For the world prices, we use the "IMF primary commodity prices" obtained from the International Money Fund (IMF)[2]. The domestic prices of wheat, barley, maize, soybean and rice are obtained from the Turkish Statistical Institute (TurkStat). We deflate all nominal prices using producer price indices which are obtained from Turkstat and IMF. For exchange rate data, we use monthly average real exchange rates (local currency per $US) from International Financial Statistics of the International Monetary Fund, Financial Statistics of the Federal Reserve Board.

5. Results and Discussion

We estimate the model for five commodities, wheat, barley, soybean, maize and rice. As an initial step, we test the order of integration to determine the stationary property of price series. We use Augmented Dickey-Fuller (ADF) to test the null hypothesis that price series are not stationary (series have unit root). Results presented in table 7 show that price series are not stationary in level, except domestic rice price. The series can become stationary by taking the first difference. Thus, all prices are of order I(1) except domestic rice price which is of order

[2] IMF commodity prices: http://www.imf.org/external/np/res/commod/index.aspx

I(0). Since price series for rice (i.e. domestic and world prices of rice) are of different orders, we can conclude that the rice market of Turkey is not cointegrated with the international rice market, i.e. domestic rice market has been isolated from world rice market. Apart from the rice price, all other price series are stationary in the first difference. We proceed by following the test sequence depicted in Figure 12. Next, we test for cointegration. We use Engle-Granger two stage a OLS method to test the null of no cointegration. A negative sign and statistically significant ECT indicates that the world and domestic prices are cointegrated. As shown in table 8, all ECTs (except ECT for rice) are significant and have negative signs which suggest that Turkey's wheat, barley, maize and soybean markets are cointegrated with those of their world counterparts. Next, since there is market cointegration, i.e. no cointegration hypothesis is rejected, we can proceed our analyses by estimating an error correction model specified in equation (2) to estimate the short-run and the long-run elasticities and assess overall market integration. The results are reported in Table 8.

Overall, statistically significant long-run coefficients and ECT[3] values suggest that all markets, except the rice market, are cointegrated with world markets. However, ECTs are quite small suggesting that wheat, barley, maize and soybean markets adjust to a new equilibrium at very slow paces.

Looking at the wheat market, domestic-world market linkage appears to be weak (0.15) in the short-run suggesting that only 15 % of a shock in the world wheat price is transmitted to the Turkish wheat price in the first month. The long-run coefficient of 0.60 suggests that in the

[3] The error correction term (ECT) can vary between 0 to |1|. A value of 0 indicates no movement to new equilibrium and thus no cointegration while a value of |1| indicates immediate movement to new equilibrium.

long run, 60 % of a shock is transmitted. Estimated ECT is small (-0.08) suggesting that following a shock, domestic wheat price adjusts to a new equilibrium at a speed of 8 % each month. Half-life adjustment (HLA) is 9 months for wheat which implies that it takes 9 months for domestic wheat price to adjust half of a change in the world wheat price. The adjusted R-square value (0.24) suggests that 24 % of the variability of the Turkish wheat market is explained by the variability in the world wheat price.

The results for the barley market are similar to those of wheat market with relatively smaller short-run and bigger long-run values. The short run variable indicates that only 9 % of a change in the world barley price is transmitted to the domestic barley contemporaneously (in current month). This indicates that the markets are not well integrated in the short-run given the pass through is incomplete. The long-run PT elasticity is 0.66, suggesting that, in the long-run, 66 % of adjustment takes place, not full adjustment. The adjustment process is also slow (-0.11), indicating 11 % of divergence from the long-run equilibrium is being corrected each month. Half of the adjustment takes place within 6 months. The adjusted R square suggests that 20 % of the variation in domestic barley price is explained by the world price variations.

The maize market has relatively higher short-run price transmission (0.24) and, although low, the highest speed of adjustment (-0.17) suggesting that 17 % of a change in domestic price passes through each month. 50% of adjustment takes place within 4 months which is the fastest adjustment among other commodity markets. The value of adjusted R square implies that 12 % of the variation of domestic maize price can be explained by the variability in world maize price.

Soybean has the highest short-run pass through elasticity (0.27) suggesting that 27 % of price signals are transmitted in the short run. Statistically significant long-run PT elasticity and ECT indicate that market is cointegrated with international market, 57 percent convergence takes place in the long run with a 13 % adjustment in each month. The half of the 57 percent is adjusted within 5 months. Only 10 % of the variation in domestic soybean price is explained by the variation in international price.

Unlike other markets, rice market does not show any statistically significant relationship the world rice price. This suggests that Turkish rice market is not cointegrated with the world rice market neither in the short-run nor in the long-run. The domestic market is isolated from international market.

6. Conclusion

There is enough evidence to conclude that Turkish wheat, barley, maize and soybean markets are cointegrated with the world market. However, the cointegration is low, i.e. transmission of changes in world prices to domestic prices is not high both in the short-run and in the long-run. As a result of these, the movement of domestic prices to new equilibrium with world prices is slow.

Low and non-existence of co-integration are not surprising considering the government involvements in the grain market. Although some SEEs were privatized, the state-owned enterprise in the grain market, the board of grain, has remained to regulate the market. On the other hand, support policies have shifted towards more production and trade distorting forms of supports. Deficiency payments are the most distorting and the most inefficient ways of supporting producers, yet extensively used in Turkey. The scope of the deficiency payments has been enlarged, but less distorting DIS payments have ended. In grain trade, the GOT imposes very high level tariffs on imports and provides export subsidies. More trade liberalization policies will increase Turkish grain market integration with both the EU and the world grain markets.

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Appendix

Table 1. Exports of agricultural products ($ million)

		2010	2011	2012	2013	2014
	Total exports	**113,979**	**134,915**	**152,537**	**151,803**	**157,715**
	Total agriculture exports	**11,899**	**14,350**	**15,105**	**16,707**	**17,635**
	of which					
0802	Other nuts, fresh or dried	1,045	1,199	1,254	1,258	1,560
1905	Bread, pastry, cakes, biscuits and other bakers' wares	487	622	739	878	939
0805	Citrus fruit, fresh or dried	862	1,065	898	931	933
1101	Wheat or meslin flour	598	892	841	947	933
2008	Fruit, nuts and other edible parts of plants	582	695	724	731	876
1512	Sunflower-seed, safflower or cotton-seed oil	103	341	418	496	790
0806	Grapes, fresh or dried	622	682	683	678	679
0207	Meat and edible offal, of the poultry of heading 01.05	203	385	527	608	651
1806	Chocolate and other food preparations containing cocoa.	364	434	479	543	577
1704	Sugar confectionery, not containing cocoa	279	329	403	490	537
2401	Unmanufactured tobacco; tobacco refuse	401	369	427	439	517
1902	Pasta, whether or not cooked or stuffed	186	285	358	494	507
2402	Cigars, cheroots, cigarillos and cigarettes	240	248	333	374	464
0702	Tomatoes, fresh or chilled.	477	432	401	391	427

Source: WTO, 2016

Table 2. Imports of agricultural products ($ million)

		2010	2011	2012	2013	2014
	Total imports	**185,541**	**240,839**	**236,544**	**251,661**	**242,224**
	Total agricultural imports	9,865	13,477	12,599	13,398	14,554
	of which					
5201	Cotton, not carded or combed	1,720	1,850	1,275	1,681	1,750
1001	Wheat and meslin	655	1,623	1,126	1,289	1,546
1512	Sunflower, safflower or cotton-seed oil	274	629	988	919	1,201
1201	Soya beans, whether or not broken	742	687	685	643	1,120
1511	Palm oil and its fractions	318	454	439	499	492
2402	Cigar, cigarillo, cigarette	247	250	337	381	475
2106	Food preparations not elsewhere specified or included	269	335	337	400	437
2401	Unmanufactured tobacco; tobacco refuse	276	298	360	379	411
1206	Sunflower seeds, whether or not broken	350	590	444	474	406
0713	Dried leguminous vegetables, shelled	258	283	215	261	384
1005	Maize (corn)	124	136	246	473	349

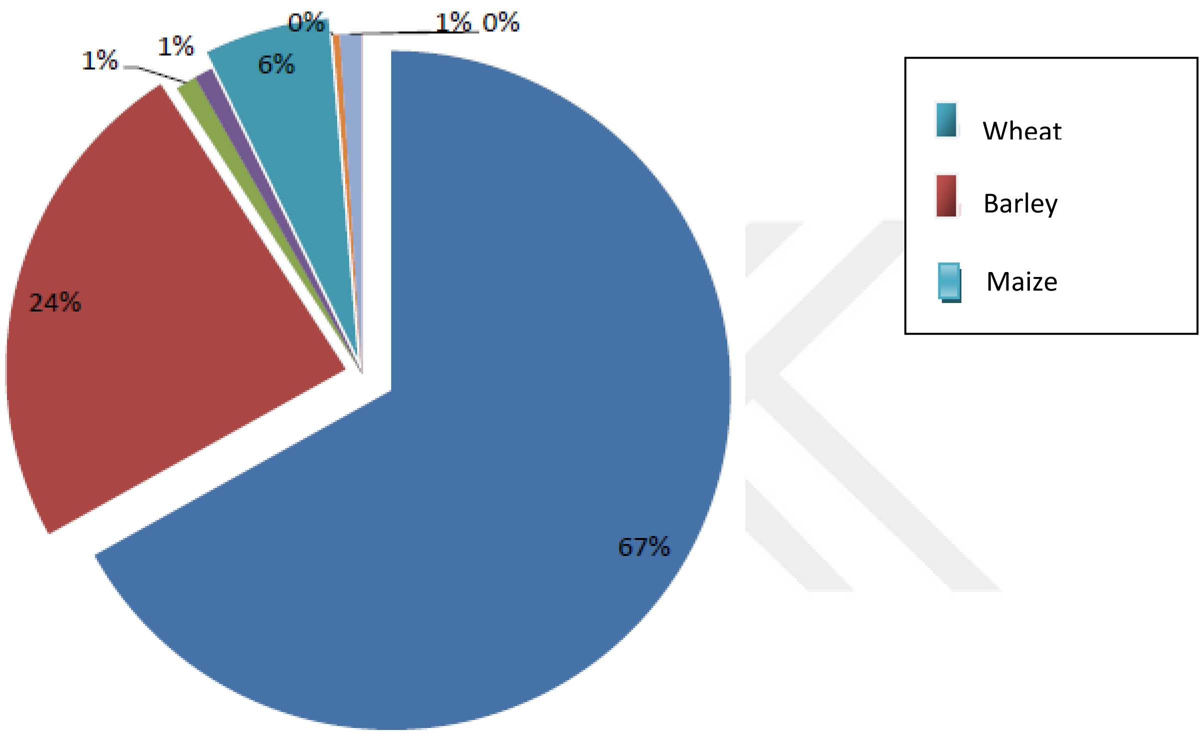
Source: WTO, 2016

Table 3. Structure of MFN tariffs in Turkey, 2011-15

		MFN applied		Final bound[a]
		2011	2015	
1.	Bound tariff lines (% of all tariff lines)	n.a.	n.a.	50.4
2.	Simple average tariff rate	12.2	12.8	37.5
	Agricultural products (WTO definition)	47.9	49.0	72.1
	Non-agricultural products (WTO definition)	5.0	5.5	17.6
	Agriculture, hunting, forestry and fishing (ISIC 1)	26.0	27.1	46.2
	Mining and quarrying (ISIC 2)	0.2	0.2	9.3
	Manufacturing (ISIC 3)	11.6	12.1	36.8
3.	Duty-free tariff lines (% of all tariff lines)	23.2	23.5	2.8
4.	Simple average rate of dutiable lines only	15.9	16.8	39.8
5.	Tariff quotas (% of all tariff lines)	..	..	0.0
6.	Non-*ad valorem* tariffs (% of all tariff lines)	1.7	1.7	0.2
7.	Non-*ad valorem* tariffs with no AVEs (% of all tariff lines)	0.3	0.2	0.2
8.	Domestic tariff peaks (% of all tariff lines)[b]	9.1	9.0	3.7
9.	International tariff peaks (% of all tariff lines)[c]	14.6	16.1	32.7
10.	Overall standard deviation of applied rates	27.1	27.6	44.7
11.	Nuisance applied rates (% of all tariff lines)[d]	6.7	5.5	0.04

