PRICE TRANSMISSION IN GRAIN MARKET: CASE OF UKRAINE

by

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Abstract

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The present study addresses the issue of the integration of the Ukrainian grain market with the world grain market. The author investigates the mechanism of asymmetric price transmission using Ukrainian and world wheat prices. The analysis of price transmission from the world to the Ukrainian grain market is useful for making inferences about the competitive environment and efficiency of the grain market in Ukraine. Furthermore, this analysis is important for authorities considering Ukraine’s accession to the WTO and its integration into the European markets. Using a threshold autoregressive model (TAR) the author finds symmetric adjustments to disequilibrium with small but significant thresholds. The empirical findings give evidence of existence of long-run equilibrium relationship between Ukrainian and world wheat prices, but point to sluggish short-run adjustment. The market takes almost a year to adjust to a world price shock. Government action in support of improvements to the transportation, communications and storage infrastructure may be warranted.

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Chapter 1

Introduction

Over the last years Ukraine's foreign trade in agricultural commodities increased by over a half from $2.3 bln. in 1999 to $3.5 bln. in 2002 with the share of grains in foreign agricultural trade accounting for about 26%. In the year 2002 having harvested a record harvest of about 38 mln. tons of grain Ukraine was classified as the sixth world's largest grain exporter. A year later a winterkill took a toll on winter wheat, which contributed to a dramatic reduction in the grain harvest to 20 mln. tons and in the year 2003 Ukraine once again switched to an import situation. Switching from an export to an import situation and vice versa always adds to price volatility. Taking into consideration the importance of grain as a source of income for agricultural producers and its importance for consumers as net buyers of grain, high price volatility may lead to disbalances in the economy as a whole: low prices harm agricultural producers, thus discouraging grain production, while high prices threaten food security as about 39% of Ukrainians live on less than $1 a day and are, thus, vulnerable to food price increases. Since the world market prices are usually not volatile, to eschew large price fluctuations in Ukraine it should be ensured that the domestic grain market is efficient, that is, that the Ukrainian grain market responds to world price changes as quickly and as fully as possible.

This paper will focus on the integration of the Ukrainian grain market with the world grain market. Examining price transmission on the Ukrainian grain market is important for several reasons. First, it can provide useful guidelines for policy makers. It is very often claimed that grain traders earn excess profits by buying grain from farmers at extremely low prices in an export situation and by selling imported grain on the domestic market at extremely high prices. However, this might occur only if there were a very weak competition on the Ukrainian grain market and, consequently, a very low degree of integration with the world grain market. The analysis of price transmission from the world to the Ukrainian grain market is a useful tool for making inferences about competitive environment and efficiency of the grain market.

Furthermore, the analysis of price transmission is important for authorities considering Ukraine's accession to the WTO and its integration into the European markets. By joining the WTO Ukraine will have greater opportunities to access new foreign markets. However, the benefits that will accrue to Ukraine as a result of the WTO accession and its integration into the European community are greatly dependent on the efficiency of the domestic market: Ukraine will be able to enjoy lower prices only if its markets are efficient enough to quickly transmit the price changes in the foreign markets onto the

Ukrainian. Thus, the key question arise in terms of how world market and Ukrainian could coordinate and how change in the world price influences changes in prices on Ukrainian markets.

This paper will focus on spatial market integration and asymmetry effects.

Spatial integration is a change in world price of grain causing a reaction in Ukrainian grain price. I plan to study the asymmetry effect on spatial integration, that is whether the reaction of the Ukrainian price to changes in the World price depends on whether this change is positive or negative.

This paper is organized as follows. The introduction is followed by section which presents literature review on similar research papers evaluating the research methods used to describe price transmission. The third section discusses the research methods and data used in this paper as well as a short background about Ukrainian agricultural market. The results and policy implications constitute the last section.

C h a p t e r   2

Literature Review.

Flexible prices are necessary to have an efficient allocation of resources. Therefore, it is not surprising that economists who study market efficiency devote time to the investigation of price transmission processes. Since it has been observed that prices react asymmetrically to different shocks, the issue of asymmetric price transmission attracted attention. The lagged adjustments in price after a change in price at a different level can be determined for price increases and for price decreases. If they are the same, that is the relationship is symmetric and the transmission is complete, it means that the markets are competitive. When the responses to price changes are asymmetric, this allows for the existence of market distortions.

This literature review focuses particularly on research on asymmetric price transmission and tests to estimate it. The examples of case of spatial asymmetry, i.e. between countries, regions are considered. In order to better understand what the estimation implies, the asymmetry effects are represented in the following diagrams:

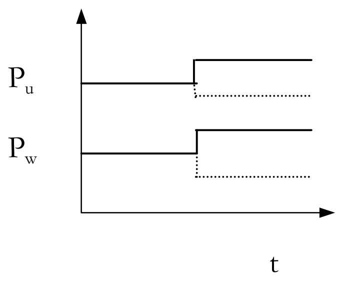

Diagram 1

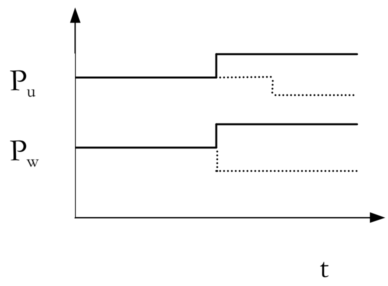

Diagram 2

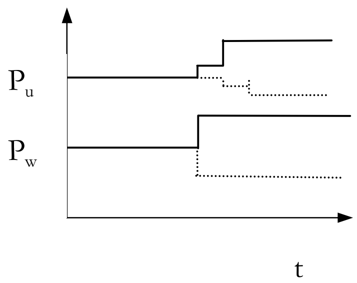

Diagram 3

Source: von Cramon Taubadel and Meyer, (2000).

Let us look at two markets, Ukrainian and world. The Ukrainian price is assumed to depend on the world price, which can increase or decrease at certain periods of time. In Diagram 1, it can be observed that the magnitude of change in Ukrainian price in response to change in world depends on the direction of that change. Diagram 2 shows how the direction of change in world price influences the speed of the response of Ukrainian price. Thus, it takes two periods for world price increase to transmit into Ukrainian market. Diagram 3 clearly shows that a decrease in world price is asymmetric in terms of both speed and magnitude since it needs three periods for Ukrainian price to partially adjust.

