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The Turkish Wheat Market: Spatial Price Transmission and the Impact of Transaction Costs

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Abstract:

Agricultural production is spread all over Turkey and the considerably different climatic and topographical conditions among the provinces lead to highly diversified agricultural production. Thus, is it reasonable to assume an integrated market all over Turkey? This paper analyzes spatial price transmission among 28 Turkish provinces with regard to wheat markets. We apply a bivariate threshold vector error correction model with two symmetric thresholds to account for transaction costs. We find an inner cluster of highly integrated provinces and identify the market size as a driving force of market integration. Furthermore, this study is unique in determining the minimum level of transaction costs. Our results suggest that the minimum transaction costs impede full market integration more often on smaller than on larger markets.

[L100, D230, Q110]

Key words:

Turkey; market integration; threshold vector error correction; new economic geography; transaction costs

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1 Introduction

Turkey spans more than 1,500 kilometers from east to west and some 700 kilometers from north to south. It covers seven highly different geographic regions, e.g., the Aegean and Mediterranean regions with an average temperature of 16°C and 18°C and the South-East and East-Anatolian regions with 8°C and 7°C, respectively. These considerably heterogeneous climatic and topographical conditions lead to highly diversified, locally adapted agricultural production. Since many villages are remote to information as well as to highway access, trade flows are fragmented and involve many middlemen. This implies that the costs of collection, transportation, and storage, i.e., transaction costs, are relatively high. The issue of transportation is especially crucial in Turkey, wherein the year 2006 transportation by rail contributed only some 9 billion ton-kilometers to the total transportation volume of 176 billion ton-kilometers, of which 95% were handled on the road (Turkstat 2006, pp. 235ff)¹.

Given the enormous geographic, climatic, and infrastructural differences within Turkey, is it reasonable to assume that transaction costs are low enough to allow for one integrated agricultural market all over Turkey? The aim of this paper is to analyze the spatial integration on the Turkish wheat market in the presence of transaction costs.

The agricultural sector accounts for about 30%² of the economically active population of Turkey, and several recent studies investigate this sector. Burrell and Oskam (2005), *inter alia*, provide an overview of Turkey's agriculture, food industry, and rural areas. Burrell and Kurzweil (2008) focus on effects of Turkish agricultural and trade policies on agricultural markets and welfare. They find poor transmission of border prices to producer prices in several markets and consider poor and variable price arbitrage within the country as a potential reason. Atici and Kennedy (2000, 2005) analyse potential effects of Turkey's EU-integration. Effects of agricultural and trade policies on the agricultural sector, consumers, and on the state budget are modelled using a partial equilibrium model and policy choices are analysed in a game theoretic framework. The authors find overall positive welfare effects of integration that come at the cost of higher income inequality, particularly reducing the income of Turkish producers of goods with low protection levels in the EU. Grethe (2007) evaluates simulation results of several studies on the integration of Turkish and EU agricultural markets as well as full integration of Turkey in the CAP (Grethe, 2004a, b, Eryugur & Cakmak, 2006, Togan et al., 2005). On average integration would lead to a decline in agricultural prices and production but effects would vary largely between regions due to spatially heterogeneous production structures. While the model results are conditional on equal (and in some cases perfect) transmission of duty paid-prices to provincial prices, Grethe concedes that this may bias results because spatial market integration within Turkey may be imperfect for some products.

Eryugur and Cakmak (2008) provide estimates of production, consumption, and welfare effects of integration with the EU and the CAP. Their simulations for 2015 predict a decline of crop products' prices and production as a result of EU integration relative to the reference scenario of non-integration. Koç et al. (2008) provide product specific results of simulations of effects of EU integration. Relative to their non-integration

¹The influence of road access and quality on food prices has been studied by, among others, Minten and Kyle (1999). The authors identify the proximity to roads and their quality as an important determinant of transportation costs, which form a large share in total transaction costs.

²Depending on the calculation method, this figure varies between 27% to 48.2% in the official statistics.

baseline scenario EU integration implies for wheat 44 percent lower prices, 5 percent lower production, and higher domestic demand and imports.

While there is a large body of literature on spatial market integration especially in developing countries, the integration among the Turkish provinces' agricultural markets has not been investigated so far. *Inter alia*, grain markets have been analyzed in China by Park et al. (2002) and in Ethiopia by Getnet et al. (2005), rice markets in Vietnam by Lutz et al. (2006), and maize markets in Ghana by Abdulai (2000). Rapsomanikis et al. (2003) provide an overview of spatial market integration among cash crop markets of developing countries. All these studies investigate the price transmission process while not accounting for the fact that transactions involve costs. For example, trade is associated with significant costs for information collection, communication, risk coverage, and finally transportation of the physical goods. Recently, Barrett (2001) and Barrett and Li (2002) criticize market integration studies based on price data exclusively for the neglect of trading behaviour by disregarding actual trade flows and transaction costs. In a comparison of several methods to analyze spatial market integration, Fackler and Goodwin (2001) identify the omission of transaction costs from the model approach as the most serious factor influencing the validity of empirical test on market integration.

Tackling this, Balke and Fomby (1997) propose a threshold error correction model to account for transaction costs. This work triggered a number of studies, e.g., by Lo and Zivot (2001), Goodwin and Harper (2000), and Goodwin and Piggott (2001), identifying significant transaction costs in market integration. Brosig et al. 2007 observe a decrease of transaction costs over time in Northeast China's soy bean markets suggesting improvement of market conditions.