Source: WTO, 2016

Graph 2.1. Land used for Grain production



Source: The Turkish Grain Board (TMO) , 2015

Figure 1. Turkey's Total grain market

Source: International grains council

Figure 2. Turkey's wheat market

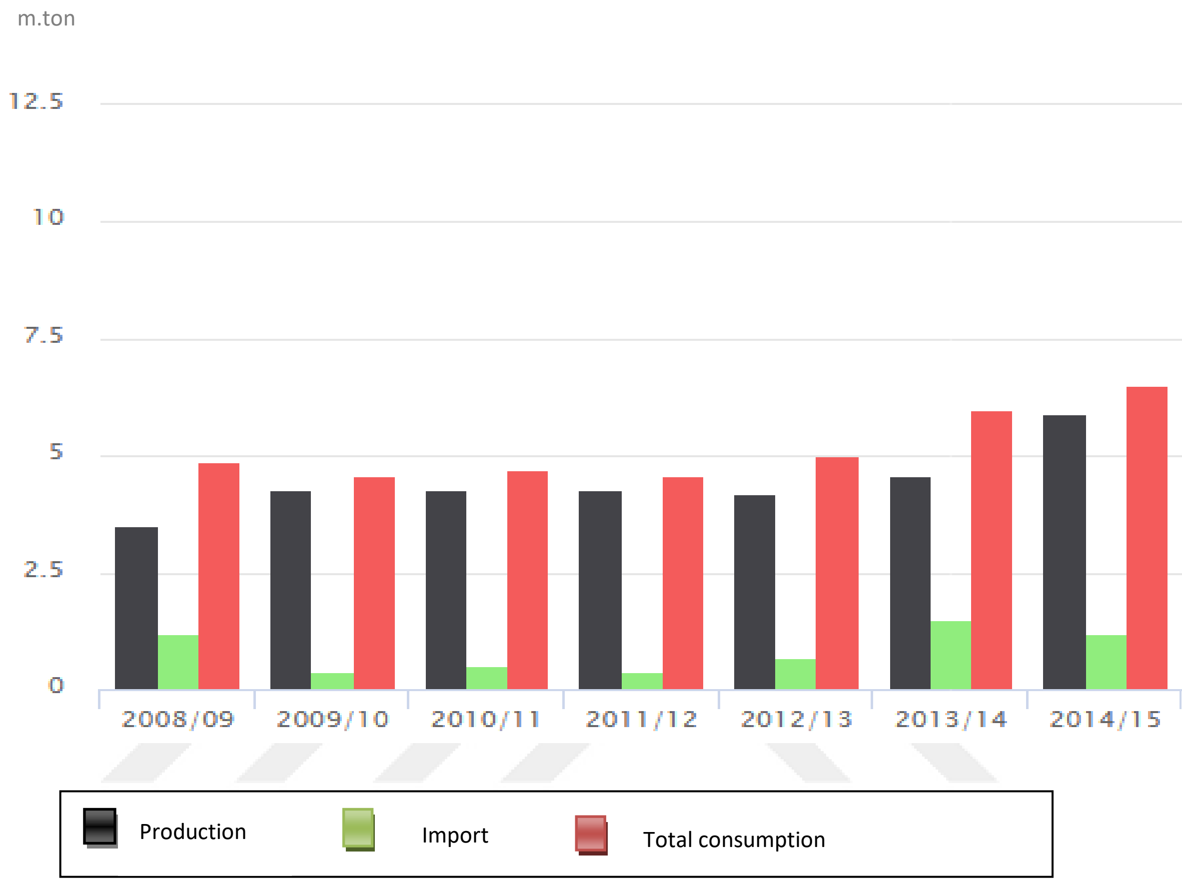
m.ton

Source : International grains council

Figure 3. Turkey's barley market

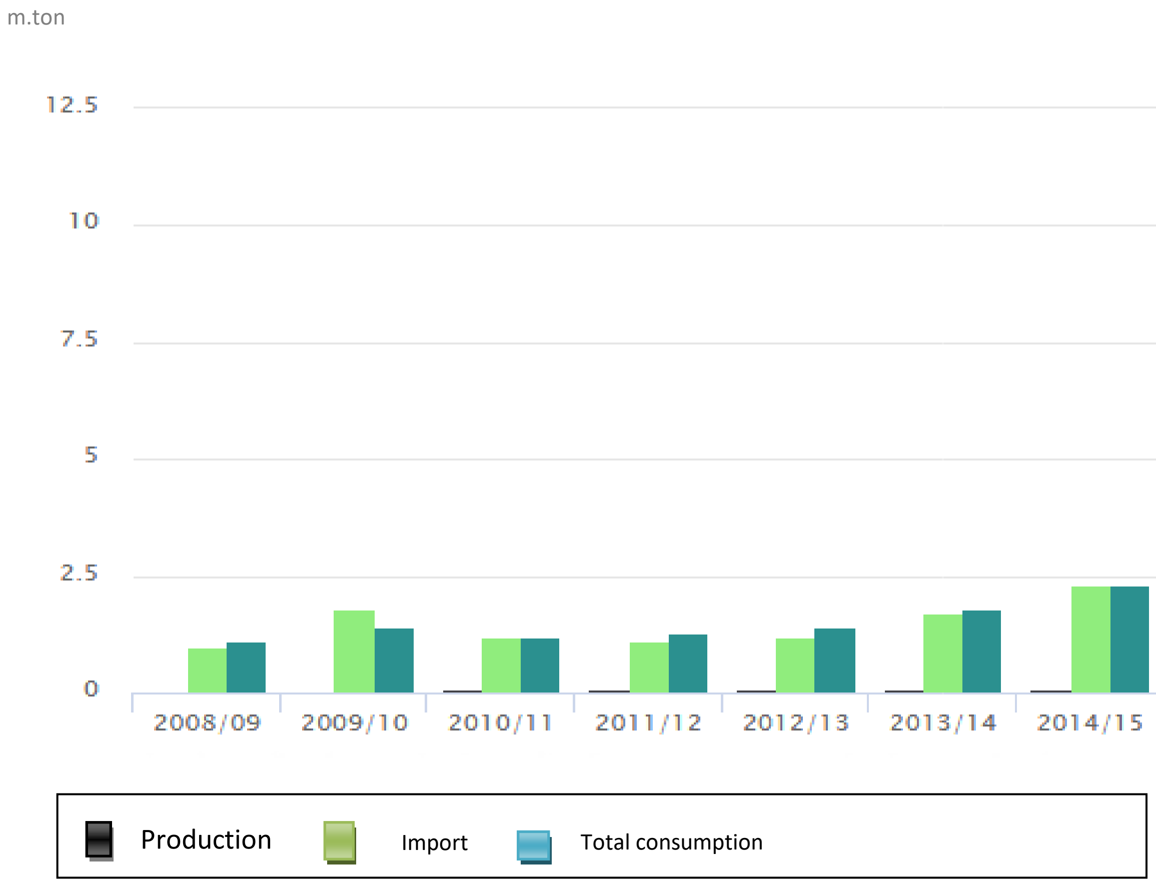
Source :International grains council

Figure 4. Turkey's Maize market



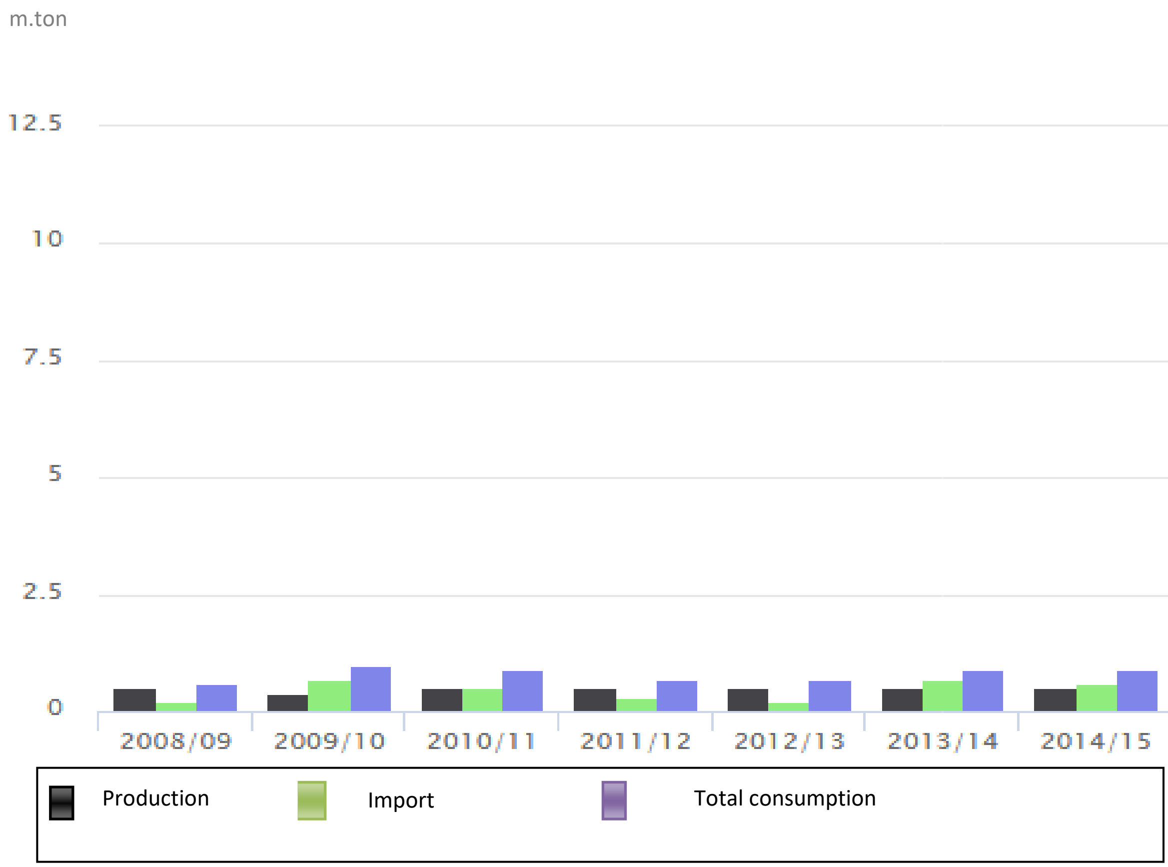
Source: International grains council

Figure 5. Turkey's Soybean market



Source: International grains council

Figure 6. Turkey's rice market



Source: International grains council

Table 4. Grain support system in Turkey (TL/Hectar)

Types of support	2013	2014	2015	2016
Diesel support	44	46	48.5	
Chemical fertilizer support	55	60	66	100
Soil Analysis support	25	25	25	

Source :USDA, 2017

Table 5. Government support program for grains

Grain Premiums Turkey: Grain Premiums (TL/mt)						
Products	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Wheat	50	50	50	50	50	50
Barley	50	50	50	50	50	50
Rice	100	100	100	100	100	100
chick peas, Dry beans	100	100	100	100	200	300
Maize	40	40	40	40	40	20

Source: USDA, 2017

Table 6. Grain tariff rates in 2016

Product group	Products	EU	others incl. US
Wheat	spelt, common and meslin	130	130
	Durum wheat	130	130
	common wheat, durum wheat and meslin seed	0	0
Barley	barley seed	0	0
	White barley	130	130
	Malting barley	130	130
Maize	maize seed	0	0
	popcorn, unpopped,	130	130
	other corn	130	130
Rice	Rice in husk for sowing	13	115
	Round, medium, long frain rice in husk	34	34
	Round, medium, long grain husked rice	36	36
	semi milled, wholly milled, broken rice	45	45