A wide range of literature also focuses on vertical asymmetry, like farmer-consumer price transmission (Hassan and Simioni, 2001). Further, if Ukrainian price responds more quickly and fully to world price increase than decrease, the asymmetry is said to be positive. More full and faster response to price decrease leads to negative asymmetry.

An important question is what reasons lie behind the different adjustment patterns.

Several studies of asymmetry deserve to be mentioned. Bailey and Brorsen (1989) in their research investigate price adjustments in cattle markets in case of vertical asymmetry. One of the possible causes of asymmetry is asymmetric adjustment costs. Another can be asymmetric information.

In case of vertical transmission, asymmetric adjustment costs arise if a firm changes its output or price and if these costs are asymmetric the adjustment may also be asymmetric. For the US beef market Bailey and Brorsen suppose that buyers (packers) and sellers (feedlot operators) are likely to have different adjustment costs. Meat packers, unlike feedlots, face fixed costs like investing in buildings, equipment, paying labor contracts and etc. So due to fixed costs, packers and feedlots may behave differently when prices rise or fall. For example, packers may raise prices to compete with packers in other regions but are reluctant to lower them. Therefore, as a result of competition between packers, farm prices may rise more quickly and fall more slowly.

Bailey and Brorsen (1989) further cite a spokesman for a large buyer of broiler who claims that price decreases are not reported as quickly as price increases, as an example of asymmetric price reporting.

Hassan and Simioni (2001) when investigating asymmetric relationships between shipping-point and retail prices for two major French vegetables, tomatoes and chicory, find that when price transmission is asymmetric, price decreases are usually transmitted more fully and quickly than price decreases. They explain it by the perishable nature of tomatoes and chicory and so retailers may hesitate to increase their prices for the fear of reduced sales and spoilage. So the asymmetry is negative in this case.

A number of additional reasons for asymmetric adjustments have been proposed. In agriculture one can often observe price support in terms of subsidies or set prices. Kinnucan and Forker (1987) believe that such price regulation can lead to asymmetric price adjustments. For example, if retailers believe that a reduction in farm prices will be temporary and price will not drop below certain point since government would interfere by imposing a price floor, while an increase in price will be permanent, asymmetric price adjustment would result.

Schroeder (1989) also conducts a study similar to Bailey and Brorsen (1989) on US cattle market. However, he investigates adjustments between wholesale and retail price for 6 specific cuts (like sausage, ham, etc.). The results are that retailers respond faster to wholesale price increases than decreases. These examples refer to asymmetry for vertical price transmission, mostly common for research.

Thus, one problem that researchers often face is explanation for asymmetric price transmission. Another problem is testing for presence and extent of asymmetry.

Different authors apply different estimating techniques. Suppose that Ukrainian price is P_u and world price is P_w, under assumption that Ukrainian price is caused by world price. When we assume symmetric and linear price adjustment, the following equation can be used to evaluate price transmission:

$$p_t^u = a + \beta_1 p_t^w + \mu_t \quad (1)$$

Innovations to this approach were brought by several researchers, considering the drawbacks of previous estimations. The following specification was presented by Houck (1977) which includes first differences of the increasing and decreasing phases of the explanatory variable. The result is:

$$\Delta p_t^u = a + \beta_1^+ D^+ \Delta p_t^w + \beta_1^- D^- \Delta p_t^w + \varepsilon_t \quad (2)$$

D^+ and D^- are dummy variables. When $P_t^w >= P_{t-1}^w$ D^+=1 and D^+=0 otherwise. When $P_t^w <= P_{t-1}^w$ D^-=1 and D^-=0 otherwise. With the help of these dummy variables, the world price which we denoted as p^w is split into variable which includes only increasing part of price (positive changes) another variable that includes only decreasing part of price (negative changes). As a result, two price adjustment coefficients are estimated: β_1^+ for the increasing price phases and β_1^- for the decreasing. Using standard F-test, it can be estimated if these asymmetric adjustment coefficients are significantly different.

Bailey and Brorsen (1989) when investigating special asymmetry based their estimation on a specification proposed by Ward (1982). Their model included lags to distinguish between the magnitude and the speed of adjustments. The model is represented in the following form:

$$PC_{jt} = \alpha_0 + \sum_{k=0}^{K} b_k TPP_{t-k} + \sum_{k=0}^{K} c_k TPP_{t-k} + TRAN + \varepsilon_t \quad (3)$$

where PC_{jt} is the price changes for the cattle market j. They looked at cattle markets in Colorado, Nebraska and Utah in time t. TPP is the positive price changes in Texas from period t-k-1 to t-k or zero if negative; TPN is the negative price changes on the same condition. TRAN is changes in monthly truck costs in cents per mile. Their first hypothesis is that the total effect of price increases is equal to total magnitude of price decreases, that is $\sum_{k=0}^{K} b_k = \sum_{k=0}^{K} c_k$. The second hypothesis was about the equality of speed of adjustment, that is $b_i = c_{i.}$ The results of their estimation show that negative and positive price changes seem to have equal overall effect between Texas and market in the other 3 states, however speed of adjustment is different. F-test of equal coefficients for positive and negative price changes shows that adjustment to positive price changes are made faster than negative.

The first attempt to apply cointegration techniques to test the asymmetric price transmission was made by von Cramon-Taubadel and Fahlbusch (1996), who suggested that an error correction model, extended to include error correction terms of asymmetric price adjustment, may be used to test for price transmission between the cointegrated price series. ECM allows to estimate both the speed of adjustment in response to a positive or negative shock and the immediate response to a positive or negative shock separately. According to this approach, the cointegration relationship is estimated according to (1). In case of asymmetric cointegration, the lagged cointegrating residuals μ_{t-1} are split into positive and negative and are used in the estimation of an error correction equation. When lagged price changes are also split for positive and negative, the equation takes the following form:

$$\Delta p_t^u = \alpha + \sum_{j=1}^{K} (\beta_j^+ D^+ \Delta p_{t-j+1}^w) + \sum_{j=1}^{L} (\beta_j^- D^- \Delta p_{t-j+1}^w) + \phi^+ ECT_{t-1}^+ + \phi^- ECT_{t-1}^- + \gamma_t$$

(4)

The application of this model is based on linear error correction. A further question arises if deviations from the long-run equilibrium will lead different output price changes if these deviations exceed a specific threshold level. Types of error correction are represented in the following diagram:

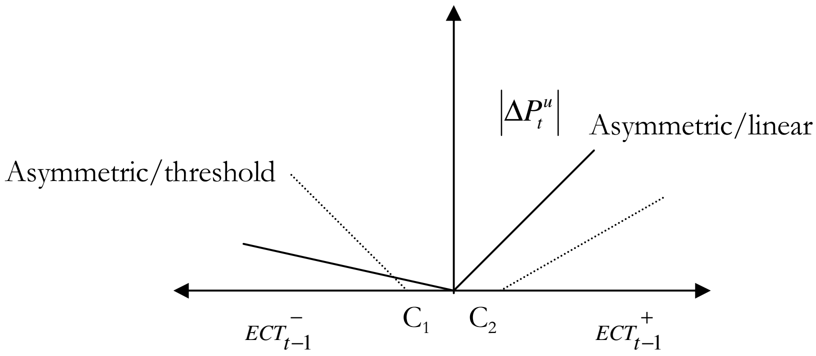

Diagram 4.

Source: von Cramon Taubadel and Meyer, (2000).

The threshold error correction model is compared with asymmetric but linear error correction. When $c_1=c_2$ threshold model becomes linear error correction. Threshold effects occur when larger shocks, above some threshold, cause a different response then smaller shocks do.

Goodwin and Harper (1999) test for non-linearity in the form of thresholds in the error correction term. They evaluate price transmission among farm, wholesale, and retail pork markets. Using grid search, they confirm the existence of threshold. According to these authors, threshold modes are usually motivated by adjustment costs. Goodwin and Harper (1999) base their analysis on Balke and Fomby (1997) who extended the threshold autoregressive models to cointegration relationships. Their specification which includes two thresholds has the following representation:

$$\Delta P_t^u = \begin{cases} \alpha^1 + \sum_{j=1}^{K}(\beta_j^1 \Delta p_{t-j+1}^w) + \phi^1 ECT_{t-1} + \gamma_t & ECT_{t-1} < c_1 \\ \alpha^2 + + \sum_{j=1}^{K}(\beta_j^2 \Delta p_{t-j+1}^w) + \phi^2 ECT_{t-1} + \gamma_t & c_1 \le ECT_{t-1} \le c_2 \\ \alpha^3 + + \sum_{j=1}^{K}(\beta_j^3 \Delta p_{t-j+1}^w) + \phi^3 ECT_{t-1} + \gamma_t & ECT_{t-1} > c_2 \end{cases}$$

Goodwin and Harper (1999) find that negative farm price shocks appear to produce a greater movement in farm prices than positive shocks. Studies using cointegration techniques have been applied for research in transition countries. Valachy (nd) investigates the effect of the takeover of a Slovak petroleum firm on its price setting mechanism. The author attempts to estimate how fuel prices respond to changes in gasoline prices and changes in price of dollar once the company which he considers (petroleum company Slovnaft) is taken over by a foreign strategic investor. He also considers approaches presented in literature review and chooses specification introduced by Houck (1977). His findings are quite interesting. Before takeover, only negative changes in input prices were reflects in price of fuel. However, after takeover, price of fuel responds symmetrically to input prices and changes in dollar.

Most literature on asymmetric price transmission concerns agricultural markets. In general, studies on agricultural commodities include cointegration procedures to analyze price transmission or market integration. Wu (nd) using cointegration methods checks for integration between world and Chinese markets of rice, wheat, corn, soybean, peanut oil and hog. Using cointegration techniques developed by Engle and Granger (1987) he finds that the equilibrium relationships between domestic and world markets exist for every product. So prices will eventually come to long-run equilibrium, even if short run integration is not present. The Granger-causality test on the wheat market showed that China's domestic price causes world price, which is logical considering country's exports, therefore, any shocks to domestic price will be reflected in the world market.

Another study on wheat market was conducted by Wang and Ke (2003). They study the efficiency of wheat future market in China using cointegration methods. The idea is that in efficient market prices reflect fully the available information, so that any profit opportunities for traders are eliminated. They test for cointegration between future and cash price of wheat. Results of their research act in favor of conclusion that China's wheat futures market is inefficient. The major factor that accounts for this inefficiency is government manipulation. Since wheat is one of the commodities related to national security, therefore government is highly concerned with pricing policies on wheat market and intervenes by tight regulation of imports and exports.

I would also like to mention the papers of Victoria Galushko (EERC'2003) and Olga Vashchuk (EERC'2003), which both present the research on Ukrainian price transmission. In a study of Olga Vashchuk "The Law Of One Price And Regional Price Convergence In Ukraine, the author analyses 30 nominal retail prices for 26 regions in Ukraine for the period 1997:01—2002:12. The Band TAR model is used to show regional prices converge to the average Ukrainian level. Threshold and speed of convergence are estimated for each group of food, non-food and services. Victoria Galushko in a work "Has Spatial Market Integration Increased Over Time: The Evidence From Ukrainian Food Markets?" addresses the issue of integration of regional Ukrainian Food markets and its improvement over time. This work is devoted to price integration in 3 markets of agricultural commodities: bread, sugar and sunflower oil. Using Error Correction Model, the long-run equilibrium and immediate response parameters are estimated to present the degree of market integration.

Since no research has been found on asymmetric price transmission on Ukrainian wheat market, this paper adds to the literature.

Chapter 3

Methodology.

In order to investigate into the issue of asymmetry, I will use threshold cointegration methods recently developed by Enders and Granger (1998). These methods allow to determine stationarity in case of asymmetric adjustments. The symmetric adjustment model can be viewed as a special case of asymmetric threshold error correction models.

In order to determine asymmetric adjustments to the long-run equilibrium, I can apply TAR (threshold autoregressive) model with an error correction model. Since I have weekly data, I will be able to capture the very short-run asymmetries if present.

The methodology used in this paper relies on study by Hassan and Simioni (2001) who in turn apply cointegration approach from the Engle and Granger (1987) and TAR methods from Enders and Granger (1998).

Step1. Assessment of the statistical properties of the price series.

Let P^u and P^w denote the Ukrainian and world price for wheat. Engle and Granger's approach of cointegration is used when the two price series are both integrated of order one, so that first differences of series provide stationarity. Thus, the first step involves determining the order of integration. This is done using augmented Dickey-Fuller test to test the unit root hypothesis in each of the price series.