In a spatial context, it is not always known a priori which price causes the other. Thus, the use of a vector error correction model seems appropriate. Hansen and Seo (2002) offer an estimation method for a threshold vector error correction model (TVECM) that identifies a threshold in the error correction process. Proposing a test on the statistical significance of the threshold, this model is capable of measuring market integration as reflected by a long-run price equilibrium while accounting for transaction costs. However, information on transaction costs or trade data is not needed since the model is based solely on price data. Applications to agriculture building on this method find significant transaction costs on the European pig market (Meyer 2004) and the nineteenth century U.S. egg market (Serra and Goodwin 2004). Recently, Balcombe et al. (2007) and Balcombe and Rapsomanikis (2008) use Bayesian methods to assess nonlinearities in spatial price behaviour, and Serra et al. (2006) use local linear regression techniques to estimate a TVECM.

In general, the threshold in a TVECM is interpreted as transaction costs associated with adjustment activities. In this study we explicitly focus on the minimum transaction costs. These are the costs that need to be exceeded by price deviations from the long-run equilibrium between two spatially separated markets to trigger any kind of price adjustment on a market. Such adjustment may occur, e.g., through physical shipment of goods between the markets, through trade with third markets, or just as a change of informed dealers' price offers trying to prevent distant competitors from entering the market. Each of such actions, shipment as well as the acquisition and utilization of price information, is associated with specific costs. The minimum transaction costs are those costs associated with the cheapest of the respective adjustment alternatives and the price deviation needs to exceed these costs to induce a price adjustment. Thus we assume that price adjustments always incur transaction costs.

Identification of minimum transaction costs is achieved by confining such interpretation of thresholds to those cases where the price adjustment below the threshold identified is

equal to zero. This guarantees that the threshold separates the regime in which price deviations are too small to outweigh transaction costs and trigger a price adjustment from the regime in which prices adjust to the long-run equilibrium.

To study market integration between the provinces of Turkey, we focus on wheat, which is the paramount crop within the Turkish agricultural sector (Bayaner 2002). Applying a variant of the threshold vector error correction model proposed by Hansen and Seo (2002), we aim to assess the impact of minimum transaction costs on the integration among the markets. We finalize the analysis employing probit regressions to evaluate the driving forces behind market integration and minimal transaction costs.

We contribute to the literature first by filling the gap of missing market integration studies on a Turkish agricultural commodity. Second, this study is unique in determining the minimum level of transaction costs. Third, we identify the market size as a significant factor influencing market integration and transaction costs. This is a crucial step beyond the pure analysis of market integration relations.

In this study we proceed as follows. The next section describes the Turkish wheat market and the data base of this analysis. Section 3 explains the model specification and presents the empirical results. Section 4 concludes and provides an outlook for further research.

2 The Turkish Wheat Market and Data Description

Wheat is the primary grain grown in Turkey accounting for 63% of total cereal production. The level of domestic wheat prices is influenced by an intervention price system, ad valorem import tariffs, and quantitative restrictions on wheat imports via a licence system (OECD, various issues). Since 2002 cereal intervention prices are no longer set by the Council of Ministers but by the Turkish Grain Board (TMO). Intervention prices are realized through intervention spots which are spread all over Turkey. Since these policies affect all provinces equally, they do not induce any interprovincial price differentials³.

The TMO fixes these prices based on actual market conditions such as costs of production, domestic and international stock levels, and forecasted production volume, aiming to establish market clearing prices. The TMO also functions as a buffer stock agency to stabilize prices and it is the major buyer of wheat in Turkey, accounting for 10-20% of total wheat production. Other wheat buyers are local merchants (middlemen) and the milling industry (Bayaner 2002).

Our empirical analysis is based on monthly grower prices for durum wheat prevailing in the different provinces of Turkey during a period of ten years from January 1994 to December 2003⁴. They are calculated as unweighted monthly averages of prices for different kinds of durum wheat reported by the provincial and district directorates for the first and the second week of each month.

To ensure that the spatial base of the province specific prices remains constant throughout the time period of the analysis, data of provinces founded after January 1994

³Wheat grower prices might vary according to the transportation costs from the production region to the intervention spot.

⁴We are very grateful to the statistical department of the Turkish Ministry of Agriculture and Rural Affairs for making this unpublished data set available.

and provinces that lost territory to the newly founded ones are not included. Thus, price data of 28 out of a total of 81 provinces are included in the data set, containing approximately 3,400 observations. The analysis covers each of the 9 agricultural regions of Turkey, with the regions Central North, Aegean, and Central South somewhat stronger represented than the other regions mirroring their importance for the wheat market in Turkey. We deflate the price data with the average monthly Turkish wholesale price index (WPI) retrieved from Turkstat (2007).

Figure 1 displays the real price development of the provinces Ankara (province 6)⁵, which has the lowest average price level of all provinces (2,672 Turkish Lira (TL)/ton), and Diyarbakir (21), which has the highest average price level (3,421 TL/ton).