Source: USDA, 2017

Figure 7. Domestic and world wheat price series

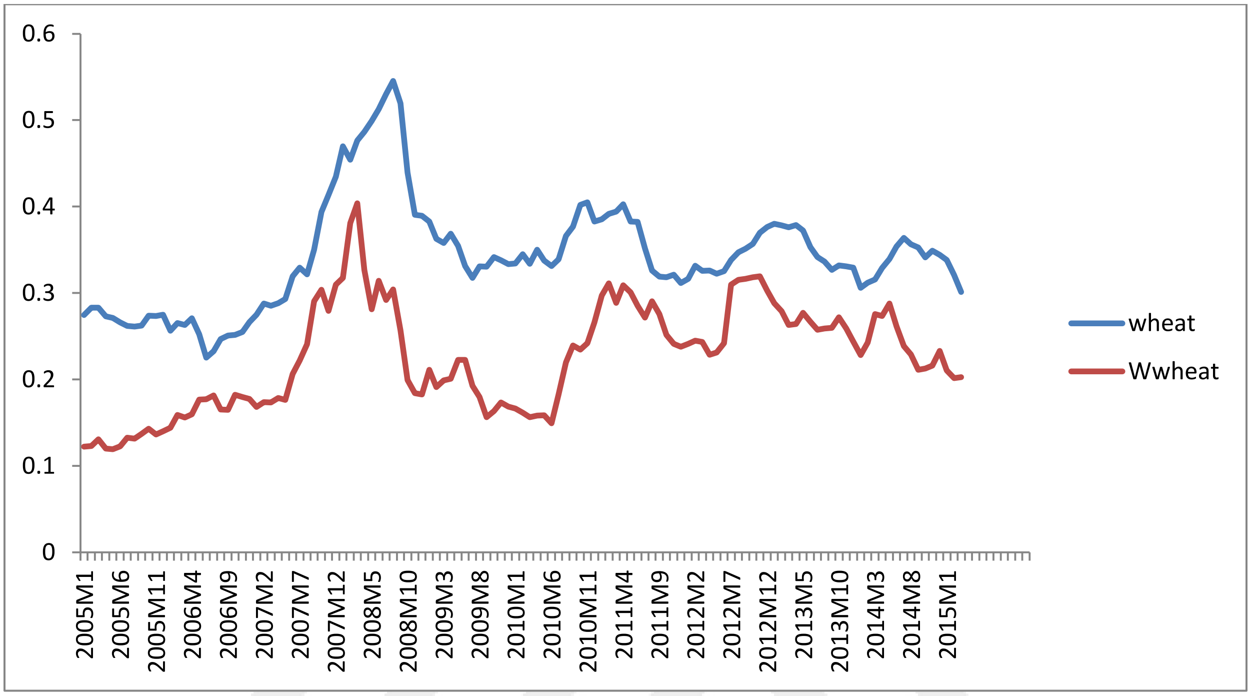


Figure 8. Domestic and world maize price series

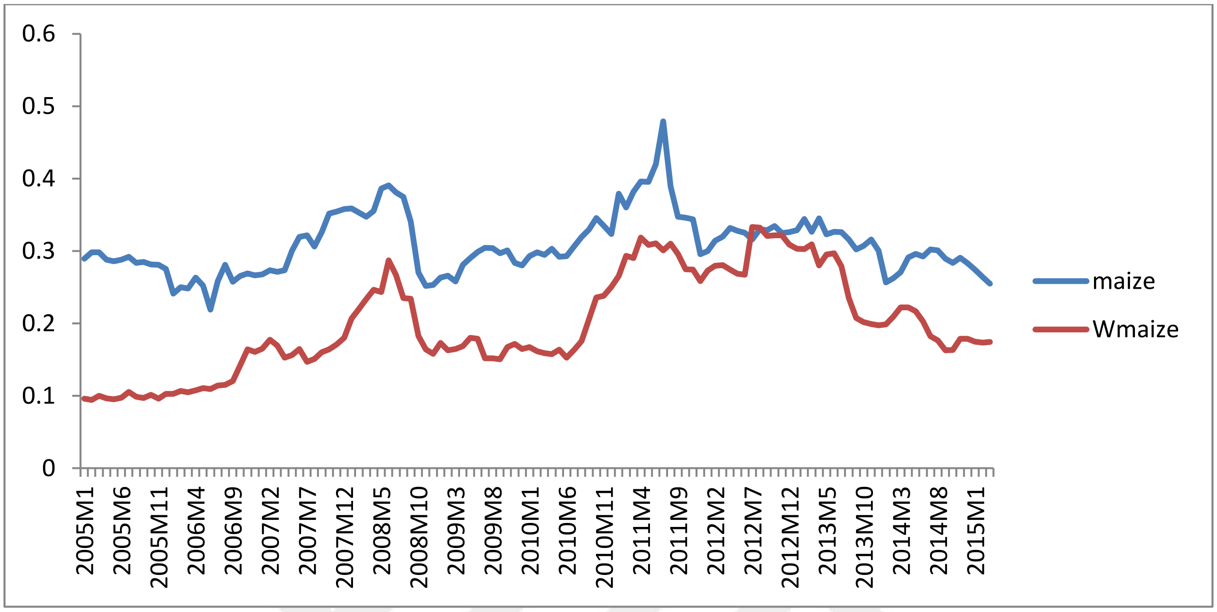


Figure 9. Domestic and world barley price series

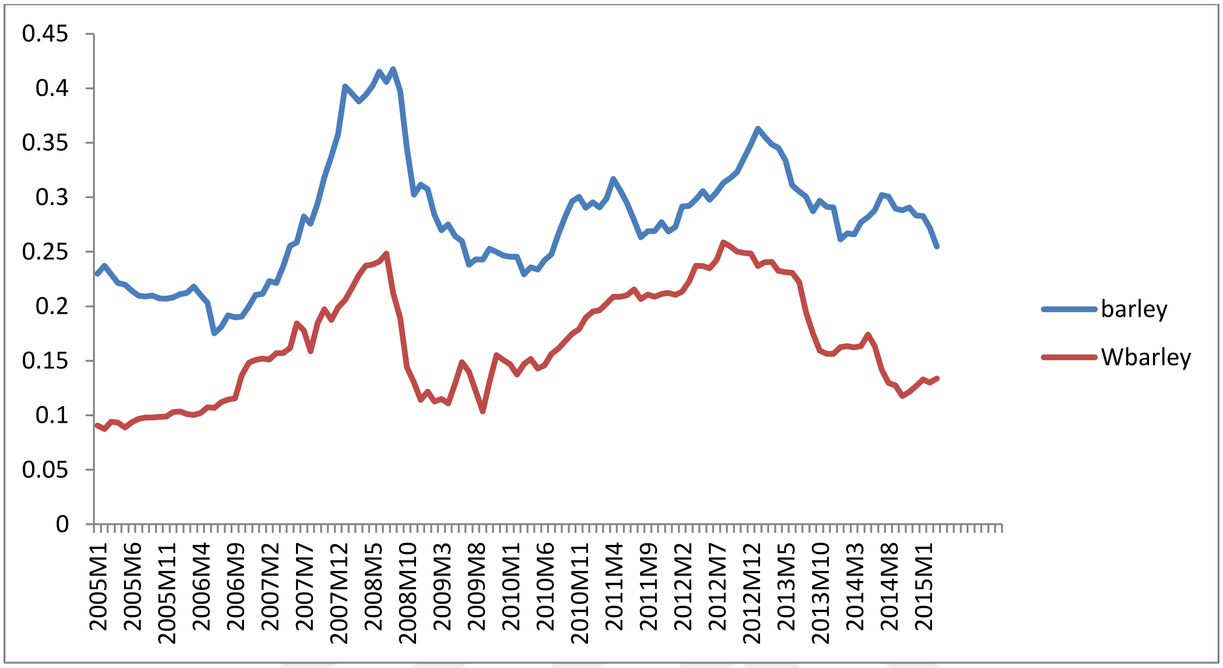


Figure 10. Domestic and world soybean price series

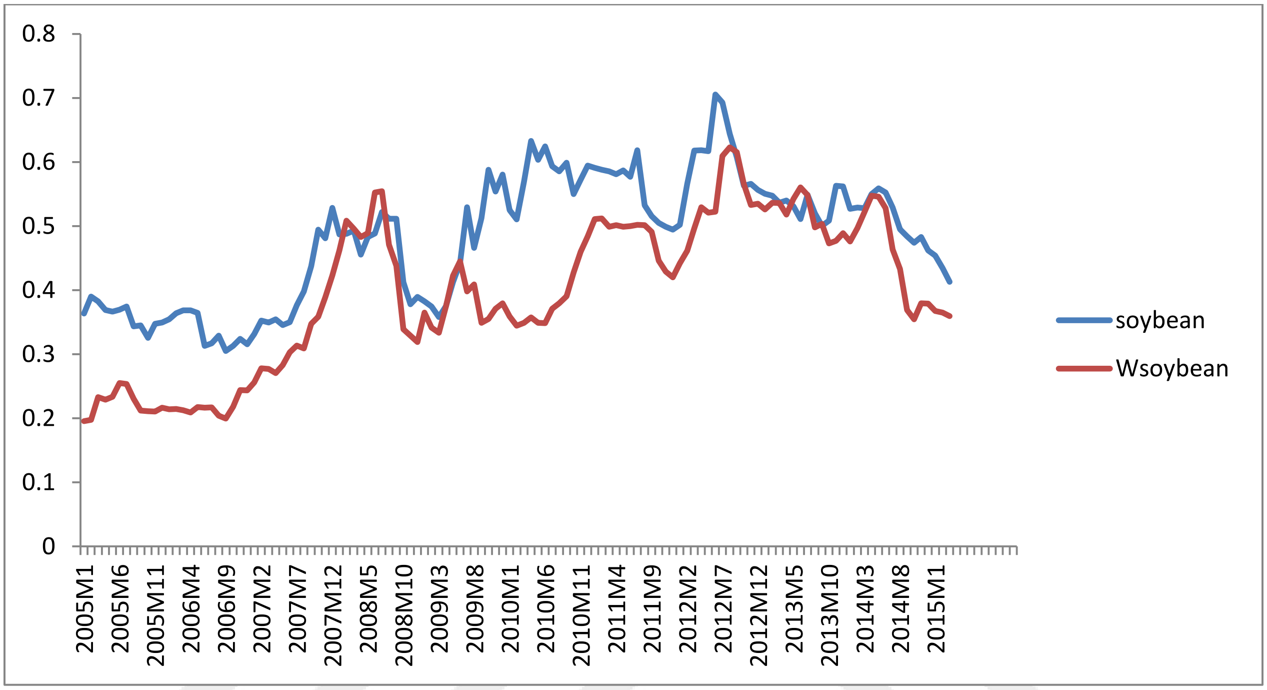


Figure 11. Domestic and world rice price series

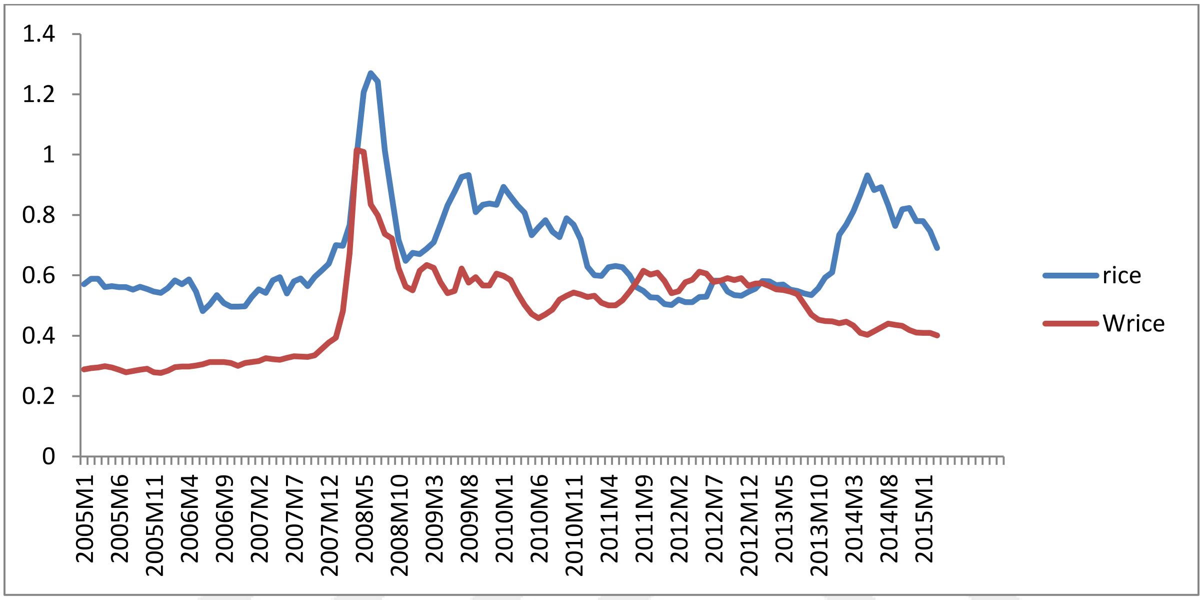
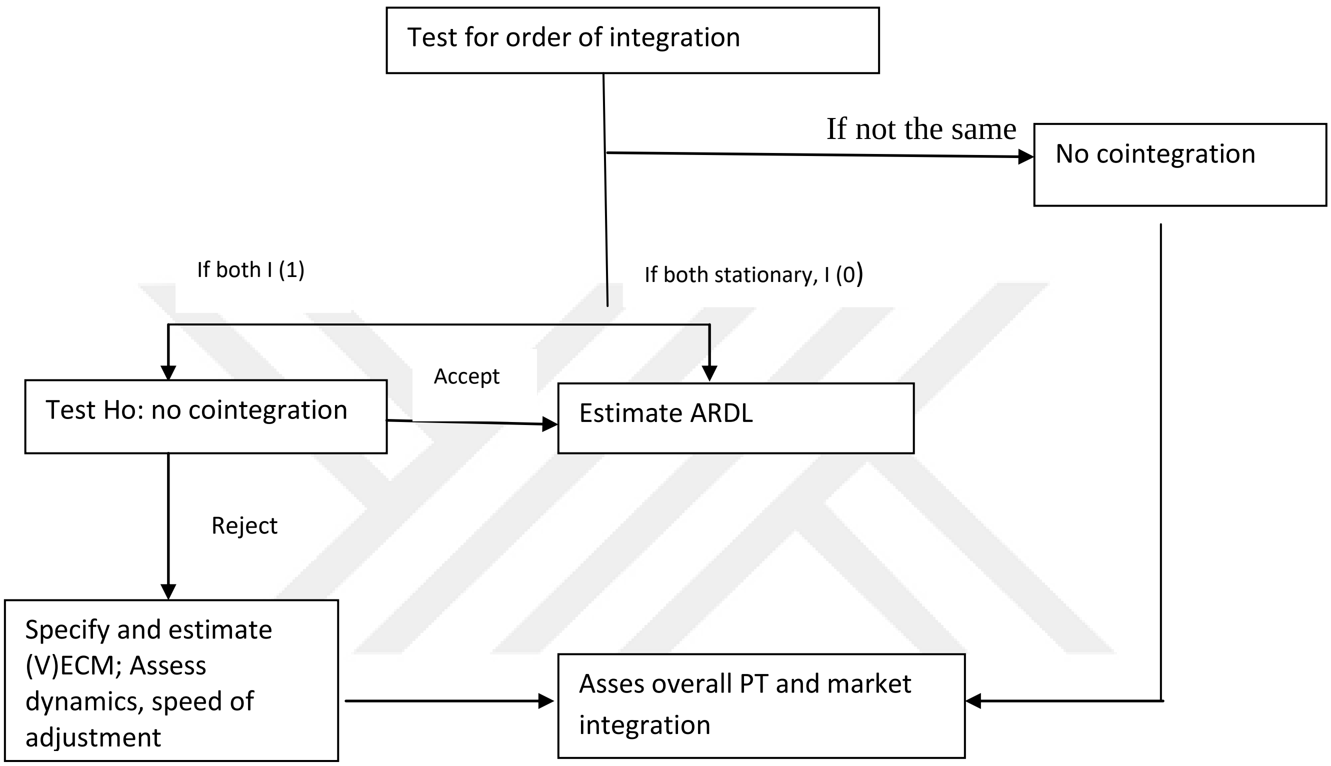


Figure 12. Conceptual framework for assessing price transmission and market integration



Source : Greb at al.(2016) and Rapsomanikis et al.(2003)

Table 7. Unit root (stationary) test

	ADF	
Commodity	Level	first difference
Barley	-1.91	-7.56***
Maize	-2.46	-10.34***
Rice	-3.41	-6.95***
Soybean	-1.87	-10.90***
Wheat	-2.18	-6.91***
World barley	-2.17	-7.56***
World maize	-1.88	-8.94***
World rice	-2.35	-7.67***
World soybean	-2.19	-7.89***
World wheat	-2.61	-8.85***
Exchange	0.72	-7.85***
Test critical values:	1% level	-3.49
	5% level	-2.89
	10% level	-2.58

ADF: augmented Dickey-Fuller test. *** 1% significance level

Table 8. Estimated short run and longrun price transmission elasticities.

	constant (c)	short-run PTE (γ)	Long-run PTE (β)	ECT (δ)	HLA	R^2	DW
Wheat	-0.18	0.15***	0.60***	-0.08***	9	0.27	1.99
	(0.25)	(0.08)	(0.17)	(0.02)			
Barley	-0.08	0.09*	0.66***	-0.11***	6	0.21	2.01
	(0.23)	(0.05)	(0.12)	(0.25)			
Maize	-0.77**	0.24*	0.25***	-0.17***	4	0.12	1.85
	(0.13)	(0.07)	(0.08)	(0.05)			
Soybean	-0.21	0.27**	0.57***	-0.13***	5	0.12	2.01
	(0.13)	(0.08)	(0.12)	(0.05)			
Rice	-0.24	0.12	0.25	-0.07	-	0.41	2.02
	(0.2)	(0.08)	(0.24)	(0.02)			

Standard errors are shown in parentheses. * **indicates 1% significance level,** 5% , and * 10% significance level.
DW is Durbin Watson statistics.HLA stands for half-life adjustment of a shock.

Chapter 2: An Analysis of Cotton Market Integration

1. Introduction

Over the last two decades, following the Uruguay Round in 1994, many developing countries moved towards liberalization of their agricultural markets to better integrate with the world market. When domestic markets are not integrated with the world market, countries do not gain from the trade as much as they could. Hence, market integration has important economic welfare implication. An important requirement for market integration is that the transmission (or pass-through) of world price movement to domestic prices should be complete or sufficiently high. Complete pass-through, however, might not take place due to the following factors: i) border protection policies such as import tariffs, import quotas, export bans and export subsidies; ii) price support policies such as input subsidies, and deficiency payments; iii) imperfect competition in the market; iv) transfer costs; v) changes in exchange rates (detailed explanation is provided in chapter 1, section 1.2.).

Cotton market is one of the highly supported industries. Government supports to the cotton sector including direct support to production, border protection, crop insurance subsidies and minimum support price mechanism are estimated to be $7.2 billion in 2015-16(International Cotton Advisory Committee, ICAC, 2016). As shown in figure 1, the share of production that receives assistance in the form of direct payments and border production on average was 55% from 1997/98 to 2007/ 08, which then increased to 83% in 2008/09. From 2009/10 to 2013/14 the average share receiving support declined to 48%, and then increased to 76% again during

2014/15 . In 2015/16 the share declined to 71%.The Chinese cotton market is subject to an intensive government intervention. The Chinese government controls the cotton import volumes and values and applies border protection measures based on quota and sliding scale duties to protect its cotton producers. In addition, China affects prices through reserves of cotton managed by China National Reserve Corporation (CNCRC). When there is a shortage, CNCRC releases cotton to the market from the reserve through auctions, and when there is a surplus it increases the reserves. Furthermore, the government of China gives subsidies to cotton growers for high quality planting seeds. As a result of these interventions, the Chinese domestic prices have exceeded the international cotton prices (ICAC, 2014).