Step 2. Estimation of the long-run relationship between domestic and world prices.

If the results of unit root test allow to conclude that both price series are integrated of order one, we can proceed with the estimation of the long-run relationship in the following form:

$$P_t^u = \alpha + \beta P_t^w + \mu_t \quad (1)$$

where μ_t may be serially correlated, and β is the coefficient to be estimated. To check for the null hypothesis of non-cointegration between the prices, we use OLS to estimate ρ in the following relationship:

$$\Delta\mu_t = \rho\mu_{t-1} + \varepsilon_t \quad (2)$$

where ε_t is white noise. The acceptance of alternative hypothesis of $\rho < 0$ implies that residuals are stationary. Here we assume symmetric adjustment since the change in μ_t is equal μ_{t-1} times ρ irrespective of whether μ_{t-1} is negative or positive.

The test is done on estimated residuals from equation (1). It involves the estimation of the following specification:

$$\Delta\mu_t^{est} = \rho\mu_{t-1}^{est} + \sum\nolimits_j \gamma_j \Delta\mu_{t-j}^{est} + \varepsilon_t \quad (3)$$

where the number of lags is included so that ε_t is white noise. The appropriate lag length is chosen based on Breusch-Godfrey Serial Correlation LM Test. The null hypothesis that ρ is equal to zero is tested against the alternative that $\rho < 0$. If the null is rejected, it can be concluded that μ_t^{est} is stationary and the price series are cointegrated. When the two price series are cointegrated, their short-run dynamics can be represented using an error-correction model in the following form:

$$\Delta P_t^u = \delta\mu_{t-1} + \sum_j \gamma_{1j}\Delta P_{t-j}^u + \sum_j \gamma_{2j}\Delta P_{t-j}^w + \varepsilon_t \quad (4)$$

This equation can be estimated replacing the error-correction term μ_{t-1} by its estimated value. The lag length is chosen so that the errors appear to be serially uncorrelated.

Step 3: Short-run adjustments: symmetric or asymmetric.

The implicit assumption which was behind the different applied tests involved in step 2 was that the Ukrainian price response to shocks in world price is symmetric. A shock to the world price would produce the same response in Ukrainian price, regardless of whether the shock reflected a price decrease or increase. The following error-correction specification can be applied when considering introduction of asymmetry into the model:

$$\Delta\mu_t = \rho_1\mu_{t-1}D^+(\mu_{t-1} \geq 0) + \rho_2\mu_{t-1}D^-(\mu_{t-1} \prec 0) + \varepsilon_t \quad (5)$$

where dummies stand for 1 when condition in parentheses holds and 0 otherwise.

This model was introduced by Enders and Granger (1998) and it is called threshold autoregressive model (TAR). If the adjustment process is convergent μ_t is equal to 0 and it can be considered as the long-run equilibrium. In case when μ_{t-1} is above the long-run equilibrium, the adjustment is $\rho_1\mu_{t-1}$. In case when μ_{t-1} is below the long-run equilibrium, the adjustment is $\rho_2\mu_{t-1}$. In case when adjustment is symmetric, that is when $\rho_1 = \rho_2$, equation (2) is a special case of equation (5).

We use estimated residuals from (1) to estimate (5) in the following form:

$$\Delta\mu_t^{est} = \rho_1\mu_{t-1}^{est}D^+(\mu_{t-1}^{est} \geq 0) + \rho_2\mu_{t-1}^{est}D^-(\mu_{t-1}^{est} \prec 0) + \sum_j \gamma_j \Delta\mu_{t-j}^{est} + \varepsilon_t \qquad (6)$$

where the lag length is chosen so that errors are white noise. To test for unit root, the p-values for the null hypothesis $\rho_1 = 0$ and $\rho_2 = 0$ and the F-statistic for null $\rho_1 = \rho_2 = 0$ can be compared to the critical values. If the alternative hypothesis is accepted, it is possible to test for asymmetric adjustment. The null hypothesis $\rho_1 = \rho_2$ can be tested using F-statistics.

The short-run dynamics of prices can us presented in the following form of error-correction model:

$$\Delta P_t^u = \delta_1\mu_{t-1}^+ + \delta_2\mu_{t-1}^- + \sum_j \gamma_{1j}\Delta P_{t-j}^u + \sum_j \gamma_{2j}\Delta P_{t-j}^w + \varepsilon_t \qquad (7)$$

where $\mu_{t-1}^+ = \mu_{t-1}D^+(\mu_{t-1} \geq 0)$ and $\mu_{t-1}^- = \mu_{t-1}D^-(\mu_{t-1} \prec 0)$.

The equation (7) can be estimated by using estimated value of residuals for error correction term and applying OLS. Lags are introduced such that errors appear to be white noise. Speed of adjustment is estimated and significance tests are performed.

C h a p t e r   4

Data description.

The analysis relies on average weekly EXW price for milling wheat reported by UkrAgroConsult, an independent private information agency. Prices on individual regional markets will differ from this average, but Figure 1 nevertheless provides good indication of price dynamics. The prices are for 3rd class milling wheat, which constitutes the major component in food production. The corresponding world prices for 3rd class soft red winter wheat are publicly available at http://apps2.fao.org:8000/monikers/ESC/WeeklyPricesServlet.js (US fob Gulf prices). The prices correspond to period from January 1998 to Novem-ber 2003. Price series constitute weekly data with 296 observations.

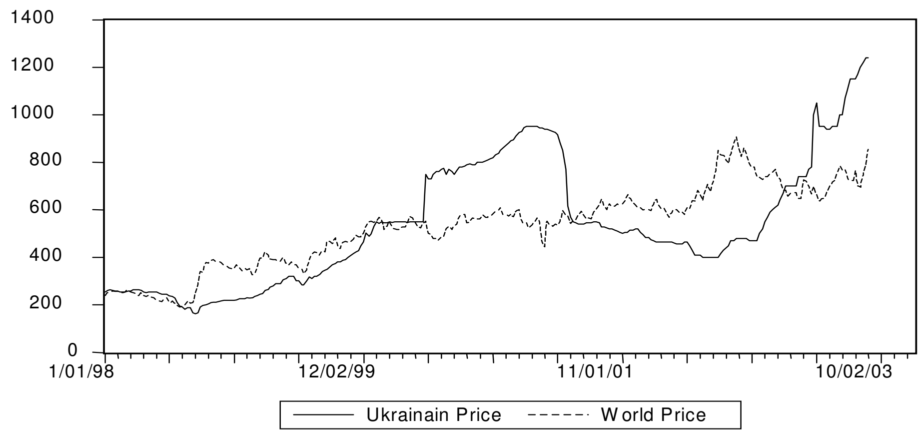

Figure 1. Milling wheat prices in Ukraine and on world market (1998-2003, UAH/t)