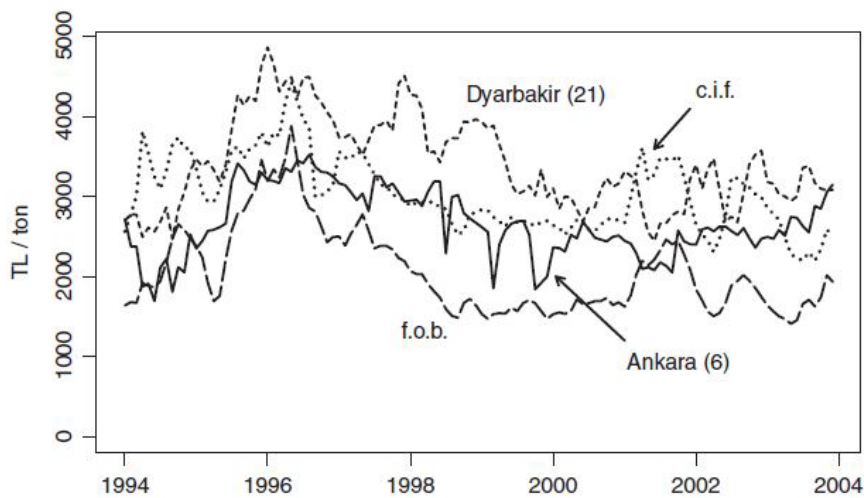


Figure 1 Development of Real Wheat Prices, 1994 to 2003.

In addition, figure 1 shows corresponding international import (c.i.f. Rotterdam) and export (f.o.b. EU ports) prices⁶ (IGC, var. iss.). The average export price is 2,065 TL/ton and is thus significantly lower than the price level of Ankara, the province with the lowest price level among the provinces considered.

The average prices in the provinces vary considerably across Turkey (table 1, column 8). While the provinces with prices above the national average are spread all over the country, a group of provinces in the center of Turkey, Afyonkarahisar (3), Ankara (6), Konya (42), Kirsehir (40), and Corum (19), have prices below the average. As integrated markets tend to have lower prices than non-integrated ones, the concentration of provinces with a low price level may hint to high market integration of the provinces in the center of Turkey.

⁵See Figure 2 and Table 1 as a legend for the geographic allocation of the provinces.

⁶The U.S.\$ quotation is converted to TL using the monthly average exchange rate provided by Eurostat (2006) and deflated using the general Turkish wholesale price index (WPI).

3 Model Specification and Results

3.1 Model and Estimation Strategy

To analyze the integration of spatially distributed Turkish wheat markets in the presence of transaction costs, we employ a TVECM as defined by Balke and Fomby (1997) and applied, e.g., by Goodwin and Piggott (2001) to measure spatial price transmission. We estimate the model utilizing a variant of the Hansen and Seo (2002) estimation procedure.

This model's major advantage is its ability to analyze the impact of transaction costs on market integration solely on the basis of price information. Yet, this requires that the markets are integrated. In this case the model is capable of identifying a lower bound of the relative costs associated with equilibrating price adjustment, e.g., through arbitrage trade. However, if markets are not integrated, which may be caused by high transaction costs, the impact of transaction costs can not be captured by this model.

A bivariate TVECM is based on the assumption that a long-run equilibrium exists between the two market prices p^a and p^b and thus that the data series are cointegrated. The short-run deviations from the long-run equilibrium enter the TVECM as the error correction term lagged by one period (ECT_{t-1}). A TVECM distinguishes price transmission regimes depending on the size of the error correction term. In the case of a two-regime TVECM applied in this study, price observations for which the absolute value of ECT_{t-1} is smaller or larger than a threshold variable γ are attributed to regime 1 and regime 2, respectively:

Regime 1

$$\begin{bmatrix} \Delta p_t^a \\ \Delta p_t^b \end{bmatrix} = \begin{bmatrix} \alpha_1^a \\ \alpha_1^b \end{bmatrix} + \sum_{i=1}^k \begin{bmatrix} \eta_i^{a,a} \eta_i^{a,b} \\ \eta_i^{b,a} \eta_i^{b,b} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^a \\ \Delta p_{t-i}^b \end{bmatrix} + \begin{bmatrix} \phi_1^a \\ \phi_1^b \end{bmatrix} [ECT_{t-1}] + \begin{bmatrix} \varepsilon_{1t}^a \\ \varepsilon_{1t}^b \end{bmatrix} \quad \text{if } |ECT_{t-1}| \leq \gamma \quad (1)$$

Regime 2

$$\begin{bmatrix} \Delta p_t^a \\ \Delta p_t^b \end{bmatrix} = \begin{bmatrix} \alpha_2^a \\ \alpha_2^b \end{bmatrix} + \sum_{i=1}^k \begin{bmatrix} \eta_i^{a,a} \eta_i^{a,b} \\ \eta_i^{b,a} \eta_i^{b,b} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^a \\ \Delta p_{t-i}^b \end{bmatrix} + \begin{bmatrix} \phi_2^a \\ \phi_2^b \end{bmatrix} [ECT_{t-1}] + \begin{bmatrix} \varepsilon_{2t}^a \\ \varepsilon_{2t}^b \end{bmatrix} \quad \text{if } |ECT_{t-1}| > \gamma$$

with η_i capturing the lagged short-run adjustment, k denotes the number of lags, ε_t a white noise error term, and ϕ the respective speed of adjustment towards the long-run equilibrium. We include $a, b=1, \dots, N$ number of provinces in the analysis with $a \neq b$. In this model the speed of adjustment towards the long-run equilibrium as well as the intercept coefficient may differ depending on the size of the deviation from the long-run equilibrium.

In this two-regime TVECM it is simplifying assumed that transaction costs are symmetric in a double sense. First, a single threshold parameter γ implies that the minimum size of deviations from price equilibrium that triggers adjustment is the same for negative and for positive deviations, i.e., irrespective of whether p^a is below or above its equilibrium ratio in respect of p^b . Second, a single adjustment vector $[\phi_2^a, \alpha_2^a]$ effective for positive

and for negative deviations (with the absolute size exceeding the threshold) implies that the speed of adjustment is assumed to be the same for these two directions of deviation from equilibrium.⁷ However, our objective to identify a spatial pattern of market integration entails dealing with a large number of individual bilateral analyses. Given our limited computational resources this requires to keep each of these analyses relatively simple. Therefore we confine our analysis to a two-regime TVECM.⁸ In particular, our approach is to first determine the most obvious threshold γ in a line search and then to test its significance by assessing how different the two adjustment regimes are.

