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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 the spatial price transmission among 28 Turkish provinces. Applying a bivariate threshold vector error correction model allows to account for transaction costs without having direct information of these. The results suggest that there is an inner cluster of several provinces that can be treated as one large integrated market. However, the degree of market integration decreases in the outer provinces of Turkey. Although transaction costs are significant for nearly all provinces, Ankara clearly stands out, showing transaction costs with every other province. The observed economic variables fail to explain this behavior. Hence, social networks as relevant factor for the interactions on the Turkish wheat market come into play. A band of non-adjustment is only established for a minority of those pairs that show a threshold. Thus, one has to critically assess the applicability of such a threshold model to analyze the market behavior of spatial price transmission.
1 Introduction

On October, 3rd 2005 official negotiations for Turkey’s accession to the European Union (EU) started. With its 783,562 square kilometers, Turkey is larger than any single country in the EU. The agricultural sector is of special interest, since agriculture contributes 10 percent (TurkStat, 2005, p. 357) to the Turkish gross national product and about 35 percent of the economically active population are employed in this sector. Agricultural production is spread all over Turkey. The highly different climatic and topographical conditions lead to diversified agricultural production. Thus, is it reasonable to assume an integrated market all over Turkey? In Turkey as well as the EU, the agricultural workforce is decreasing over time. Hence, an interesting question is whether prices that do not adjust to decreasing trends in other provinces hinder farmers to leave the sector. Given the tremendous impact of the agricultural sector, there is considerable scope for rapid adjustment. I.e., if farmers gave up agriculture, they could engage in other economic sectors and enhance the overall welfare of Turkey more than remaining farmers. Hence, the analysis of agricultural price formation processes in Turkey is extremely relevant.

Only few analyses focus on the economic situation of the Turkish agriculture. Burrell and Oskam (2005), inter alia, provide an up to date overview of Turkey’s agriculture, food industry and rural areas. They take Turkey’s accession in 2015 as a working hypothesis and emphasize the long-term processes and institutional developments. An overall positive effect is also stated by Cakmak and Kas-
NAKOGLU (2002) who apply a regional agricultural sector model to evaluate the effects of EU membership. The authors expect a decreasing producer surplus, which will be outweighed by an increase in consumer surplus. Similarly Arıcı and KENNEDY (2000) conclude that keeping the status quo is beneficial for the Turkish agricultural sector. The potential agricultural welfare losses of joining the EU are said to be offset by gains in the rest of the economy. Looking beyond the economic impact, CAKMAK (2004) considers the structural and institutional adjustment ability of Turkey as relevant factors easing the accession process.

The aim of this study is to analyze market integration and assess the impact of transaction costs in the Turkish agricultural sector. Wheat is the paramount crop within the Turkish agricultural sector (see BAVANER, 2002, p. 3). Thus, using monthly wheat prices at farm gate level from 1994 to 2003 provides a feasible framework for the analysis. BARRETT and LI (2002) criticize recent studies based on price data alone for their neglect of transaction costs. The Turkish agriculture is marked by subsistence and semi-subsistence farming with low productivity, high hidden unemployment and low competitiveness, fragmented trade flows and many middlemen. Thus, one can expect the costs of collection, storage, marketing, and processing to be relatively high. In their seminal paper, HANSEN and SEO (2002) develop a model that is capable of measuring market integration, as the speed of price adjustment, and taking account of transaction costs at the same time. In a vector error correction model framework, it provides the feature to test for significance of a threshold in the price transmission path. This papers’ contribution to the literature is twofold. First, the analysis of the Turkish wheat market provides valuable information about the pattern of market integration of the agricultural market in Turkey. Second, the application of the threshold vector error correction
model to more than 400 price pairs allows to assess the properties of the model in such a large data set.

The next section describes the data base and the model is presented in section 3. The empirical results are given in section 4, followed by conclusions and an outlook for further research.

2 Data Description

The basis for this analysis are prices for durum wheat received by farmers, which were collected by TMARA (2006) on provincial level for the period of January 1994 to December 2003. To eliminate the effects of inflation – the price level rose by approximately 12,000% – as common factor on market integration, the prices were deflated by the general wholesale price index (WPI). This is the sole manipulation, since neither seasonal nor trend adjustment is made. Provinces founded after January 1994 are excluded from the sample, as well as provinces that lost territory to the newly founded ones. This shall ensure that the provincial prices have the same spatial base throughout the observation period. The 28 price series employed cover all nine agricultural regions. The price development of two example provinces is displayed in figure 1, where Ankara (province six) has the lowest average price among all provinces, and Diyarbakir (province 21) has the highest.