Brazil is the fourth largest exporter of cotton, and the third largest supporter of its producers. The Brazilian government has a program called the Equalizer Price Paid to the Producers (PEPRO). Under the PEPRO program, the government gives subsidies to producers based on guaranteed prices. PEPRO was also used to compensate farmers for appreciation of the Brazilian Real per US dollar. Moreover, the government also supports cotton producers by giving subsidized credits for production, marketing and investment (ICAC,2014). On the other hand, Brazilian cotton production is affected by high pest control, labor, fertilizer and transportation costs as well as weak infrastructure of rails, highways and ports (ICAC, cotton fact sheet Brazil, 2009)

Turkey is the second largest importer of cotton, and the fourth largest supporter of cotton after China, USA and Brazil. The government of Turkey supports producers by paying premium per kilogram of seed (ICAC, 2014). The government also supports farmers by giving low-cost loans through cooperatives, TARIS.

All these policies raise questions as to: (i) whether these interventions have distorted the cointegration of the domestic cotton markets of China, Brazil and Turkey with the world cotton market. If they have, then (ii) how does a weak cointegration affect the world cotton trade? The first question can be addressed by estimating exchange rates and price transmission elasticities and the second question can be analyzed within a partial equilibrium framework.

The purpose of this article is to estimate exchange rate and price transmission elasticities for three developing countries (China, Turkey and Brazil) and measure their impact on the world cotton market.

1.1. Price transmission, market integration and the Law of One Price (LOP)

The concept of price transmission has been analyzed within the context of the law of one price (*inter alia* Asche et al., 2012 and Olsen et al.,2015), or within the context of market integration (*inter alia* Mundlak and Larson, 1992; Quiroz and Soto, 1996; Abdulai,2000; Sharma, 2002; Baquedano et al.,2011;Minot, 2011; Sekhar, 2012 and Baquedano,2014) or reform policy evaluation following the implementation of structural adjustment programs (Baffes and Gardner, 2003; Rapsomonikis, 2004). Another set of research analyzes vertical price transmission along the supply chain from the consumer to the producer (*inter alia* Wohlgenant, 1985; Kinnucan and Forker, 1987; Goodwin and Holt, 1999; von Cramon-Taubadel, 1999; Vavra and Goodwin, 2005 and Brosig 2011; Bor et al. 2013).

Market integration and LOP requires that once prices are converted to a common currency, the price of a commodity should be the same in different countries.

For a net importing country, Law of One Price (LOP) implies that import price equals world price plus per-unit transaction cost. With this in mind, let prices in the initial equilibrium be defined as follows

(1) $$P_m = P_w + T$$

Where P_m is the import price in US dollar P_w is the world price in US dollar and T is per-unit transportation cost. On the other hand, import price in local currency is expressed as follows:

(2) $$\tilde{P}_m = P_m \cdot e$$

where $\tilde{P}_m$ is the local currency price of imports, $e = LCU/USD$ is the exchange rate (Local Currency Unit divided by U.S. Dollar). Expressing equations (1) and (2) in proportionate change form yields

(1') $$P_m^* = (1-\tau)P_w^* + \tau T^* \quad \text{where} \quad 0 < \tau = \frac{T}{P_m} < 1$$

(2') $$\tilde{P}_m^* = P_m^* + e^*.$$

The effect of changes in the world price and exchange rate on local currency price can be found by substituting (1') into (2') :

(3) $$\tilde{P}_m^* = (1-\tau)P_w^* + \tau T^* + e^*$$

Since transportation cost data is not available, dropping τT^* from equation (3) yields

(4) $$\tilde{P}_m^* = (1-\tau)P_w^* + e^*$$

Expressing equation (4) in the regression form :

(5) $$ln\tilde{P}_i^* = c + a_i lnP_w^* + b_i lnE_i^*$$

Where *i*= Brazil, China and Turkey

LOP is tested with the null hypotheses that exchange rate pass-through is complete, i.e., the exchange rate elasticity $\tilde{P}_m^*/e^*$ is 1 (or *b*=1) and world price pass through is complete i.e., price transmission elasticity $\tilde{P}_m^*/P_w^*$ is 1 (or *a*=1).