To interpret the obtained threshold as the minimum level of transaction costs incurred in spatial arbitrage or any other kind of market adjustment requires the additional restriction that ϕ_1 is not statistically different from zero. If ϕ_1 differs significantly from zero, deviations from the long-run equilibrium are corrected in regime 1 also. Hence, if adjustment is worthwhile even below the threshold, we can not conclude that in this range transaction costs prevent any adjustment. Then there are rather two regimes distinct in respect to their speed of adjustment, meaning, for instance, that small deviations from the equilibrium price ratio are corrected slower than large ones and may also differ in other short-run adjustment parameters. However, in this case, the threshold can not be interpreted as a proxy for the minimum transaction costs that are associated with interprovincial market adjustment. We apply a Wald test to check if the null hypothesis that ϕ_1 is not statistically different from zero is rejected.

This model allows us to retrieve twofold information. First, we can establish whether the two markets are integrated. Second, if the markets are integrated this model allows us to investigate the influence of transaction costs. In this study, we use a dataset of 28 provinces allowing us to study market integration in 756 cases. This yields a spatial pattern of both integration on the Turkish wheat market and the size of the minimum transaction costs for the integrated markets at the same time.

The estimation procedure for each pair of provinces analyzed takes five steps. First, we test the individual price series' stationarity using the augmented Dickey-Fuller (ADF) unit-root test. If integration of order one can be confirmed, we test for cointegration of the pair of price series applying the Johansen method. In the third step we test for market integration using the null hypothesis

$$\beta_1 = 1 \text{ against the alternative hypothesis } \beta_1 \neq 1$$

in the long-run equilibrium relationship

$$p_t^a = \beta_0 + \beta_1 * p_t^b + u_t \quad (2)$$

A cointegration vector with β_1 different from unity would allow absolute price differences between provinces to change proportionally with the level of (deflated) prices and to become potentially large. Although, as Goodwin and Piggott (2001) point out, there may be reasons for such situations to conform with market integration (e.g., nonconstant

⁷However, the distinction between parameters ϕ_1^a and ϕ_1^b according to the superscripts *a* and *b* allows for adjustments in market "a" to market "b" to be different from adjustments in market "b" to market "a". This distinction is likely to be appropriate in particular for trade between a large (central) and a small (peripheral) market.

⁸One run through the chosen two-regime model for all 756 relations took approximately 40 hours.

tariffs, risk premia, brokerage fees), we find the restriction $\beta_1 = 1$ adequate for our study considering that price adjustment frequently occurs with only little or no actual trade. Hence, failure to reject the null hypothesis leads us to accept that the two respective markets are integrated.

Estimating the TVECM in the fourth step requires determining the threshold parameter γ . Differing from the approach suggested by Hansen and Seo (2002), in which a concurrent grid search over possible values for the cointegration vector β and the threshold variable γ is conducted, we follow an alternative procedure offered by Meyer (2004). For all price pairs for which we find that markets are integrated, we retrieve the ECT t-1 from the cointegration regression given by equation 2 with $\beta_1 = 1$. We define the TVECM and determine the threshold value γ by conducting a line search over the range of all possible values of the threshold variable. We choose that value of γ as the threshold, which minimizes the log determinant of the error covariance matrix of (1):

$$\zeta(\hat{\gamma}) = \min \left(\log \left| \frac{1}{n} \sum_{t=1}^n \hat{\varepsilon}_t(\gamma) \hat{\varepsilon}_t(\gamma)' \right| \right) \quad (3)$$

This method is in line with Escribano and Navarro (2002) who show that one can estimate the cointegrating vector superconsistently even while neglecting non-linearities. We first estimate the TVECM with the number of lags k set to one. If the Breusch-Godfrey test indicates that the residuals are autocorrelated for one province pair, the estimation is repeated with two lags. We did not find autocorrelation in a model with 2 lags for any province pair. A trimming parameter π_0 is set equal to 0.10 to ensure that each regime is estimated based on at least 10% of the total observations. To test for robustness, we compare the results of another model estimation with π_0 set equal to 0.05. As the fifth step, we test the statistical significance of the threshold parameter applying a supremum Lagrange-Multiplier (supLM) test, developed by Hansen and Seo (2002). Since γ is not identified under the null, conventional test statistics have non-standard distributions. Therefore, we use the fixed regressor bootstrap to calculate appropriate p-values for the supLM test within 10,000 replications⁹.

3.2 Empirical Results

We present the results of the threshold vector error correction model applied to 28 Turkish provinces in three parts. We first give the general statistical results, followed by the main findings with regard to market integration. The findings concerning the transaction costs form the third part. Finally, we introduce the results of our analysis on the determinants of market integration and the observed pattern of minimum transaction costs.

⁹Within the fixed regressor bootstrap algorithm, the linear model is simulated by holding all regressors of the model fixed at their sample values, whereas the residuals of the model are multiplied by normally distributed random draws. The supLM test statistic is calculated for each simulated model. The p-value corresponds to the percentage of simulated supLM values which exceed the actual supLM of the original sample.