——— figure 1 about here ———–

In order to class the national prices, they are compared to matching international import (c.i.f. Rotterdam) and export (f.o.b. EU ports) prices (IGC, var. iss.). The U.S.$ notation is converted to Turkish Lira using the monthly average exchange
Figure 1: Development of Real Wheat Prices from 1994 to 2003

Legend: Price developments for provinces 6 and 21
c.i.f. Rotterdam, No.2 dark northern spring 14%
f.o.b. EU specified zones, standard grade
prices in TL per ton, deflated by WPI rate provided by Eurostat (2006) and deflated using the general WPI. The average export price was 2,065 TL/ton, whereas Ankara has an average of 2,672 TL/ton. The import price is 3,039 TL/ton on average in contrast to 3,421 TL/ton in Diyarbakır. Thus, one can conclude, as figure 1 shows, that the Turkish prices are well above the international ones, which is due to the governmental price support schemes. For further analysis, natural logarithms of the prices are used.

3 Model Specification

A workhorse in the analysis of market integration and price transmission is the error correction model (ECM) in its manifold variations. The deviations from the long run equilibrium are given by the value of the error correction term (ECT).
Figure 2: Error Correction Paths

Legend: Error correction path assumed under (1) the linear ECM and (2) the threshold ECM. $c_1, c_2$ are the threshold values.

Figure 2 shows the price change ($\Delta p$) as a function of the deviation (ECT). Line (1) depicts the linear relationship, where any deviation leads to a correcting price change, not considering transaction costs. The path depicted as line (2), in contrast, is flat within the interval $[c_1, c_2]$. Thus, the ECT serves as threshold variable, dividing the price adjustment process between the regimes. This feature allows to account for non-linearities due to e.g. transaction costs that prevent adjustments to small deviations in the inner regime.

Two thresholds $c_1$ and $c_2$ are given in figure 2. From the analysis of the absolute values of the ECT it follows that $-c_1 = c_2$. However, a major drawback for two-threshold ECMs is the missing econometric test for significance of the two thresholds in a multivariate ECM setting. In their seminal paper, Hansen and Seo (2002) tackle this by introducing a formal method to search for a single
threshold in a dataset. In a bivariate model, they implement maximum likelihood estimation (MLE) for a joint grid search over the single threshold value $\gamma$ and the cointegrating vector $\beta$. Their threshold model is given as

\begin{align}
\text{Regime 1 (inner)} \\
\begin{bmatrix}
\Delta p^a_t \\
\Delta p^b_t 
\end{bmatrix}
= 
\begin{bmatrix}
\alpha_1 \\
\alpha_2 
\end{bmatrix}
+ \sum_{i=1}^{k} 
\begin{bmatrix}
\beta_{i,a}^{a,a} & \beta_{i,b}^{a,b} \\
\beta_{i,a}^{b,a} & \beta_{i,b}^{b,b} 
\end{bmatrix}
\begin{bmatrix}
\Delta p^a_{t-i} \\
\Delta p^b_{t-i} 
\end{bmatrix}
+ \begin{bmatrix}
\phi_{i}^a \\
\phi_{i}^b 
\end{bmatrix} [ECT_{t-1}] + \begin{bmatrix}
\epsilon_t^a \\
\epsilon_t^b 
\end{bmatrix} 
\text{if } |ECT_{t-1}| \leq \gamma 
\end{align}

\begin{align}
\text{Regime 2 (outer)} \\
\begin{bmatrix}
\Delta p^a_t \\
\Delta p^b_t 
\end{bmatrix}
= 
\begin{bmatrix}
\alpha_3 \\
\alpha_4 
\end{bmatrix}
+ \sum_{i=1}^{k} 
\begin{bmatrix}
\delta_{i,a}^{a,a} & \delta_{i,b}^{a,b} \\
\delta_{i,a}^{b,a} & \delta_{i,b}^{b,b} 
\end{bmatrix}
\begin{bmatrix}
\Delta p^a_{t-i} \\
\Delta p^b_{t-i} 
\end{bmatrix}
+ \begin{bmatrix}
\phi_{2}^a \\
\phi_{2}^b 
\end{bmatrix} [ECT_{t-1}] + \begin{bmatrix}
\mu_t^a \\
\mu_t^b 
\end{bmatrix} 
\text{if } |ECT_{t-1}| > \gamma 
\end{align}