Seasonal price fluctuations frequently imply that agricultural prices fall at harvest time and rise shortly before the next harvest. In reality wheat prices do not follow this seasonal pattern. This can be easily explained. The Ukrainian price is related to the world price through equation $P_u=P_w*E_{uah/\$}+TC$ in export situation and $P_u=P_w*E_{uah/\$}-TC$ in import situation (IER, 2002). Thus, such variables as exchange rate between Ukrainian hryvnya and dollar and transportation costs of moving the grain in export/import situation, as well as various policy measures, like import duties and tariff rate quotas, and weather conditions influence price fluctuations and explain why neither world, nor Ukrainian price follows the seasonal pattern.

It can be observed that in 2000 and 2003 Ukrainian price is above the world price. These cases are explained by Ukraine's net import/export situation. It is known that in 2003, for example, there was grain crisis with arising rumors of shortages, which, combined with poor harvest, caused quite a sudden increase in prices. Government was blamed for releasing over-optimistic estimates of the 2002 grain crop and traders were accused of over-exporting. Government's announcements about its intention to import 2.2 mln. tons of Russian and Kazakh wheat in 2003/2004 resulted in a suspension of imports by commercial traders. However, Russia and Kazakhstan which promised to supply grain at lower prices reneged on their promise and the crisis resulted in substantial increase in prices. It can be added that cases when Ukrainian price is above the world correspond to import situation. The case when world price is higher than domestic is an export situation for Ukraine.

Descriptive statistics are presented in the Appendix 1.

Results.

Step 1:

To start with, I investigate the stochastic properties of the two price series, that is determine their order of integration. If price series are stationary or inergrated of order zero, it is denoted as I(0). If series must be differenced once to become stationary, it is denoted as I(1). If series must be differenced d times to become stationary, it is denoted as I(d). The difference between I(d) and I(o) is the I(0) has finite mean and variance when for the former they do not exist. (Baffes, 1991). In order to be cointegrated, price need to be integrated of the same order. Usually prices are found to be I(1) their first differencing would give I(0). If prices are integrated of different order, no cointegration exists, because at least one of series contains explosive component. To check for the order of integration I apply Augmented Dickey-Fuller (ADF) test. The results of ADF tests support the presence of unit root in each case. Test results are presented in detail in Appendix 2. According to methodology, prices are checked for the order of integration. If the value of ADF statistic is less that the critical values, it shows that series is stationary. Both prices are integrated of order (I), that is each is nonstationary in levels but stationary in first differences and there exists a linear combinations between them which is stationary.

Table 1. Checking prices for the order of integration:

Variable		Decision	Test-statistics	t-stat,critical value at 5% s.l
Ukrainian Price	Level	accepted	0.102761	-2.871263
	1st difference	rejected	-6.106697	-1.941921
World Price	Level	accepted	1.243720	-1.941918
	1st difference	rejected	-7.564985	-3.425397

* decision is based on 5% level of significance. H_0: non-stationary series.

Step 2:

The estimated long-run equilibrium relationship between the world and Ukrainian price is given in Appendix 3. This equation is estimated in order to determine whether the prices are cointegrated. Export and import dummies are introduced to account for different price changing patterns in an export and import situation. The coefficients give the relationship between the Ukrainian price and the World price.

$$P_t^u = 176.6743\text{D\_Im} - 146.8839\,\text{D\_Ex} + 1.022573 P_t^w, \quad R^2=0.76 \qquad (1)$$

(0.0000) (0.0000) (0.0000) p-values in brackets

Where D_Im is the dummy variable equaling 1 in an import situation and where 0 in an export situation and the opposite holds for the variable D_Ex. The introduction of dummy variables into the long-run equilibrium equation is motivated by the fact that the relationship between the World and the Ukrainian price is likely to be different in case of a potential import situation, where Pu>Pw, versus a potential export situation, where Pu<Pw. As was already mentioned in the Data Description section, in case of export $P_t^u = P_t^w$ - transaction costs, in case of import $P_t^u = P_t^w$ + transaction costs. However, in case of import transaction costs could be higher since they could also involve import tariff. This may explain different transaction cost coefficients that are discovered for the wheat market.

Each of the price series is nonstationary and transformation into the first differences is required to obtain a stationary series. The linear combination of these two series gives the residuals which are stationary I(0) and this gives the basis for conclusion that two price series are indeed cointegrated. The corresponding cointegration test, i.e. that null hypothesis that ρ is equal to zero in equation $\Delta\mu_t^{est} = \rho\mu_{t-1}^{est} + \sum_j \gamma_j \Delta\mu_{t-j}^{est} + \varepsilon_t$ ((3) in methodology) is presented in table 1a and Appendix 3.

Table 1a. Checking residuals for the presence of a unit root.

Variable		Decision*	Test-statistics	t-stat
Residuals from (1)	Level	rejected	-4.124291	-1.941910

*decision is based on 5% level of significance.

Perfect spatial integration will be achieved if the price series are cointegrated with a cointegrating parameter β near variable Pw estimated from long-run equilibrium equation (1) is unity. The slope parameter was tested to be equal to 1 and with probability of 61.5% this hypothesis cannot be rejected. Hence, the long-run integration exists between prices. The test of equality between slope coefficients of D_Im and D_Ex variables as well as significant difference from 0 of each of these coefficients were performed and the result was that at any level of significance the two slope coefficients are significantly different from 0 and from each other. Thus, it can be concluded that Transaction Costs are different in export and import situations. The graphical presentation of this difference is depicted in Figure 2.