3.2.1 General Statistical Results

Table 1 holds the statistical results for the 28 provinces included in this study¹⁰. Column “MI” provides the numbers of other provinces’ markets that a province’s wheat market is found to be integrated with. We arrived at these figures in a procedure of several steps. First, the augmented Dickey-Fuller test confirms that all price series are integrated of order one, with neither an intercept nor a trend. Hence, the use of a cointegration model is necessary.

Table 1: General Statistical Results

No.	Name	<i>MI</i>	<i>MI%</i>	<i>MIneigh%</i>	<i>TC</i>	<i>TClevel%</i>	<i>price dif %</i>
		(3)	(4)	(5)	(6)	(7)	(8)
2	Adiyaman	15	54	33	1	1.56	-1.83
3	Afyon	21	75	83	0		-1.51
5	Amasya	9	32	0	1	7.25	1.12
6	Ankara	18	64	75	5	20.01	-8.79
7	Antalya	6	21	0	0		1.02
10	Balikesir	11	39	0	0		-2.79
15	Burdur	2	7	0	0		-1.59
16	Bursa	12	43	0	1	12.10	-1.57
18	Cankiri	9	32	67	2	15.82	-1.19
19	Corum	14	50	67	2	13.88	-4.90
20	Denizli	6	21	33	1	5.07	-1.13
21	Diyarbakir	13	46	100	1	12.26	16.77
23	Elazig	21	75	50	1	7.41	2.55
24	Erzincan	13	46	50	2	8.45	-6.36
26	Eskisehir	12	43	75	1	16.42	-4.50
29	Gümüşhane	19	68	100	1	8.32	5.24
31	Hatay	12	43	0	1	3.92	-0.46
32	Isparta	11	39	50	1	6.23	6.34
35	Izmir	9	32	0	1	8.64	-3.15
36	Kars	13	46	0	1	10.26	1.49
37	Kastamonou	13	46	50	2	9.48	5.40
38	Kayseri	23	82	100	2	4.15	0.07
40	Kirsehir	17	61	100	3	5.36	-0.83
42	Konya	14	50	60	0		-2.00
43	Kütahya	6	21	20	0		-2.93
44	Malatya	3	11	20	0		8.83
45	Manisa	11	39	0	2	29.80	-1.54
46	Kahraman Maras	7	25	33	2	23.79	-1.76

Source: Own calculations. EViews 5.1

Legend: Column 3: number of marketsintegrated with the resp. provinces’ market

Column 4: relative number of integrated markets [%]

Column 5: relative number of integrated neighboring markets [%]

Column 6: number of markets with revealed minimum transaction costs

Column 7: average level of minimum transaction costs relative to wheat price [%]

Column 8: % difference of mean price in this province relative to mean price of all provinces

The trace statistic of the Johansen cointegration test conducted for 756 pairs of provinces suggests that a statistically significant linear long-run relationship exists in 440 cases (app. 60% of all pairs of price data). Restricting the slope coefficient of the long-run relation to unity is accepted in 340 cases (app. 45%) indicating that the respective

¹⁰Further results are available from the authors upon request.

markets are integrated. Thus, nearly half of all possible province pairs in Turkey share an integrated wheat market in which prices do not drift apart in the long-run.

Given the cointegration coefficients the TVECM is estimated next. The coefficients of determination (system R^2) of all 340 pairwise regressions underline the relevance of the threshold model. The average value of the coefficient of determination is 6% for the linear VECM. Models for price pairs with a significant threshold (equation 1) have a coefficient of determination of 16% on average in regime 1 (i.e. based on the observations with error terms *below* the threshold) and 60% in regime 2 (i.e. based on the observations with error terms *above* the threshold). Hence, explaining price movements with deviations from spatial equilibrium that are above a certain threshold considerably increases the fit of the model. Other threshold applications that report values of R^2 also find increases compared to the linear or asymmetric ECM (see inter alia Huang and Yang, 2006). Looking at the results of all province pairs, one finds nearly 27% of all coefficients of the TVECM significant in regime 1, whereas this number is considerably higher, approximately 35%, in regime 2, which adds to the pattern of the R^2 .

3.2.2 Pattern of Market Integration

Based on the result that the markets of 340 province pairs are integrated, we further investigate the spatial distribution of market integration.

As one of the main results, our analysis reveals that the structure of market integration (MI) of the provinces in Turkey is heterogeneous. The degree of integration of a province's market with all other markets ranges between about 7% to over 82% (table 1, column 4). Similarly, the integration of a province's market with the markets of directly neighbouring provinces varies significantly, ranging between 0% and 100% (table 1, column 5). Furthermore, the markets in the geographic center of Turkey seem to be integrated with each other while border provinces seem to be more separated from other provinces' markets, indicated by a low degree of market integration. This is depicted in figure 2. The background shade of a province indicates the share of other provinces' markets, which are integrated with the market of this province, whereas the dashed, ruled, and checkered patterns indicate the share among directly neighbouring provinces' markets, which are integrated with the market of this province.