with $\Delta p_t = p_t - p_{t-1}$, a constant $\alpha$, $\phi$ as the speed of error correction, the coefficients $\beta$ (regime 1) and $\delta$ (regime 2) capture the lagged short run adjustments, and $\epsilon$ and $\mu$ are the white noise error terms. $a \neq b$ and $a,b = 1, \ldots , N$ the number of provinces included in the analysis. A vector model is chosen since it is not clear \textit{a priori}, which price causes the other. Both regimes include $k$ lags. The threshold $\gamma$ is searched over the full range of the absolute value of the ECT, with the restriction, that a minimum share of observations is contained in each regime. In $\pi_0 \leq P(|ECT_{t-1}| \leq \gamma) \leq 1 - \pi_0$, $\pi_0$ is the trimming parameter that sets the probability for observations to be below the threshold or within one regime. Most applications\footnote{See inter alia MEYER (2004) and HANSEN and SEO (2002)} set $\pi_0 = 0.05$. Hence, 95% of the observations at most are in one regime.

The model in equation (1) results in one single threshold that is significant, if the adjustment parameter $\phi_1$ and $\phi_2$ differ significantly between the two regimes. If
the adjustment parameter for the inner regime, $\phi_1$, is not different from zero, one can interpret the threshold as transaction costs that need to be outweighed by price differentials to make arbitrage worthwhile.

To estimate the restricted bivariate TVECM, a three step procedure is proposed. First, all time series are tested for stationarity using the augmented Dickey-Fuller (ADF) unit-root test. If non-stationarity can be confirmed, each possible price pair is tested for cointegration applying the Johansen method. Estimating the TVECM as a third step, conditional on cointegration, requires the determination of the threshold parameter $\gamma$. Meyer (2004) proposes to use the ECT from the linear estimate generated by the Johansen method and to apply a search procedure only over $\gamma$. The statistical significance of the threshold parameter is calculated next. Since $\gamma$ is not identified, conventional test statistics have non-standard distributions. Therefore, Hansen and Seo (2002, pp. 299f) develop a supremum Lagrange-Multiplier test and use bootstrap techniques to calculate appropriate $p$-values.

4 Empirical Results

The augmented Dickey-Fuller test confirms unit roots in the levels of all 28 price series, with neither an intercept nor a trend. The Johansen cointegration test for all possible bivariate combinations of provinces suggests that 60% of all price pairs show a statistically significant linear long run relationship. Similarly, Park et al. (2002) analyze arbitrage opportunities among 25 provinces on the Chinese grain markets for rice and maize. They find arbitrage rates of about 64% on the rice market and 75% for maize. In terms of regional differences and market structure, China can
be compared to Turkey. Using the Chinese results as a benchmark, there is considerable room to improve the integration on the Turkish wheat market and thus, reduce welfare losses.

Looking at the regional pattern, one finds significant discrepancies. There seems to be an inner cluster of provinces in the center of Turkey from Afyon (province 3) in the west to Elazığ (23) and Diyarbakır (21) in the east. They show cointegration with two out of three other provinces. Such a high level of cointegration is not found for any single province at any border of Turkey. Thus, significant adjustment to prices of other provinces seems to diminish with the distance, which would be consistent with the effect of increasing costs of transportation\(^3\). This, however, is not the only effect, as the integration with direct neighbors shows. Within this inner cluster the provinces have integrated markets with 67 to 100 percent of their neighbors. In the outer areas of Turkey, the integration with neighbors falls dramatically. Down to the minimum of no market integration in a cluster in the west of Turkey containing the provinces of Balıkesir, Bursa, Izmir, and Manisa. Here, not a single province is cointegrated with its neighbor, which is especially startling, since e.g. Bursa has an integrated market with 16 other provinces. This finding underlines the assumption that transaction costs – being more than just the costs of transportation – impede some adjustment.