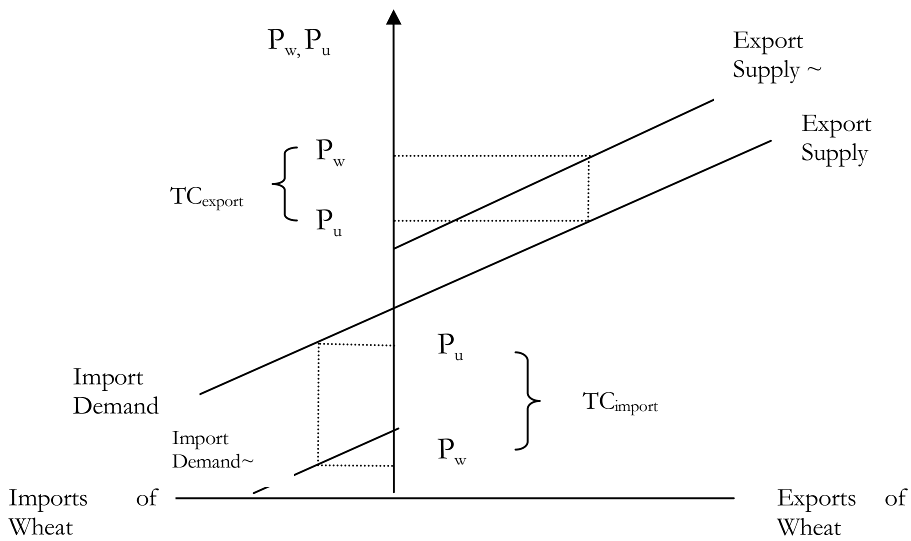

Figure 2. Asymmetry in Transaction Costs in Import/Export situation.

This diagram reflects the relationship between world and Ukrainian price. In case of exports, it can be seen that world price is above Ukrainian (which is reflected by export supply schedule) and in case of imports it is below Ukrainian (which is now reflected by import demand schedule). The difference is Transaction Costs. From the long-run equilibrium equation it can be observed that the coefficient on D_Im is greater in magnitude than the coefficient on D_Ex. Thus, import transaction costs are higher than export. Also, the coefficient on D_Im is positive showing that world price is lower and the transaction costs should be added for import to occur. The negative coefficient near D_Ex reflects the fact that world price is higher and transaction costs should be subtracted from it to obtain the Ukrainian price.

Short-run integration is tested in the following estimated error correction model (ECM), (estimated equation 4 from the methodology section):

$$\Delta P_t^u = -0.019191\mu_{t-1}^{est} + 0.264764\Delta P_{t-1}^u + 0.110814\Delta P_{t-6}^u + 0.146712\Delta P_{t-12}^u +$$

(0.0922) (0.0000) (0.0544) (0.0134)

$$0.128934\Delta P_t^w + \varepsilon_t \text{ , } R^2=0.10, n=289 \quad (2)$$

(0.0381) p-value in brackets

Short-run integration means that world price change will be immediately transmitted into change in Ukrainian price. The short-run integration is tested in the null hypothesis of setting all slope coefficients to be equal and equal to zero and the coefficient on the error correction term to be 1. The calculated F-statistic of 1637.4 suggests the rejection of the null hypothesis and conclusion that there does not exist short-run integration, only long-run.

The estimation results along with specification tests are presented in Table 1b in the Appendix 4. It can be observed that when the World price increases by 1 hrv, the immediate response of Ukrainian price is the increase of almost 13 kop. and the coefficient on the error correction term shows how fast, that is how many weeks, since I have weekly data, will it take to absorb the remained part (87 kop.) of the shock. For example, 0.87*0.019=0.016 which will be absorbed in 1 week and 0.89-0.016=0.85 kop. (approximately) left to be absorbed in future periods and so on. Considering the speed of adjustment and influence of lagged changes in Ukrainian price on change in Ukrainian price at time t, it was calculated that about 70% of the initial shock is absorbed in the first 6 months and about 96% absorbed within a year. 50% of a shock is absorbed within 3.5 months, 75% is absorbed within 8 months and 87.5% is absorbed within 9.5 months. The adjustment is limited. Results from various diagnostic tests confirm the absence of any misspecification of the estimated ECM.

Step3:

In order to check for asymmetric adjustment, I split residuals from (1) into positive and negative introducing 2 dummy variables, i.e. based on equation (5) rather than (3) from methodology and obtain the following result:

$$\Delta\mu_t^{est} = -0.069188 \quad \mu_{t-1}^{est} D^{+}(\mu_{t-1}^{est} \geq 0) - 0.152508 \quad \mu_{t-1}^{est} D^{-}(\mu_{t-1}^{est} \prec 0) - 0.198576 \quad \Delta\mu_{t-2}^{est} + \varepsilon_t$$
(3)

Thus, we estimate (3) using the estimated residuals from (1) and lag number is chosen to provide serially uncorrelated errors. The residuals are estimated in the form of the Threshold Autoregressive (TAR) model using the threshold τ = 0.The test of the null hypothesis $\rho_1 = 0$ and $\rho_2 = 0$, which can be rejected at a reasonable level of significance, is presented in table 2a.

Table 2a. Testing the significance of symmetry coefficients.

	Coefficient	p-value
ρ_1	-0.069188	0.0833
ρ_2	-0.152508	0.0204

The null of $\rho_1 = \rho_2 = 0$ can also be rejected based on F-statistics of 6,648349, confirming that the price series are cointegrated. Given cointegration, the null hypothesis of symmetric adjustment $\rho_1 = \rho_2$ can be tested using Wald test. Based on F-statistics of 1.907215 or on p-value of 0.168336 the null hypothesis of symmetry of coefficients cannot be rejected at a reasonable level of significance. Thus, assuming that threshold τ = 0, price transmission appears to be symmetric in the TAR model specification.

Here, it is necessary to mention that much of the literature finds no evidences of asymmetry using the threshold zero. To find a potential threshold other than zero and test further for asymmetry, the Chan's method is used. This method involves taking the estimated residuals from (1) and sorting them is ascending order. The search of the threshold is performed among the middle 70% of these residuals, excluding the 15% largest and 15% smallest values. The threshold which gives the lowest residual sum of squares in (3) is selected. Chan (1993) showed that this procedure yields a superconsistent estimate of the threshold, which is used in implementing cointegration and asymmetry tests. Using this method, I found a positive threshold of plus/minus 5.377704 that resulted in the smallest residual sum of squares in cointegration equation of estimated residuals.