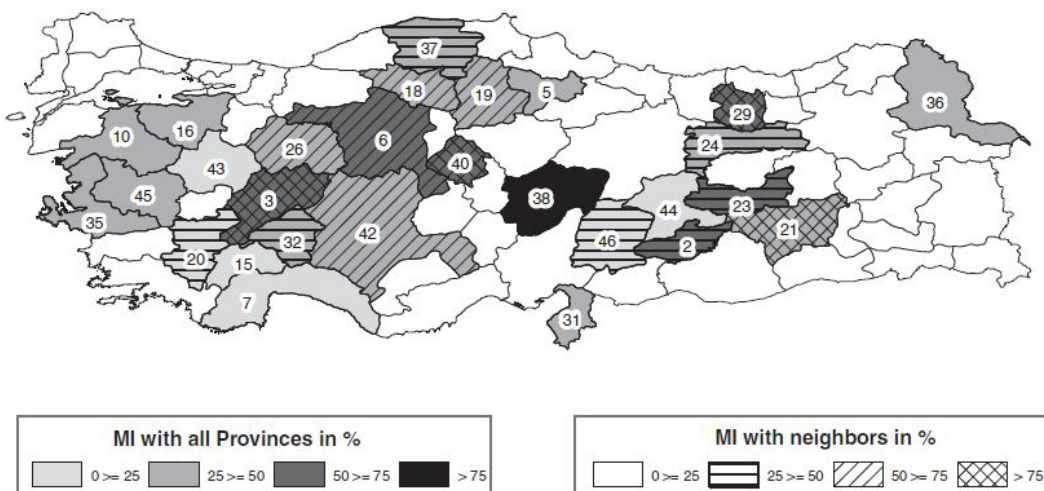


Figure 2 Spatial Distribution of Market Integration.

In more detail, the center of integration spreads from Afyon (3) in the west through Kayseri (38) to Elazig (23) in the east. These three provinces have an integrated market with more than 75% of all other provinces. Such a high level of market integration is not found for any single province at any border of Turkey since none of the latter provinces is integrated with more than 50%. Furthermore, local market integration is rather high in this core region, where the provinces share an integrated market with up to 100% of the respective neighboring provinces. Similar to the overall integration, such a high level of local integration cannot be established for any border province. The most remarkable example of markets that don't seem to be locally integrated is an area in the west of Turkey containing the provinces of Balikesir (10), Bursa (16), Izmir (35), and Manisa (45). Here, not a single province is integrated with its neighbor, which is especially startling, since, e.g., Bursa has an integrated market with 12 other provinces.

Hence, there is a significant difference in the structure of market integration between the peripheral provinces in the outer areas and the borders of Turkey on the one side and the geographic center on the other side. The provinces in the center form a large integrated market in which prices do not drift apart in the long-run. The peripheral provinces, in contrast, do not seem to react to their neighbors' prices although some of them are integrated with almost 50% of all other provinces. This finding might be rooted in the high level of transaction costs that many of these provinces face.

3.2.3 Pattern of Transaction Costs

As the second main result of this study, we reveal the spatial pattern of transaction costs that impede full market integration. Of the 340 province pairs that share an integrated market, 66 have a significant threshold. In other words, a two-regime threshold model represents these province pairs better than a linear model. This finding is robust to choosing π_0 since we find the same province pairs to have a significant threshold in two separate sets of regressions, setting π_0 to 0.10 and 0.05, respectively. For 32 of these 66 province pairs, the Wald test rejects the null hypothesis that the adjustment coefficients in the inner regime ϕ_1 are not statistically different from zero. Thus, adjustment takes place throughout the full range of deviations from the long-run equilibrium and the identified threshold merely distinguishes two regimes differing in the speed of adjustment. One cannot interpret the thresholds as minimum levels of transaction costs in these cases, as price adjustment occurs below the thresholds, i.e., economic action is worthwhile (c.f. section 3.1). In the remaining 34 cases with a significant threshold, the estimated coefficient ϕ_1 is not different from zero. Hence, the threshold separates a regime without price adjustment from a regime with a significant adjustment of prices towards the long-run equilibrium. Since deviations of the price from the long-run equilibrium are not corrected if the deviation is smaller than the threshold, the identified threshold marks the minimum transaction costs associated with any kind of adjustment action.

The number of the price pairs of a province for which minimum transaction costs are identified is given in column 6 of table 1. For 7 provinces, the model does not identify a minimum level of transaction costs for any respective price pair, which may be due to well functioning markets, where the true minimum costs of a transaction are lower than the observed price deviation. The minimum transaction costs vary strongly between 1.56 and 29.80% of the average provincial wheat price (table 1, column 7).

As an example, for the province Kahraman Maras, minimum transaction costs are identified for 2 out of the 7 markets (29%) with which this province is integrated. Their average level amounts 23.79% of the province's mean wheat price.

Figure 3 shows the distribution of the transaction costs among the Turkish provinces by foreground pattern while the background shade represents, as in figure 2, the degree of integration with all other provinces. In contrast to the pattern of market integration, one cannot visually identify a particular spatial pattern of minimum transaction costs.

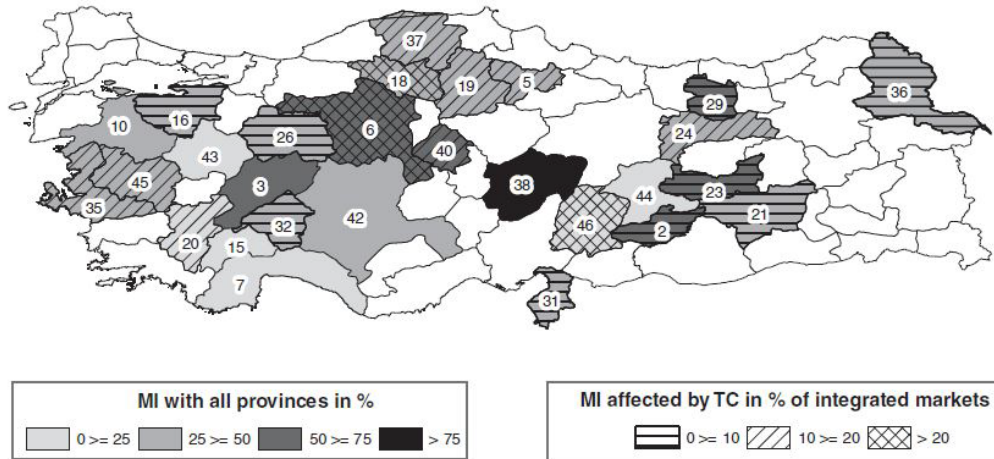


Figure 3 Spatial Distribution of transaction Costs Affecting Market Integration. Provinces Without Numbering were Excluded from Empirical Analysis. Source: Authors' Calculations and Representation.