In the next section we estimate equation (5) and in section three we analyze the impact of estimated elasticities in a partial equilibrium model. Then we conclude.

2. Estimation

2.1. Model and Data

Model

The relationship between domestic price, world price and exchange rate can be expressed as follows:

$$P_t^d = c + aP_t^w + be_t + u_t \qquad (5')$$

where P_t^d, P_t^w and e_t denote domestic cotton price and world price of cotton and exchange rates in logarithmic forms, respectively. c, a and b are parameters to be estimated and u_t denotes the error term.

As an initial step, we perform Augmented Dickey-Fuller (ADF) test to determine whether the series are stationary or not. If prices are stationary, OLS analysis can be used. If not, cointegration analysis is the appropriate econometric method. As shown in table 1, prices are non-stationary in level, but stationary in first difference, I (1). Hence, cointegration analysis is the appropriate method to infer the long-run relationship between nonstationary time series. For cointegration analysis, we perform Engle and Granger (1987) cointegration test by estimating equation (5') below and testing whether the residuals ($\hat{u}$) are stationary. If the residuals are stationary, then it is said that the two price series are cointegrated. That is, there is a long-run equilibrium relationship between domestic prices and the world price (i.e. there is comovement between prices and domestic prices follow world price signals). Since cointegration is present, the next step[4] is to run an Error Correction Model (ECM) to estimate the price transmission and exchange rate elasticities for the short and the long run and the speed of adjustment to a new equilibrium following a shock.

To derive ECM, two steps are required (*i*) estimating equation (5') and (*ii*) inserting the estimated residuals in equation (6) to correct the deviation from the equilibrium in the last period.

$$\Delta p_{it}^{d} = c + \sum_{j=0}^{n} \beta_j \Delta P_{t-j}^{w} + \sum_{j=0}^{n} \rho_j \Delta e_{t-j} + \delta\underbrace{\left(p_{t-1}^{d} - a p_{t-1}^{w} - b e_{t-1}\right)}_{\text{Error correction term}} + \varepsilon_t \qquad (6)$$

Where the Greek letter Δ is the first difference operator, $\Delta X_t = X_t - X_{t-1}$ and p_t^d represents the domestic price of cotton in local currency unit for country i at time t. p_t^w and e_t are world price of cotton in US dollar and exchange rates. All series are in natural logarithmic form.

Equation (6) suggests that changes in domestic cotton prices stem from three sources: changes in world price, changes in exchange rates and changes in error correction term. Equation (6) may contain more lags of changes in domestic prices, world prices and exchange rates, which are decided using Akaika Information Criateria (AIC).

The economics interpretation of equation (6) is as follows: The parameters β and ρ represent the short run coefficients of world price and exchange rates elasticites[5] respectively indicating how much of a given shock in the world price of cotton, and exchange rate will be transmitted to the domestic market prices in the current period (also called initial

[4] We follow steps from figure 2 for estimation.
[5] Since they are in logarithmic form, they can be interpreted as price transmission elasticities.

adjustment term, short-run effect, or contemporaneous effect). δ is interpreted as coefficient of speed of adjustment to the long run equilibrium showing how much of the past price difference is eliminated in each period (also called error correction term, speed of adjustment or feedback effect). α and b are the long-run coefficients (long run price transmission elasticities). Finally, ε_t is mean zero and *iid* error term.

We use monthly price and the exchange rate data covering the period from September 2002 to December 2014. For the world price, we use Cotlook A index, which is a proxy for the world price of cotton, obtained from National Cotton Council of America (NCCA). The monthly domestic price data for China is obtained from the Chinese Yearbook of Cotton prepared by the China Cotton information Center (CCIC). The domestic price for Turkey is obtained from the Turkish Statistical Institute (TurkStat) and the Brazilian cotton price data is obtained from the Center for Advanced Studies on Applied Economist (CEPEA/ESALQ). The CEPEA/ESALQ cotton price index is a reference for the Brazilian cotton market and provides the daily prices.

We take averages of each month's daily prices to obtain the monthly prices. We deflate all nominal prices using producer price indices that are obtained from the International Monetary Fund for China, Brazil and world prices, and from the Turkish statistical Institution for Turkey. For the exchange rate data, we use monthly average real exchange rates (local currency per $US) obtained from International Financial Statistics of the International Monetary Fund, Financial Statistics of the Federal Reserve Board.

2.2. Results

Results are presented in table 2. Of the three countries examined, China has the adjusted R square of 0.30, which implies that 30 percent of Chinese domestic price variability is explained by world cotton price and exchange rates movements. Similarly, the contemporaneous effect is 0.37 suggesting that a 10 percent increase in the world price leads to a 3.7 percent increase in the Chinese cotton price in the current period. Long run effect is 0.69 and the error correction term in absolute value is 0.19 showing that the world price changes are transmitted to domestic price at a speed of 0.19.

Turkey's results are close to those of China in terms of the short-run effect and adjusted R square. The adjusted R square of 23% implies that 23 percent of the variation in domestic price is explained by the world price and exchange rates movements. The short-run effect is 0.33 implying that a 10 percent increase (decrease) in the world price increases (decreases) the domestic price by 3.3 percent in the current period. The long run value is 0.72 which passes through at a 4 percent speed of adjustment.

Brazil has the adjusted R square of 0.30, suggesting that 30 percent of variability of domestic price movement reflects movements in the world price and the exchange rates. Brazil also has the highest short-run effect of 0.63 indicating a shock of 10 percent increase in the world market which leads to a 6.3 percent increase in the Brazilian domestic price in the immediate month. The same value for the long run effect is 0.86. The error correction term for Brazil is the highest of all three countries (0.23) suggesting that it will take shorter time for the Brazilian cotton market to adjust a shock from the world price and the exchange rate movements.

As for the Real Exchange Rate (RER) elasticities (b_i), exchange rate elasticities with 0 values indicate no transmission, no adjustment while 1 indicates a complete transmission and adjustment to a new equilibrium. Our results indicate partial transmission for China, Turkey and Brazil. The estimated exchange rate elasticities for the long run are 0.14, 0.50 and 0.73 which suggest that following a 10% shock, 1.4%, 5% and 7.3% increase take place in the domestic prices of China, Turkey and Brazil respectively. Exchange rate shocks adjust in the long run at speeds of 0.14, 0.04 and 0.23.

As discussed earlier the price and the exchange rate elasticities that are significantly smaller than one indicate that there is a weak market cointegration, and that the LOP does not hold. The Wald test results suggest that the estimated price and exchange rate elasticities are significantly different from 1 both in the short run and in the long run.

Considering the extensive government interventions, these results are not surprising. The Chinese government applies border protection measures with a tariff of 40% to control import volumes. In addition, the cotton reserves managed by CNCRC are used to affect prices in favor of producers by affecting supply and demand (and thus prices). Finally, the government pays direct subsidy to cotton growers (ICAC, 2016).

Nearly 90% of the producers in Turkey receive a premium of 0.75 TL per kilogram. The Secretariat estimates that total payment to cotton producers in 2015/16 was $381 million (ICAC,2016). The government of Brazil provides direct subsidies based on guaranteed prices and subsidized credit for production with an annual average of $500 million (ICAC, 2016). These seem to be the underlying causes of the weak cointegration of the domestic markets with the international cotton market.

Since the markets are not cointegrated strongly, the question that comes to mind is whether the weak market integration affect the cotton trade. The next section addresses this question by conducting an Equilibrium Displacement Model (EDM).

3. Theoretical model

As Wohlgenant (2011) defines "EDMs are essentially logarithmic differential equations characterizing comparative statics of a system of equations describing movement from one equilibrium to another resulting from a change in one or more of the parameters (exogenous variables) of the equation system."

EDM uses reduced-form elasticities (also known as total elasticities) to calculate the percentage change in an endogenous variable per one percent change in exogenous variable letting other endogenous variables in the model adjust. Hence, it allows us to calculate the percentage change in the world cotton export and import quantities in respond to changes in price and exchange rate elasticities letting the domestic and world prices adjust.

3.1. Comparative Statics

Since we are interested in the world cotton market, we derive import demand and export supply equations from domestic markets of importing and exporting countries. To begin with, consider a country that is net importer of homogenous cotton. Let initial equilibrium of the market be as follows:

$D = D(P_d)$ (Domestic demand) (1)

$S = S(P_d)$ (Domestic supply) (2)

$M = M(P_w)$ (Import Supply) (3)

$P_d = P_w.E$ (Domestic price) (4)

$D = S + M$ (Market equilibrium) (5)

where E is exchange rate P_w is world price. In this model, all exogenous variables except exchange rate are suppressed.

Of key interests is effect of exchange rate on import. To derive import demand curve, we first write the model in equilibrium displacement form as follows:

$$D^* = \eta P_d^* \tag{1'}$$

$$S^* = \epsilon P_d^* \tag{2'}$$

$$M^* = \varepsilon P_w^* \tag{3'}$$

$$P_d^* = \alpha P_w^* + bE^* \tag{4'}$$

$$D^* = k_d S^* + k_m M^* \tag{5'}$$

Where the asterisked variables indicate relative change ($D^* = dD/D$); $k_d = S/D$ is the share of consumption from domestic supply; $k_m = M/D$ is the share of consumption from imports; η (<0) is domestic demand elasticity, ϵ(≥0) is the domestic supply elasticity, $\varepsilon(>)0$ is the import supply elasticity.

Substituting (1′) and (2') into (5') yields import demand curve (6)

$$\eta P_d^* = k_d \epsilon P_d^* + k_m M^*$$

$$M^* = \frac{(\eta - k_d \epsilon)}{k_m} P_d^*$$

Domestic consumers respond to domestic price. Substituting (4') into the equation above (to express import demand in world price) yields:

$$M^* = \frac{(\eta - k_d \epsilon)}{k_m} (\alpha P_w^* + bE^*)$$

$$M^* = \frac{a(\eta - k_d \epsilon)}{k_m} P_w^* + \frac{b(\eta - k_d \epsilon)}{k_m} E^*$$

or

$$M^* = a\acute{\eta} P_w^* + b\acute{\eta} E^* \tag{6}$$

where

$$ή = \frac{(η - k_d ϵ)}{k_m} \quad (7)$$

is the price elasticity of import demand.

The same analysis can be used for exporting country to derive export supply curve. With the same assumptions, let initial equilibrium be defined as follows:

$D = D(P_d)$ (Domestic demand) (8)

$S = S(P_d)$ (Domestic supply) (9)

$X = X(P_w)$ (Export demand) (10)

$P_d = P_w.E$ (Domestic price) (11)

$S = D + X$ (Market equilibrium) (12)

Of key interests is exchange rate effect on export. To derive export supply curve, we write the model in equilibrium displacement form as follows:

$$D^* = ηP_d^* \quad (8')$$

$$S^* = ϵP_d^* \quad (9')$$

$$X^* = εP_d^* \quad (10')$$

$$P_d^* = αP_w^* + bE^* \quad (11')$$

$$S^* = k_s D^* + k_x X^* \quad (12')$$

Where $k_s = D/S$ is the share of production for domestic demand and $k_x = X/S$ is the share of export and the parameters denotes the same as importing country case.