Thus, the residuals are estimated in the form of the TAR model using the thresholds τ1 = 5.377704 and symmetric τ2 =-5.377704. The following result is obtained.

$$\Delta\mu_t^{est} = -0.058509 \quad \mu_{t-1}^{est} D^{+} (\mu_{t-1}^{est} \geq 5{,}377704) \\ -\ 0.125673 \quad \mu_{t-1}^{est} D^{-} (\mu_{t-1}^{est} \prec -5{,}377704) \quad -\ 0.205344 \quad \Delta\mu_{t-2}^{est} + \varepsilon_t \tag{4}$$

The test of the null hypothesis $\rho_1 = 0$ and $\rho_2 = 0$ (the coefficients on positive and negative dummies), which can be rejected at a reasonable level of significance, is presented in table 3a.

Table 3a. Testing the significance of symmetry coefficients.

	Coefficient	p-value
ρ_1	-0.058509	0.0758
ρ_2	-0.125673	0.0006

Thus, the coefficients are significantly different from zero. F-statistic shows that the null hypothesis of $\rho_1 = \rho_2 = 0$ can be rejected at any reasonable level of significance and the p-value 0.2897 clearly indicates the failure to reject the null $\rho_1 = \rho_2$ at 10% level of significance (Tables 3b and 3c in the Appendix 5). These findings suggest that the adjustment is asymmetric. Thus, I proceed with building the TAR model. The TAR model is presented in the following form:

$$\Delta P_t^u = \underset{(0.0122^{**})}{-0.032799} \cdot D^+ \mu_{t-1} + \underset{(0.7104)}{0.008123} \cdot D^- \mu_{t-1} + \underset{(0.0000^{***})}{0.262329} \Delta P_{t-1}^u +$$

$$\underset{(0.0218^{**})}{0.131018} \Delta P_{t-3}^u + \underset{(0.0514^{*})}{0.111229} \Delta P_{t-6}^u + \underset{(0.0277^{*})}{0.135639} \Delta P_t^w + \varepsilon_t, \quad R^2=0.11, \ n=289 \quad (5)$$

The estimation output is presented in Table 4 of the Appendix. Results from various diagnostic tests (Breusch-Godfrey Serial Correlation LM Test, White Heteroskedasticity Test, Ramsey RESET Test) are presented in the Appendix 5 in tables 4b, 4c and 4d.

The estimated values of the short-run adjustment parameters δ_1 and δ_2 (see (7) in methodology section) reported in table 3.1 indicate that adjustment of Ukrainian prices to the long-run equilibrium is faster when deviations are positive. Thus, decreases in the World price are transmitted faster than increases. However, it should be mentioned that adjustment parameter on negative deviations is not significant.

Table 4a. Summary of asymmetry results:

Coefficient	p-value
δ_1 = -0.032814**	0.0122
δ_2 = 0.008123	0.7104

The p-value of 0.1094 in the test for the symmetry of the adjustment coefficients supports the symmetry hypothesis and gives justification for the estimation of the TAR model with the common coefficient. The following result is obtained.

$$\Delta P_t^u = -0.021519D \underset{(0.0650^{*})}{\ } \mu_{t-1}^{est} + 0.261101 \underset{(0.0000^{***})}{\ } \Delta P_{t-1}^u + \qquad (6)$$

$$\underset{(0.0164^{**})}{0.137027} \Delta P_{t-3}^u + \underset{(0.0100^{*})}{0.151459} \Delta P_{t-12}^u + \underset{(0.0178^{**})}{0.147011} \Delta P_t^w + \varepsilon_t, \ R^2=0.11, n=289$$

Using the speed of adjustment coefficient as well as the lagged values of Ukrainian price we can calculated the absorption period in Ukrainian market for the initial change is the world price. About 78% of the initial shock is absorbed in the first 6 months and about 99.9% is absorbed within a year. The calculation was made considering the immediate effect on Ukrainian price, and, in each subsequent period, the speed of adjustment and the impact of change in world price on lagged changes in Ukrainian. These changes in turn are taken cumulatively over time to determine the full extent of adjustment in the Ukrainian price. I calculated that 50% of the shock is absorbed within 3 months, 75% is absorbed within 5.5 months and 87.5% within almost 8 months. The adjustment does not seem to be fast. In integrated markets half of a year should be sufficient time for traders to enter agreements and execute transactions. The specification of this equation is supported by the tests presented in Appendix 4. The short-run integration is tested in the null hypothesis of setting all slope coefficients to be equal and equal to zero and the coefficient on the error correction term to be 1. The calculated F-statistic of 1453.415 suggests the rejection of the null hypothesis and conclusion that there does not exist the short-run integration, only the long-run.

It should be added that different specifications for initial equilibrium equation and search for thresholds other than zero were performed, however, the hypothesis of symmetry could not be rejected in any of multiple model search cases. I tried to investigate if positive and negative changes in world price would have a different immediate impact on change in Ukrainian price by including two dummy variables for positive and negative changes in the world price, however the hypothesis of symmetry of these two coefficients could not be rejected, hence, indicating that the immediate response of Ukrainian price to positive or negative world price changes is the same. The inclusion of seasonal dummies to reflect the seasonal pattern of price fluctuations didn't improve the fit of the model and all four seasonal dummies appeared to be insignificant.

Thus, the final result can be presented in the following diagram.

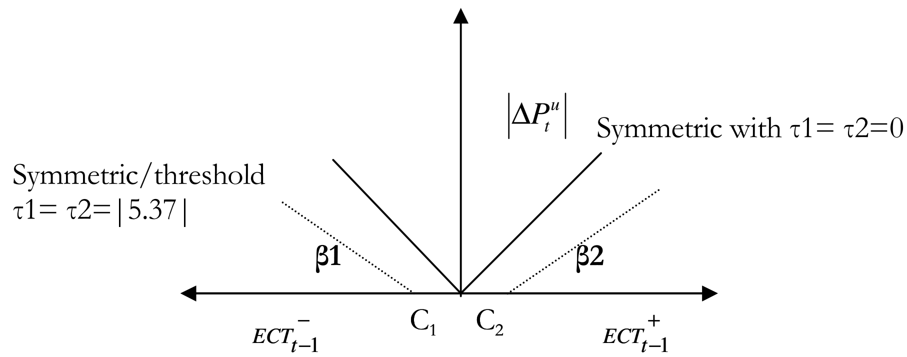

Diagram 5. Symmetric adjustment.

It is clearly seen from the diagram around zero threshold adjustment is symmetric as well as with the positive threshold other than zero. Thus, positive and negative changes is world price are transmitted with the same speed (β1= β2).