The average level of the minimum transaction costs amounts to about 11% of the wheat price. Results suggest that the degree of market integration and the level of transaction costs are related to each other. While provinces integrated with less than 50% of all other markets have a level of minimum transaction costs of about 12% of the wheat price on average, the level of minimum transaction costs reduces to 9% once the provinces are integrated with more than 50%. Furthermore, among the integrated relations, the share where transaction costs prevent price adjustment in the inner regime differs between provinces with different degrees of integration: it is 25% on average for provinces which are integrated with less than 50% of other provinces and 18% on average for the remaining provinces, those with a higher percentage of integration relations. Thus, the higher the degree of overall integration of a province, the lower is the impact of transaction costs. For example, the province Adiyaman's degree of market integration is relatively high since it is integrated with 54% of all provinces, though, only one market relation reveals minimum transaction costs (table 1, column 6).

So far, we find an uneven pattern of market integration across the provinces. Furthermore, the level of minimal transaction costs varies strongly. There seems to be an inverse relation between market integration and transaction costs. As a first step in understanding this relation, we investigate driving forces behind it.

3.2.4 Analyzing the Determinants

From the group of highly integrated markets in the center of Turkey, one could assume that significant adjustment to prices of other provinces diminishes with distance. This would be consistent with the effect of increasing costs of transportation. To handle a set of 28 provinces, we measure distance as the road mileage between the capitals of a province pair. In a probit model with the market integration as binary dependent variable, the distance as explaining variable turns out to be insignificant. Likewise, we cannot explain the level of transaction costs with the distance between two markets. As pointed out by Goodwin and Piggott (2001), we expect that the greater the distance between two

markets, the higher the value of the identified threshold in the model. Since our results are very counterintuitive, further research should investigate the impact of distance on market integration in a more detailed manner. In particular, more detailed information is required about the behaviour and possible actions of the wheat traders on the markets. How many traders sell on the central compared to the border markets? Which information sources do the traders use to decide when and where to sell? What kind of spatial arbitrage actions are possible? For example, Goodwin and Piggott (2001) distinguish explicit arbitrage from more implicit arbitrage¹¹.

Neoclassical theory neglects the size of a market as a determinant for market integration. Nevertheless, we try to explain the detected pattern of market integration and transaction costs with the size of the wheat market within each province. This approach is similar to Krugman (1991), who emphasizes the size as well as the transportation costs that may lead to an industrial core and agricultural periphery within an economy. Our hypothesis is that large markets show lower transaction costs and a higher degree of integration than small ones. We define market size as the total production and processing capacity within a province. As demand and supply should eventually coincide and are probably strongly correlated, we use demand and supply as single non-constant explanatory variables in two separate regressions. The sum of the individual provinces' market sizes gives the market size of a province pair. Since two provinces can either have integrated markets or not, we utilize a binary choice model. By this approach, we allow market size to be one reason for the different degrees of integration among Turkish provinces.

Table 2: Determinants of Market Integration

	<i>mibin</i>	
<i>c</i>	.034*** (0.13)	-0.35*** (0.11)
<i>de</i>	3.17*10 ⁻⁷ ** (1.61*10 ⁻⁷)	
<i>su</i>		2.08*10 ⁻⁷ ** (8.3*10 ⁻⁸)
<i>N</i>	378	378
<i>R</i> ²	0.75	1.21
<i>prob</i>	0.0487	0.0120

Source: Own calculations. EViews 5.1.

Legend: Results of probit regressions of the binary variable *market integration* on variables listed in rows. *, **, *** denote significance at the 10%, 5%, or 1% level, respectively. Standard errors in brackets. McFadden *R*² is reported.

Table 2 holds the results of two probit regressions with market integration (*mibin*) as the dependent variable and market size (plus a constant) as the independent variable. In one regression, market size is measured by the size of the market demand (*de*), whereas market size is measured by the size of the market supply (*su*) in the second. The results for model 1 and model 2 are given in the first and second column of table 2, respectively. They show that the probability of two provinces to have an integrated market rises

¹¹ In the case of explicit arbitrage, traders transport grain from one market to the other if the spatial price difference exceeds the transport costs. More implicit arbitrage results from producers (or dealers) who consider price differences between spatially separated markets while planning the quantities they supply. This should result in price differences, which do not exceed the difference in the costs of selling in one market versus the other (Goodwin & Piggott, 2001).

significantly with increasing market size. Hence, the larger the combined markets of two provinces, the more likely it is that the markets are integrated, regardless of whether market size is measured in terms of supply or demand.

In the next step, we investigate the factors that imply that price transmission between two provinces is hampered by transaction costs, in other words that significant thresholds are identified by the TVECM. Since the application of the TVECM to detect the minimum level of transaction costs between two provinces requires that the markets are integrated, the transaction costs are not identified in case market integration between two provinces is prevented by prohibitively high transaction costs.