The TVECM is estimated with the absolute ECT as threshold variable and \(k\) in equation (1) set to one. The minimum share of observations \(\pi_0\) is set to 0.05 and 10,000 bootstrap replications are conducted. The results for the Turkish provinces are displayed in figure 3, where grey boxes refer to linear market integration.

\(^3\)However, we were unable to support this hypothesis with empirical evidence in econometric regressions.
Figure 3: Pattern of Market Integration

Source: Own calculations, GAUSS 7.0
Legend: ■ market integration with a significant threshold, □ linear market integration, □ markets not integrated
\( \pi_0 = 0.10, 10,000 \) bootstrap replications

Black boxes represent province pairs which have integrated markets once a significant threshold is overcome.

Figure 3 shows that the majority of all arbitrage activities is not significantly affected by transaction costs, as only some 19% of all province pairs show a significant threshold. Hence, the adjustment process differs for small and large deviations from the long run equilibrium. There is not a single case, where threshold cointegration is established without finding market integration at the same time.

Taking a closer look at the spatial pattern of the thresholds reveals an outstanding behavior of Ankara (province 6). Its price transmission with ten provinces occurs with a threshold, while no other province shows more than four thresholds. To
illustrate this finding the results of the application to Ankara and Denizli are pro-
vided. The estimated coefficients of the TVECM for Denizli ($p_{20}^0$) and Ankara ($p_6^0$) are presented with heteroskedasticity-robust Eicker-White standard errors (in ital-
ics). The results are normalized on Denizli and the coefficients do not change sub-
stantially when normalized on Ankara. According to the Breusch-Godfrey test, no residuals are autocorrelated. The search procedure yields a threshold pa-
rameter of $\gamma = 0.130$. Based on this parameter, the TVECM (1) is divided into
two regimes.

Regime 1 (inner)

$$
\begin{bmatrix}
\Delta p_{20}^0 \\
\Delta p_6^0
\end{bmatrix} =
\begin{bmatrix}
0.002 \\
-0.013
\end{bmatrix} +
\begin{bmatrix}
0.182 & 0.095 \\
0.111 & -0.104
\end{bmatrix}
\begin{bmatrix}
\Delta p_{20}^0 \\
\Delta p_6^0
\end{bmatrix} +
\begin{bmatrix}
-0.139 \\
-0.115
\end{bmatrix}
[ECT_{t-1}] +
\begin{bmatrix}
\mu_{20}^0 \\
\mu_6^0
\end{bmatrix}
if |ECT_{t-1}| \leq 0.130
$$

(2)

Regime 2 (outer)

$$
\begin{bmatrix}
\Delta p_{20}^0 \\
\Delta p_6^0
\end{bmatrix} =
\begin{bmatrix}
0.006 \\
0.060
\end{bmatrix} +
\begin{bmatrix}
-0.231 & -0.114 \\
-0.059 & -0.275
\end{bmatrix}
\begin{bmatrix}
\Delta p_{20}^0 \\
\Delta p_6^0
\end{bmatrix} +
\begin{bmatrix}
-0.228 \\
0.183
\end{bmatrix}
[ECT_{t-1}] +
\begin{bmatrix}
\mu_{20}^0 \\
\mu_6^0
\end{bmatrix}
if |ECT_{t-1}| > 0.130
$$

Regime 1 is defined by those prices in Ankara and Denizli where the absolute deviation from the long-run equilibrium is below 13 percent. Calculated at the average deflated price of Ankara this deviation approximates 347 TL/t. Thus, if the absolute deviation from the long-run equilibrium price in Ankara is below 347 TL/t, regime 1 will occur. This deviation will not be corrected, since the coefficients $\phi_1$ for the error correction term $ECT_{t-1}$ are not significantly different from zero. Hence, this threshold can be interpreted as level of transaction costs that prevent price adjustments to small deviations. Only if they exceed 13%, or
347 TL/t, regime 2 applies and prices will adjust to the long run equilibrium. The average level for all significant thresholds is 0.11. This is only slightly higher than the result of Meyer (2004), who found the level of transaction costs to be at 9.5%. Hence, the Turkish wheat market shows a similar level of transaction costs as the German and Dutch pig market, which is said to be well integrated.