Substituting (8') and (9') into (12') and making use of (11') to find export supply curve (13)

$$ϵP_d^* = k_s ηP_d^* + k_x X^*$$

$$X^* = \frac{(ϵ - k_s η)}{k_x} P_d^*$$

$X^* = \frac{(\epsilon - k_s \eta)}{k_x}(\alpha P_w^* + bE^*)$

$X^* = \frac{a(\epsilon - k_s \eta)}{k_x} P_w^* + \frac{b(\epsilon - k_s \eta)}{k_x} E^*$

or

$X^* = a\acute{\varepsilon} P_w^* + b\acute{\varepsilon} E^*$ (13)

Where

$\acute{\varepsilon} = \frac{(\epsilon - k_s \eta)}{k_x}$ (14)

is the price elasticity of export supply. Equations (6) and (13) are of key interest equations which we use to develop the world cotton model in the next section.

3.2. World Cotton EDM Model

Structure

We adopt a two country excess supply and excess demand model similar to one used by Chamber and Just (1979) and Kinnucan and Myrland (2000, 2005).

Net Exporters

(1) $X_{us}^* = \acute{\varepsilon}_{us} P_w^*$
(2) $X_{br}^* = a_{br} \acute{\varepsilon}_{br} P_w^* + b\acute{\varepsilon}_{br} E_{br}^*$
(3) $X_{uz}^* = \acute{\varepsilon}_{uz} P_w^*$
(4) $X_{au}^* = \acute{\varepsilon}_{au} P_w^*$
(5) $X_{in}^* = \acute{\varepsilon}_{in} P_w^*$
(6) $X_{rw}^* = \acute{\varepsilon}_{rw} P_w^*$

Net importers

(7) $M_{\mathrm{ch}}^* = a_{ch} \acute{\eta}_{ch} P_w^* + b\acute{\eta}_{\mathrm{ch}} E_{ch}^*$
(8) $M_{tr}^* = a_{tr} \acute{\eta}_{tr} P_w^* + b\acute{\eta}_{tr} E_{tr}^*$
(9) $M_{Id}^* = \acute{\eta}_{id} P_w^*$

(10) $M^*_{bg} = ή_{bg} P^*_w$

(11) $M^*_{vn} = ή_{vn} P^*_w$

(12) $M^*_{wr} = ή_{rw} P^*_w$

Price linkages

(13) $P^*_{br} = a_{br} P^*_w + b_{br} E^*_{br}$

(14) $P^*_{\text{ch}} = a_{cg} P^*_w + b_{ch} E^*_{\text{ch}}$

(15) $P^*_{tr} = a_{tr} P^*_w + b_{tr} E^*_{tr}$

Market equilibrium

(16) $\sum_i^6 kx_i X^*_i = \sum_j^6 km_j\, M^*_j$

where the asterisk (*) denotes proportionate change (e.g., $P^* = dP/P$). X^*_i represents the world's excess supply for the exporting countries USA, Brazil, India, Australia, Uzbekistan and Rest of the world. M^*_j represents world's excess demand for the importing countries China, Turkey, Indonesia, Bangladesh, Vietnam and rest of the world. η'_i(<0) is price elasticities of excess demand in the net importing region and $ε'_i(> 0)$ is price elasticities of excess supply in the net exporting region. P^*_w , $P^*_{\text{ch}}, P^*_{tr} and\ P^*_{br}$ represent proportional changes in world price, Chinese price, Turkish price and Brazilian price of cotton. $E^*_{br}, E^*_{\text{ch}}$ and E^*_{tr} represent proportional change in exchange rate of Brazil, China and Turkey. Equations (1)-(16) constitute an equilibrium displacement model (EDM).

The model contains 16 endogenous variables, twelve to represent changes in trade flow(X^*_{us} , X^*_{br}, X^*_{uz}, X^*_{au}, X^*_{in} , X^*_{rw}, M^*_{ch}, M^*_{tr}, M^*_{id}, M^*_{bg}, M^*_{vn}, M^*_{rw}) and four to represent changes in price (P^*_w, P^*_{ch}, P^*_{tr}, P^*_{br}).

In this model, all exogenous variables that affect demand and supply are suppressed except three exogenous variables which are exchange rates for China, Turkey and Brazil (E^*_{ch} E^*_{tr} and E^*_{br}).

Parameterization

The model's structural elasticities ή and έ are derived from the following formulas:

$$ή = \frac{(η - k_d ϵ)}{k_m} \tag{17}$$

$$έ = \frac{(ϵ - k_s η)}{k_x} \tag{18}$$

where k_m and k_x are import and export share parameters as defined in table 4 . The values of price elasticity of demand (η) and price elasticity of supply (ϵ) are obtained from existing literature. We rely on the estimates of Shepherd (2006) for cotton price elasticity of supply from FAO commodity and trade policy research papers. For price elasticity of demand, we rely on Poonyth et al. (2004) from FAO. (A list of price supply and demand elasticities is provided in table 5).

Reduced form

We express model's reduced-form (total elasticities) in matrix notation

$$YΠ = ΓZ \tag{19}$$

Where $Π$ is 16× 16 matrix of parameters of model's endogenous variables, Y is 16× 1 vector of endogenous variables. $Γ$ is 16 × 3 matrix of parameters corresponding to the model's exogenous variables. Inverse of (19) yields:

$$Y= EZ \tag{20}$$

Where $E = Π^{-1}Γ$ is a 16× 3 matrix containing the model's full set of total elasticities. We simulate equation (20) two times. in the first, we assume the LOP holds and thus used 1 for price and exchange rate elasticities (i.e. a=1, b=1). In the second simulation we use the estimated price and exchange rate elasticities from table 2 and compared the two simulations' results.

4. Results

In theory, an increase in exchange rate refers to depreciation and a decrease refers to appreciation of local currency if exchange rate is defined as local currency unit per US dollar. If a local currency depreciates, exports increase and imports decrease. If local currency appreciates, imports increase and exports decrease.

For an exporting country, an increase in exchange rate would cause its export to increase. This would lower world price, which would cause imports worldwide to increase, and exports of competitors to decrease. Similarly, for an importing country, an increase in exchange rate would cause imports to decrease. This would cause world price to decrease, which would increase imports of competitors and decrease exports worldwide.

Table 3 presents results. Focusing first on price effects, results suggest that an increase in exchange rates of all countries causes world price to decrease. Domestic price effects differ such that an increase in exchange rates of importing countries decreases domestic prices whereas an increase in exchange rate of exporting country increases domestic price of that country.

Looking at the effects of exchange rate changes on trade flow, an isolated 10% increase in exchange rates of China and Turkey increase cotton exports by 6.4% worldwide. An isolated 10% increase in Brazil exchange rate decreases exports by 13%.

Looking at the second part of the table 3, increase in exports worldwide are lower when LOP does not hold. An 10% isolated increase in exchange rates of China and Turkey increases total exports by 0.9% and 3.2% respectively which was 6.4% when LOP is assumed to hold. Similarly, when LOP is violated, a 10% increase in Brazil exchange rate decreases world exports by 20.4% which was 13% when LOP holds.

Exchange rate changes have negative effects on imports worldwide in response to changes in exchange rates of China and Turkey. Total imports decrease by 6.4% in response to an isolated 10% change in exchange rates of China and Turkey, and increase by 13% in response to a 10 % in Brazil exchange rate. When the LOP does not hold, these figures decrease such that an isolated 10% increase in exchange rates of China and Turkey decreases total imports by 0.9% and 3.2% respectively, (as opposed to 6.4% when the LOP holds). Similarly, total imports increase by 9.5% when exchange rate of Brazil increases 10%.

5. Conclusion

Our empirical results suggest that the law of one price does not hold for the world cotton market with respect to China, Brazil and Turkey and EDM results show that there are significant impacts of this violation on cotton trade flow and prices.

An increase in exchange rates of China and Turkey cause export of cotton worldwide to increase and imports to decrease. These effects are lower when LOP does not hold. An increase in exchange rate of Brazil, however, causes its exports to increase but exports worldwide to decrease. These effects are lower when LOP is violated.

Total imports decrease in response to an increase in exchange rates changes in importing countries. When LOP does not hold total import decreases are lower in response to Chinese and Turkish exchange rate changes,

When exchange rates of China and Turkey increase, domestic prices increase, but world price decreases. When LOP does not hold these effects are lower. Brazilian price increase in response to an increase in Brazilian exchange rate, but world price decreases. These effects are lower when LOP does not hold.

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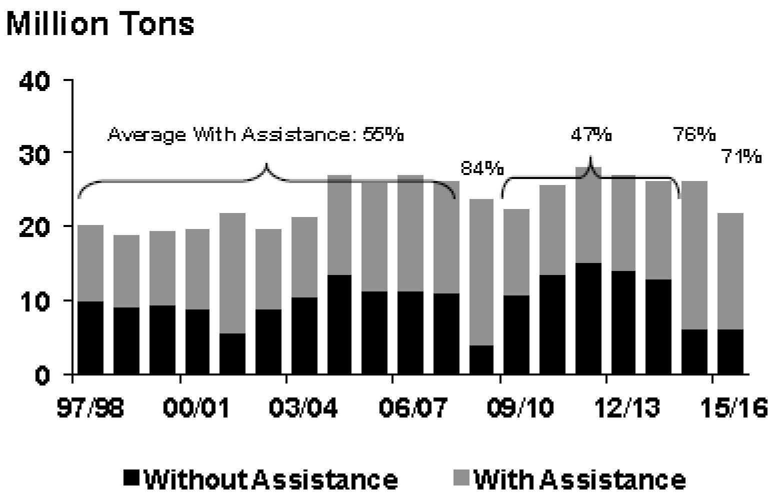
Appendix 1

Figure 1. World production under direct assistant.



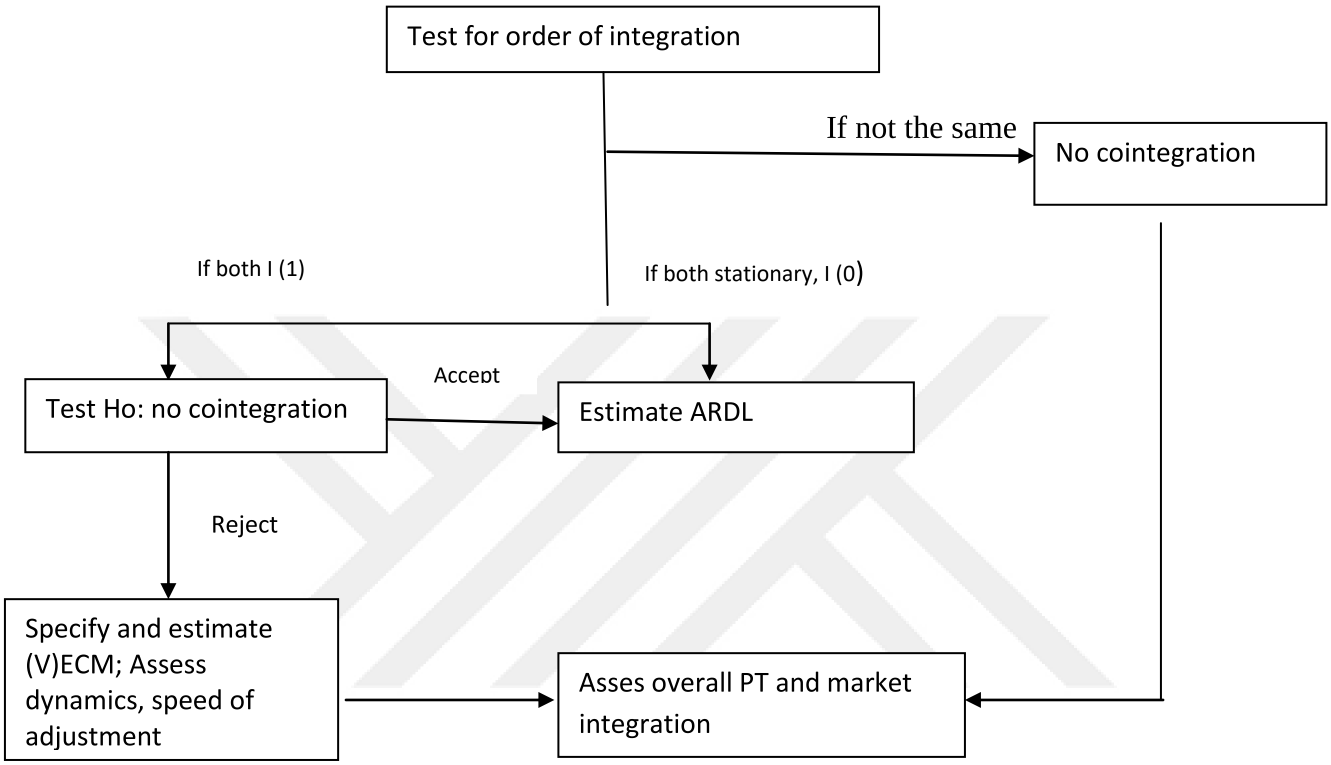
Source: ICAC, 2016

Table 1. Unit root test for cotton market

	Augmented Dicker-Fuller (ADF) test statistic		
	At Levels	First Difference	
World price	-2.08	-8.79***	
China			
Domestic price	-1.85	-12.29***	
Exchange rate	0.50	-8.92	
Brazil			
Domestic price	-2.58	-5.93***	
Exchange rate	-3.52	-9.79	
Turkey			
Domestic price	-2.08	-9.73***	
Exchange rate	-3.27	-8.92***	
Critical values	1 percent	5 percent	10 percent
ADF	-3.51	-2.89	-2.58