We take this into account within a probit regression framework by constructing a binary variable transaction costs, which is equal to 1 for the market pairs for which either transaction costs are observed, i.e. that a significant threshold is identified and no adjustment is found in the inner regime, or for which market integration can not be observed. The transaction cost variable is equal to 0 for the remaining province market pairs for which price transmission is not constrained by transaction costs i.e. markets are integrated linearly or with a threshold and significant adjustment on both of its sides.

We estimate two model specifications. The binary variable transaction costs (tc_{bin}) is regressed on the explanatory variables demand (de) plus a constant in one model and on supply (su) plus a constant in a further model. From table 3 it becomes evident that supply and demand both significantly influence the probability that transaction costs impede price transmission between markets. The negative sign of the significant coefficients of the variables de and su indicates an inverse relation. Hence, the larger the markets of two provinces, the smaller is the probability that transaction costs prevent price adjustment.

Table 3: Determinants of Transaction Cost

	tc_{bin}	
c	0.42*** (0.13)	0.42*** (0.11)
de	-2.64* 10 ⁻⁷ * (1.61* 10 ⁻⁷)	
su		-1.71*10 ⁻⁷ ** (8.3*10 ⁻⁸)
N	378	378
R^2	0.52	0.83
$prob$	0.1024	0.0394

Source: Own calculations. EViews 5.1.

Legend: Results of probit regressions of the binary variable *transaction cost* on variables listed in rows. *, **, *** denote significance at the 10%, 5%, or 1% level, respectively. Standard errors in brackets. McFadden R^2 is reported.

Analyzing driving forces of market integration and transaction costs reveals the importance of the size of the provinces' markets. Results suggest that small markets may not have volumes large enough to establish cheap and efficient trade relations. Once a market grows beyond a certain size, transaction costs decrease to a level, which does not disturb trade. Thus, large markets lead to low costs of transaction, which facilitate integrated markets. Nevertheless, we stress that further analysis beyond our initial contribution could offer intriguing new insights into this interesting area.

4 Conclusion and Outlook

The wide range of geographic and economic differences among the Turkish provinces puts the general assumption of one single market into doubt. This paper studies the integration of wheat markets in Turkey. Transaction cost of integrating adjustment are accounted for by applying a symmetric two-threshold vector error correction model which is estimated based on monthly wheat price data.

The results suggest that about 45% of all province pairs exhibit a long-run price equilibrium. Furthermore, we find for 90% of these province pairs with a long-run equilibrium that price adjustment to the long-run spatial equilibrium are not hampered by significant transaction costs. Thus, for 40 % of all province pairs analysed we do not find indications of separated markets. Regional differences are tremendous with regard to the strength of market integration. There is a geographic center of highly integrated provinces which can be treated as one large market across provincial boundaries. In contrast, the markets of the peripheral provinces at the border of Turkey have a lower degree of market integration on average.

In probit regressions, we identify the market size as a determinant of market integration and transaction costs. We find that the larger a market, the less likely it is that transaction costs prevent adjustments to price disequilibria and the more likely it is that two markets are integrated. Low integration of wheat markets particularly of peripheral provinces must be considered an obstacle to agricultural and economic development because potential gains from interprovincial trade and from specialisation are foregone.

We expect that the 44% decrease in the wheat producer price predicted for the case of Turkey's EU accession (Koç et al., 2008) would substantiate slower and to a lower degree in the peripheral provinces with relatively low market integration than in the provinces in the center with highly integrated markets. Therefore, wheat producer prices will remain higher in the peripheral provinces implying that consumers' welfare gains due to EU accession would be lower than expected.

Also, our results indicate that further development of provincial wheat markets which are still small but exhibit the potential to grow is particularly hampered by transaction costs. This result might be generalized and hold for other agricultural markets as well. Transaction costs could be reduced by investments in transport and communication infrastructure as well as market transparency. To optimally target these investments, it is necessary to identify the peripheral regions with a high agricultural potential to grow and to determine the deficits in market infrastructure.

One limitation of our model stems from the fact that regional prices are influenced by centrally administered intervention purchases. Therefore, price comovement can not be attributed to well functioning interprovincial arbitrage activities exclusively. Inter-regional price co-movement might rather result from the governmental intervention even in the presence of low market integration. However, if weakly co-moving prices are still observed in different regions, this can clearly be interpreted as an indicator of low market integration.

In addition, there are some limitations of the model, which might have caused a bias in estimating the thresholds leading to imprecise estimates for the transaction costs. In particular, restricting the model such that the thresholds are symmetric might imply that the estimated thresholds are overstated. Also, the model assumes that transaction costs are constant although the underlying time period comprises 10 years. Transaction costs might have changed, e.g., due to investments in the transport infrastructure. Furthermore, the estimation is based on a likelihood function, which might not be unimodal but rather jagged, so that parameters might not be identified within certain regions of the parameter

space (Balcombe&Rapsomanikis, 2008). Besides, we assume that the transition from one regime to the other regime is sharp and discontinuous. However, transaction costs might differ between economic agents implying that the regime switch is rather smooth and continuous. Several of these issues could be overcome by estimating the TVECM based on non-parametric methods, as, e.g., local polynomial fitting or Bayesian methods. These methodological issues should be accounted for in future research. Nevertheless, this study demonstrates that our model approach is capable to identify the basic spatial pattern of market integration in Turkey.

In future research, factors beyond transaction costs which influence the degree of market integration should be accounted for in the framework of our analysis. In particular, low market integration could also result from market power of intermediate traders. Traders might increase their profits by transmitting price increases on the central market to the peripheral market at a lower speed than price decreases. This issue could be enlightened based on wheat price data of different stages of the supply chain within a vertical price transmission model, which should be supplemented by expert interviews.

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