Market integration is clustered around the provinces of Afyon (province 3), Elazığ (23) and Diyarbakır (21). This cluster contains the most important wheat growing provinces as well as the largest markets. Contrasting this finding, the threshold behavior cannot be explained by market size, since Konya, a neighboring province to Ankara of similar market size, shows a threshold only for the price transmission with Ankara. The transmission process is linear for all the other 17 integrated provinces. Distance fails as well, since Konya and Ankara should show a similar threshold pattern if distance to the other provinces was a significant determinant. The same logic applies to the trade pattern and processing capacity. Konya is the largest and Ankara the second largest province for importing as well as processing wheat. Hence, employing the observed variables that determine the market structure fails to explain the significance of transaction costs for Ankara.

One possible explanation might be the informal networks among Turkish farmers and traders, which is supported by anecdotic evidence. The agricultural sector in Turkey is almost exclusively run by family farms that have strong social relations to other farmers in their neighborhood as well as to traders. A study related to the agricultural sector provides evidence that farmers utilized their informal connections “more frequently when formal networks fail or are not functional.” Wegerich (2004, p. 337). This study confirms the importance and the advantages of an informal network. Riddle and Gillespie (2003) show the relevance and utilization of
informal networks for new ventures in the Turkish clothing export industry. They state that “[...] informal social ties – particularly friends and family connections – are key sources of information [...]” RIDDLE and GILLESPIE (2003, p. 105). Assuming that such informal networks are spread more widely in rural areas and that urban provinces rely more on formal networks might explain why Ankara faces significant transaction costs. While rural farmers and traders share their valuable information, which eases the trade, urban market participants face higher transaction costs to gain the same level of information. This raises a set of interesting questions on the economic interpretation of these results. As given in figure 3 Ankara shows a threshold in the error correction in a large number of its cointegrated relations. The province of Ankara has approximately 4 million inhabitants (TURKSTAT, 2005). Thus, a huge number of market participants cannot gain the full potential welfare. However, it needs to be stressed that this is a conjecture. Further research should clarify this important issue.

Another interesting finding relates to the ‘band of non-adjustment’. Of those 49 province pairs that show a significant threshold, only 21 show a neutral band. Thus, the economic reasoning to apply the TVECM in order to enable modeling a ‘band of non-adjustment’ is supported in less than 50% of all cases. The remaining thresholds cannot be interpreted as level of transaction costs, since deviations from the long run equilibrium are corrected below the threshold too.

5 Conclusion and Outlook

Turkey’s negotiations for EU accession officially started on October 3rd 2005. It’s agricultural sector is of special interest due to the economic importance in terms
of employment and contribution to the GDP. The wide range of geographic and economic differences among the provinces puts the general assumption of one single market into doubt. However, there is only a small body of literature covering this field. Thus, the Turkish wheat market serves as an appropriate example to analyze the agricultural sector in Turkey. Recent market integration studies based on price data alone have been criticized for their neglect of transaction costs. In order to tackle this critique a testable one-threshold model is employed that can account for the effects of transactions costs without relying on direct transaction cost data. As to date there is no method available to test a two threshold VECM a restricted three regime TVECM is used. The application to the Turkish wheat market reveals that 60% of all province pairs exhibit a long run price equilibrium, albeit with tremendous regional differences. There is an inner cluster of provinces that can be treated as one large market across provincial borders. However, this does not hold for those provinces at the borders of Turkey. Furthermore, a significant threshold can only be found in 8.4% of all linearly cointegrated province pairs. Less than 50% of them show no adjustment in the inner regime. One has to critically assess the applicability of the restricted TVECM to model transaction costs. Since this interpretation was only valid in about 4% of all cointegrated price pairs, there is reason for doubt. Hence, it is strongly recommended that further research focuses on the development of a testable two-threshold TVECM, which would enable modeling three regimes with asymmetric price adjustment in the presence of transaction costs. An extension to modeling more than two prices would offer intriguing new insights into the multivariate interdependencies of the price formation process. Finally, the TVECM clearly points to the outstanding behavior of Ankara. The capital province shows a threshold in the price trans-
mission process to almost 50% of all the other provinces it is cointegrated with. Based on the available price data alone the reasons for this finding cannot be established. Thus, further research should aim at investigating the market structure and the importance of informal networks among Turkish farmers and traders in more detail.

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