*** unit root null hypothesis is rejected at 1 percent level.

Figure 2. Conceptual framework for assessing price transmission and market integration



Source : Greb at al.(2016) and Rapsomanikis et al.(2003)

Table 2. Short and long-run world price and exchange rates elasticities

	China	Turkey	Brazil
Short Run parameters			
World price (β)	0.37***	0.33***	0.64***
	(0.08)	(0.05)	(0.07)
Exchange rate (ρ)	0.53	0.11***	0.29***
	(0.84)	(0.07)	(0.13)
Constant	-0.33**	-0.27**	-0.91
	(0.15)	(0.09)	(0.24)
Long Run Parameters			
Error Correction term (δ)	-0.19***	-0.04***	-0.23***
	(0.05)	(0.01)	(0.05)
World price (a)	0.69***	0.72***	0.86***
	(0.04)	(0.02)	(0.05)
Exchange rate (b)	0.14***	0.50***	0.73***
	(0.04)	(0.02)	(0.04)
R^2	0.32	0.25	0.33
D-W	2.29	1.88	1.81
N	147	179	179

All prices are in U.S. dollars. All prices and exchange rate are in real terms.*** , **, * are 1, 5, 10 percent significance levels respectively. D-W is Durbin Watson. N is number of observations. Numbers in parentheses are standard deviations.

Table 3. Results with LOP compared with estimated coefficients in the long run.

	a=1 b=1			a=0.6 b=0.14	a=0.72,b=0.50	a=0.86,b=0.73
Variables	Ech	Etr	Ebr	Ech	Etr	Ebr
Xus	0.19	0.19	-0.65	0.03	0.10	-0.49
Xbr	1.35	1.34	3.29	0.17	0.60	2.77
Xua	0.29	0.29	-0.97	0.04	0.15	-0.74
Xin	0.81	0.81	-2.74	0.12	0.42	-2.07
Xuz	3.15	3.13	-10.64	0.46	1.62	-8.03
Xrw	0.53	0.52	-1.78	0.08	0.27	-1.35
Total	**0.64**	**0.64**	**-1.30**	**0.09**	**0.32**	**-2.40**
Mch	-0.55	-0.08	0.27	-0.07	-0.03	0.14
Mtr	-0.62	-4.25	2.11	-0.09	-2.14	1.64
Mid	-0.52	-0.52	1.77	-0.08	-0.27	1.34
Mbg	-1.86	-1.84	6.28	-0.27	-0.95	4.74
Mvn	-3.78	-3.75	12.76	-0.55	-1.94	9.63
Mrw	0.00	0.00	0.01	0.00	0.00	0.01
Total	**-0.64**	**-0.64**	**1.30**	**-0.09**	**-0.32**	**0.95**
Pch	1.17	0.17	-0.58	1.02	0.09	-0.44
Ptr	0.17	1.17	-0.58	0.02	1.09	-0.44
Pbr	0.17	0.17	0.42	0.02	0.09	0.56
Pw	-0.17	-0.17	-0.58	-0.02	-0.09	-0.44

Table 4. Domestic export and import share parameters used to compute export supply and demand elasticities.

item	Definition	Value
k_{us}	share of US's production exported (=Xus/Sus)	0.79
k_{br}	share of BRAZIL's production exported (=Xbr/Sbr)	0.56
k_{au}	share of AUSTURALIA's production exported Xau/Sau)	0.97
k_{in}	share of INDIA's production exported (=Xin/Sin)	0.32
k_{uz}	share of UZBEKISTAN's productionexported(=Xuz/Suz)	0.25
k_{rs}	share of ROW's production exported (=Xr/Sr)	0.33
k_{ch}	share of CHINA's consumption imported(=Mch/Dch)	0.43
k_{tr}	share of TURKEY's consumption imported(=Mtr/Dtr)	0.42
k_{id}	share of INDONESIA's consumption imported(=Min/Din)	0.99
k_{bs}	share of BANGLADESH's consumption imported(=MbG/Dbg)	0.95
k_{vm}	share of VIETNAM's consumption imported(=Mv/Dv)	0.99
k_{rd}	share of ROW's consumption imported(=Mr/Dr)	0.32

Values are 2011-2012 averages computed from data obtained Food Agricultural organization (FAO)

Table 5. . Price supply and demand elasticities used to compute export supply and import demand elasticities.

	Supply	Demand
USA's elasticity	0.80	-0.60
Brazil's elasticity	1.20	-0.60
Austuralia's elasticity	0.80	-0.60
India's elasticity	1.20	-0.80
Uzbekistan's elasticity	0.80	-0.60
Rest of the world's elasticity	0.95	-0.60
China's elasticity	1.20	-1.00
Turkey's elasticity	1.20	-0.60
Indonesia's elasticity	0.80	-0.60
Bangladesh's elasticity	1.20	-0.60
Vietnam's elasticity	1.00	-0.60
Rest of the world's elasticity	0.95	-0.60

Values for Vietnam and ROWs best guess values are used

Chapter 3: Do Gasoline Prices in Turkey Respond Asymmetrically to Crude Oil Price Shocks?

1. Introduction

Consumers are generally sensitive to changes in the price of products that they consume frequently.One of the concerns is that companies increase the price of products as a result of increases in their costs, but do not reduce the price when costs fall. This phenomenon is known as asymmetric price transmission (APT) where firms tend to adjust retail prices more quickly in response to increases in costs (input prices) than to decreases.

APT has significant welfare and policy implications. If, for example, APT exists, consumers do not benefit from a price reduction and sellers do not benefit from a price increase that they would under symmetric price transmission condition. Hence, there is a different welfare distribution under symmetric price transmission than under asymmetry (Meyer and Cramon-Taubadel, 2004). APT has been tested for various commodity markets including beef (Goodwin and Holt, 1999), cheese products (Kim and Coterill 2008), and banking (Neumark and Sharpe, 1992; Kleimeier-Ros, 2002).One of the products that consumers are particularly sensitive to is gasoline. Since the price of gasoline is highly volatile, the concern whether positive and negative changes in crude oil price asymmetrically pass-through to retail gasoline price is particularly relevant to consumers.

Turkey has very limited oil reserves. The country imports most of its oil from the international market. As a result of this dependency, gasoline prices are directly affected by fluctuations in international crude oil prices. Moreover, Turkey's gasoline tax is one of the highest in the world. According to Energy Market Regulatory Authority (EMRA) report in 2015, total tax constitutes 64 percent of the gasoline price, which is the highest among the OECD countries.

According to Bloomberg 2016 report, Turkey ranks 6th in terms of percentage of personal income spent on gasoline, 23.33%, which makes Turkish consumers more sensitive to asymmetric price movements. Hence, it is important to know whether APT exits in the Turkish gasoline market. The objective of this study is to address the question of whether price asymmetry is observed in the gasoline market of Turkey. We test this hypothesis using daily data and an Error Correction Model (ECM). Given a limited number of APT studies conducted on Turkey's gasoline market, there is a need to further investigate APT using various methodologies, different data frequencies and time period.

The remainder of this paper is as follows: the next section provides a theoretical framework for APT. Section 3 reviews the literature on price asymmetries in the gasoline market. Section 4 describes the data and the econometric model. Section 5 provides empirical results and discussions and section 6 concludes.

2. Theoretical Framework

There is little consensus on what causes asymmetric price transmission. A number of reasons, including exercise of market power, consumer search costs, and inventory managements, are proposed to explain asymmetric pass-through. These arguments mostly point out an adjustment problem at retail level and so called "price stickiness".

Non-competitive behavior is a dominant explanation of asymmetric pass-through in the literature. In the oligopolistic coordination theory, prices are sticky downward suggesting that due to imperfect market condition a few firms exploit market power by responding more rapidly to positive changes in their costs than to negative changes. BCG (1997), Lewis (2004), Radchenko (2005), and Akcelik and Ozmen (2014) suggest the oligopolistic coordination theory as a likely explanation of the APT.

Another explanation for APT is the consumer search theory which states that consumers have a greater incentive to search following an increase in costs than a decrease, and firms respond more rapidly to cost increases than to decreases to maximize profits. As a consequence of consumers search behavior, retail prices are sticky downward with respect to costs changes. Verlinda (2008), Yang and Ye (2008), Tappata (2009), Lewis (2011), Remer (2012), Cabral and Fishman (2012) and Remer (2015 find evidence in favor of consumer search-based theories.

APT also may take place due to inventory management strategies. The inventory management model, developed by Reagan and Weitzman (1982), suggests that firms reduce their prices more slowly compared to reduction in costs to avoid running out of stock. BCG (1997) argue that "If half of all world oil reserves suddenly disappeared, the long-run competitive price of gasoline would increase greatly, and consumption would decrease greatly. Oil companies could accommodate that change quickly by raising gasoline prices. Since refinery production schedules cannot be adjusted immediately…the results would be a short-run building up of finished gasoline inventories. In contrasts, if world oil reserves doubled overnight, the short-run response in the gasoline market would be limited by available supplies of finished gasoline." BCG (1997) and Kaufmann and Laskowski (2005) suggest that the asymmetric inventory adjustment may be a possible source of asymmetry. Balke et al. (1998) suggests that the accounting method FIFO (first in first out) could cause asymmetric pass-through.

3. Literature review

Several studies have analyzed the relationship between crude oil price and the price of gasoline. Studies differ by country analyzed; time period of the data used; time frequency; econometric model employed and the stages of the supply chain.

The literature dates back to 1991. Bacon (1991) analyzes the UK gasoline market and finds evidence of asymmetry using quadratic partial adjustment model (QPAM) with fortnightly data. He describes this phenomenon with the phrase "rockets and feathers" where gasoline prices go up like rockets in response to increases in crude oil price, but fall like feathers in response to decreases. Since that time, many studies have found evidence of rockets and feathers for different countries. Of these studies, one of the most comprehensive is that of Borenstein, Cameron, and Gilbert (1997, BCG hereafter). BCG use a series of asymmetric Error Correction Model (ECM) for different stages of supply chain with weekly and biweekly US data. They find strong evidence of asymmetry in various stages from crude oil through wholesale to retail market. The empirical model used by BCG has served as a foundation for asymmetric price adjustment in gasoline market. Balke, Brown, and Yucel (1998) extend the work of BCG for the US gasoline market using two different model specifications with weekly data. The authors find asymmetry when used differenced data, whereas they find no evidence of asymmetry when they use VAR model in level. Their findings are sensitive to model specification.

Although the majority of the studies have analyzed the US and UK gasoline markets, rockets and feathers hypothesis has been tested for other countries as well. Bettendorf et al. (2003) examine the retail price adjustment in the Dutch gasoline market using the same model BCG used with weekly data. They find that asymmetric behavior changes based on the choice of the day on which the prices are observed. Galeotti et al. (2003) find asymmetry in both speeds of adjustment and the pass-through of crude oil shocks for five European countries; Germany, France, UK, Spain and Italy. Alper and Torul (2009) investigate the impact of crude oil price shocks on retail gasoline price in Turkey using a structural VAR with monthly data. They report that retail gasoline prices respond to increases in crude oil prices, but not to decreases.

On the other hand, some studies find no evidence of asymmetry in the retail gasoline markets. Shin (1994), using quadratic partial adjustment model with monthly data, finds no asymmetry between wholesale gasoline and crude oil for the US market. Godby et al. (2000) use Error correction TAR model with weekly data and find no asymmetry between crude oil and retail gasoline prices for Canadian market. Bachmiere and Griffin (2002) find no evidence of asymmetry for the US gasoline market using daily data and Asymmetric ECM. Ladislav and Lunackova (2015) use seven countries' data (Belgium, Germany, France, Italy, the Netherlands, UK and the USA) and find no statistically significant asymmetry.

4. Data Econometric Model and Data

For estimation, we follow the econometric model specified by BCG and modified by Bachmeier and Griffin (2003). The model is an extension of the error correction model developed by Engle Granger (1987). A basic relationship between retail gasoline price and crude oil is as follows:

$$R_t = \phi_0 + \phi_1 C_t + \epsilon_t \tag{1}$$

where R_t and C_t are retail gasoline price and crude oil price, respectively, at time t. If price series are cointegrated, then an error correction model (ECM) can be used to estimate short-run and long-run elasticies, which takes the following form:

$$\Delta R_t = \sum_{i=0}^{n} \beta_i \Delta C_{t-i} + \sum_{i=1}^{k} \gamma_i \Delta R_{t-i} + \lambda_1 (R_{t-1} - \phi_1 C_{t-1} - \phi_0) + \varepsilon_t \qquad (2)$$

where the Greek letter Δ is the first difference operator, $\Delta R_t = R_t - R_{t-1}$ and ε_t is mean-zero, normally distributed *iid* error term. The existence of cointegration implies that a long-run linear relationship between retail and crude oil prices and $R_{t-1} - \phi_1 C_{t-1} - \phi_0$ in (2) captures the extent to which retail prices adjust crude oil shocks in the long-run (also called Error Correction Term (ECT)).

This specification in equation (2) allows one to separately identify the effects of short-run crude oil changes (β_i) and own-price changes (γ_i) from retail price adjustment to long-run relationship with crude oil (λ).

Granger and Lee (1989) propose a modification to ECM (2) to allow testing asymmetric price transmission between the cointegrated variables yielding to the following form:

$$\Delta R_t = \sum_{i=0}^{n} (\beta_i^+ \Delta C_{t-i}^+ + \beta_i^- \Delta C_{t-i}^-) + \sum_{i=1}^{k} (\gamma_i^+ \Delta R_{t-i}^+ + \gamma_i^- \Delta R_{t-i}^-) + \lambda_1^+ ECT_{t-1}^+ + \lambda_1^- ECT_{t-1}^- + \varepsilon_t$$

(3)

Where ΔC_{t-i}^+ takes the value of ΔC_{t-i} in eq.(1) if it is positive, zero otherwise and ΔC_{t-i}^- takes the value of ΔC_{t-i} if it is negative and zero otherwise. The same thing is applied for other right hand side variables. Hence, equation (3) allows positive and negative crude oil shocks to have different effects on current retail prices. Likewise, past changes in retail price and the ECTs are allowed to have unique effects on current retail prices. The orders of n and k represent the length of lagged terms for increases and decreases in crude oil and past retail prices changes respectively. We use Akaika Information Criterion (AIC) to decide optimal lag length.

This specification allows testing four types of asymmetries. First one is the asymmetry from crude oil to retail prices which test asymmetry in magnitude. In general, if $\beta_i^+ > \beta_i^-$, then price asymmetry (rockets and feathers) exists. This asymmetry is the one commonly analyzed in the literature. Secondly, asymmetry from past retail prices to current retail prices, which can be shown by testing $\gamma_j^+ \neq \gamma_j^-$. Third, asymmetry in the speed adjustments ($\lambda_1^+ \neq \lambda_1^-$); If $\lambda_1^+ \neq \lambda_1^-$, the convergence process (the speed of adjustment) is different depending on the direction of the deviation from the equilibrium. Finally, asymmetry in lag length in adjusmtent; If, for example, the lag length for positive crude oil price (or retail price) is not equal to that of negative crude oil (or retail price), then asymmetry exist in the lag structure. Thus, in general the rockets and feathers exists if at least one of the followings holds.

$$\beta_i^+ \neq \beta_i^- \quad (4)$$

$$\gamma_i^+ \neq \gamma_i^- \quad (5)$$

$$\lambda_1^+ \neq \lambda_1^- \quad (6)$$

$$n^+ \neq n^- \text{ or } \; k^+ \neq k^- \quad (7)$$

An F-test can be used to test the null hypotheses of symmetry for (4)-(6).

We use 10 years daily data starting from January 1, 2005 to December 2015.Crude oil prices are obtained from the U.S. Energy information Administration, and gasoline prices are obtained from Energy Market Regulatory Authority (EMRA) of Turkey. The Real Exchange Rates (Lira per US dollar) are obtained from International Monetary Fund (IMF). The sample data contains retail prices of firms that are located in the European part of Istanbul. Gasoline and crude oil prices are expressed in cent per liter.

5. Empirical Results and Discussion

As an initial step, we test whether the variables are stationary using Augmented Dickey Fuller test. Results presented in table 1 show that all series are stationary in the first difference.

We fail to reject the null hypotheses that series have a unit root (non-stationary) in level, but reject the null in the first difference. Thus, all series are stationary in the first difference (integrated of order one, I(1)).The residuals from equation (1) is stationary in level, I(0), which suggests that gasoline prices and crude oil prices have a long-run equilibrium, and that they are cointegrated.

We estimate equations (2) and (3) using OLS. The estimated coefficient for the long-run in equation (2), ϕ_1, is 1.08 suggesting that there is a full pass-through of crude oil shocks in the long-run which is consistent with previous literature (BCG, 1997 and Verlinda,2008). The estimated coefficients of (3) are presented in table 2. Results are consistent with the rockets and feathers literature.

As mentioned earlier, price asymmetry exists if current period positive crude oil price coefficient (β_i^+) is significantly greater than negative crude oil coefficient (β_i^-). The corresponding coefficients in table 2 are 0.10 and .04 supporting the existence of asymmetric price transmission hypothesis.

Error correction terms (λ_1^+ and λ_1^-) are both statistically significant and negative which implies that when retail gasoline price is above (below) their long-run equilibrium, there exists a convergence to the long-run equilibrium. The coefficient of positive ECT, .048 is greater than that of negative ECT, 0.011. This implies that the adjustment process is faster when the direction of the shock to crude oil is positive.

Looking at the lag structure, we observe that one lag is statistically significant in positive crude oil price changes, whereas five lags are significant for negative crude oil price changes.

This difference implies that the pass-through of a shock to gasoline market takes place faster when crude oil price increases than when it decreases.

In order to understand whether the estimated coefficients are statistically different, the null hypotheses in equations 4-6 are tested jointly. Table 3 reports the test results of these hypotheses. Results suggest that there is asymmetric price behavior in the short run in retail gasoline price in response to crude oil changes since we reject the null hypothesis $H_0: \beta_j^+ = \beta_j^-$. The null hypothesis that speeds of adjustments are equal ($H_0: \lambda_1^+ = \lambda_1^-$) is rejected confirming the existence of asymmetry in the speeds of convergence. As for the hypothesis that past positive and negative gasoline prices equally affect current gasoline prices, $H_0: \gamma_j^+ = \gamma_j^-$, we fail to reject it which suggests symmetric pass-through.

Our results are consistent with those of Alper and Torul (2009) , but contradict with Akcelik and Ozmen (2016) who find asymmetric past-through in diesel market, but no pass-through asymmetry in gasoline[6].

As mentioned earlier, the most common theoretical explanations for price asymmetry in the oil market are the oligopolistic coordination theory, the consumer search behavior, and the inventory management theory.

We believe that the market power argument is a reasonable explanation for the asymmetry in the Turkish gasoline industry. Considering the oligopolistic nature of the industry, market power exertion of a few large firms is potentially high. In addition, the concentration ratio is high in the gasoline market wherein the four largest firms hold about 60 percent of the market share. This

[6] This difference might be due to the econometric method used and the period of time covered.

high concentration suggests the presence of market power exertion which could explain the downward price stickiness at the retail level.

Consumer search costs do not seem to be the source of asymmetry considering the fact that consumers' search are not really high due to free and immediate access to price information on the internet. Besides, the gas station density in Istanbul is very high, which substantially decreases the cost of searching for an alternative gas station. Similarly, inventory managements could not be responsible for APT at retailer level. Gas stations do not have huge storage capacities, as a result of this, they obtain gasoline more frequently; once a week or even daily. This suggests that firms are unable to use their inventories to respond asymmetrically to crude oil changes.

6. Conclusion

In this paper, we test whether price asymmetry exists in the gasoline market of Turkey. We use daily data and asymmetric error correction model and find evidence that supports the common belief that retail gasoline prices respond more quickly to increases in crude oil prices than to decreases. Four types of asymmetry were tested: asymmetry from crude oil to gasoline; asymmetry from past gasoline prices to current gasoline price; asymmetry in the lag structure; and asymmetry in the speed of adjustments. We find the evidence for all kinds of asymmetries except the one from past gasoline prices to current gasoline price. We argue that market power may be the main potential cause of asymmetric price pass-through.

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Appendix

Table 1. Unit root test

Variable	ADFc	ADFct
Crude oil price		
Level	-2.099	-2.224
first difference	-23.321***	-23.320***
Retail price		
Level	-1.273	-2.224
first difference	-16.477***	-23.32***
Residuals		
Level	-8.934***	-8.926***
Critical Values		
1%	-3.441715	-3.97441
5%	-2.866446	-3.417807
10%	-2.569442	-3.131347

*** Stationary at 1% significance level. c represents unit root test with intercept, and ct represent with intercept and trend.

Table 2. Asymmetric ECM results: asymmetries in short-run prices and adjustment speeds.

Coefficient	Estimate	Coefficient	Estimate
ΔC_t^+	0.10***	ΔR_{t-1}^+	-0.03
	(0.034)		(0.047)
ΔC_{t-1}^+	0.06	ΔR_{t-2}^+	0.02
	(0.034)		(0.047)
ΔC_t^-	-0.04***	ΔR_{t-1}^-	0.09
	(0.033)		(0.063)
ΔC_{t-1}^-	-0.11***	ΔR_{t-2}^-	-0.80***
	(0.034)		(0.063)
ΔC_{t-2}^-	-0.096***	λ_{t-1}^+	-0.048***
	(0.031)		(0.004)
ΔC_{t-3}^-	-0.15***	λ_{t-1}^-	-0.011***
	(0.031)		(0.005)
ΔC_{t-4}^-	0.03**		
	(0.031)		
ΔC_{t-5}^-	-0.07**		
	(0.031)		

***** ,**** are 1% and 5% significance levels. Values in parentheses are standard error. Coefficients corresponding to ΔC are crude oil changes, ΔR are retail gasoline changes and λ are error correction terms.+ and – signs indicates positive and negative changes, respectively. ΔR_t is the dependent variable.

Table 3. Wald test results

Null Hypothesis	Value
$\beta_i^+ = \beta_i^-$	-0.368***
	(0.08)
$\gamma_j^+ = \gamma_j^-$	0.043
	(0.11)
$\lambda_1^+ = \lambda_1^-$	0.12*
	(0.04)

***is 1%significance level. Values in parentheses are standard errors.