In the range of the threshold no price adjustment takes place. No presence of asymmetric adjustment was found.

CONCLUSIONS.

The Ukrainian and World price series were found to be cointegrated. Thus, the prices are moving together in long-run and the long-run integration appears to be perfect based on the failure to reject the null hypothesis that $\beta = 1$, but short-run cointegration does not exist.

After a shock the market returns to its long-run equilibrium when 100% of the shock is absorbed. As derived in the results section, the change in the world price is transmitted into the change in Ukrainian price by 99.9% in a year, which is close to unity, however the time length is quite large to make conclusions about not sufficient level of integration and efficiency of the market. 50% of the shock is absorbed within 3 months, 75% is absorbed within 5.5 months and 87.5% within almost 8 months. The adjustment does not seem to be fast. In integrated markets half of a year should be sufficient time for traders to enter agreements and execute transactions. Thus, the overall conclusion is that price transmission is limited. Victoria Galushko (EERC' 2003) in her calculations of absorption period in the bread market in Ukraine using period 1997-2002 found that about 86% of market pairs do not reach equilibrium within 6 months from the occurrence of the shock, which supports the evidence of slow adjustment.

Asymmetry tests were performed, price transmission was found symmetric under a zero threshold. Using a threshold other than zero, namely the symmetric threshold of plus/minus 5,377704, the symmetry hypothesis was rejected as well. This latter threshold was found to be optimal using the Chan (1993) selection criterion.

A search for non-zero threshold was performed since no theoretical or empirical support was found for using only a zero threshold in the analysis of short-run price adjustment. I interpret this positive threshold as a border between a symmetric adjustment (confirmed by the fact that symmetry was found with a non- zero threshold) beyond the threshold and no adjustment at for small disequilibrium falling within the positive and negative bounds set by the threshold.

There is a strong intuitive explanation for the existence of the threshold. The gap between predicted and actual values of Ukrainian price given by the predicted error provides a measure of the extent of disequilibrium in the error correction models. The threshold measures the extent to which the market was not in equilibrium in previous year. While Error Correction Models say that traders correct today disequilibria occurring yesterday, it is intuitively plausible that equilibrating action only occurs when the market is far enough away from equilibrium Thus, a symmetric threshold would imply that if Ukrainian price was previously above (or below) the long-run equilibrium level and if this gap was sufficiently large, traders would be indeed transmit the price in a downward (or upward) direction through arbitrage activities. For small disequilibrium the incentives for arbitrage may become insignificant. This gives the motivation for searching for thresholds. The search for thresholds is especially justified in the presence of transactions costs, which are statistically significant in the long-run equilibrium equation and assist in the explanation of the slow shock transmission process.

Asymmetries in market adjustment, when detected, have implication for the behaviour of intermediaries in the market. Beyond certain threshold or disequilibrium gap, traders will change their behaviour and price adjustments would take place and these adjustments may not be symmetric.

Interestingly and perhaps surprisingly, there was no evidence of asymmetry on the Ukrainian wheat market. One of the possible reasons for the asymmetry could be monopoly power on the market. Symmetry in the transmission of positive and negative shocks from the world market onto the Ukrainian market can be explained by the high level of competition between traders and low monopoly power to determine different pattern of transmission for positive and negative world price shocks.

Transaction costs can be identified as a key contributing factor in slow price transmission. Ukraine now vitally needs investment in infrastructure like railway and road transportation and information transfer. High transaction costs limit the opportunities for the arbitrage to take place. Especially with respect to areas of infrastructure which have a public good component, government support may be warranted. It is also important to mention the information transfer. The wheat market is quite competitive with large number of traders executing transactions daily on exchanges. In this context transparency and availability of information about current market situation is crucial. High storage costs and limited elevator capacities accompanied by costs of documentation procedures lead to quite costly transactions that explain absence of arbitrage in the market. This can be a priority area for government policy actions on improving the market efficiency and price integration.

Another area for improvement is increasing competition and further market liberalization. Though I already mentioned that wheat market is quite competitive, regional distortion may still arise. For example, though not officially stated, some regions have conducted a policy of restricting interregional wheat trade.

For further research it would be interesting to evaluate the impact of policy measures on price transmission. Besides transaction costs, exchange rate and trade barriers such as import/export quotas and tariff rate are likely to influence the pattern of price fluctuations. For example, taking a longer period for estimation and dividing the sample into sub samples may help shed light on the impact of different trade policy regimes. Search for alternative specifications of the model or other possible thresholds could be a basis for further research. Further research could possibly be focused on markets other than wheat but in the field of agricultural commodities.

BIBLIOGRAPHY

Baffes J. *"Some Further Evidence on the Law of One Price: The Law of One Price Still Holds"* (1991). American Journal of Agricultural Economics 73: 1264-1273

Bailey D. and Brorsen W. *"Price Asymmetry in Spatial Fed Cattle Markets"* (1989), Western Journal of Agricultural Economics 14(2): 246-252.

Balke, N.S. and Fomby, T.B. *"Threshold Cointegration"* (1997), International Economic Review, Vol. 38., 627-645.

Chan, K.S. (1993). *"Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model".* The Annals of Statistics 21: 520-533.

Cramon Taubadel, S. von and J. Meyer, 2000, *"Asymmetric price transmission: Fact or artefact?"*, Diskussionsbeitrag 2002, Institut fur Agrarokonomie, Gottingen.

Cramon-Taubadel, S. and Fahlbusch S. (1996) *"Estimating asymmetric Price Transmission with the Error Correction Representation: An Application to the German Pork Market"*, Kiel, Germany, University of Kiel, Department of Agricultural Economics.

Engle, R.F. and C.W.J. Granger (1987), *"Cointegration and error correction: Representation, estimation and testing",* Econometrica 49: 251-276.

Gardner L.B. and Brooks M.K. *"Food Prices and Market Integration in Russia: 1920-93"* (1994). American Journal of Agricultural Economics 76: 640-646.

Harper D. and Goodwin B. *"Price Transmission, Threshold Behavior, and Asymmetric Adjustment in the U.S. Pork Sector"* (2000). Journal of Agricultural and Applied Economics, Vol. 32, 543-553.

Hassan, D. and Simioni M. (2001). *"Price Linkage and Transmission between shippers and retailers in the French vegetable channel"*. Institute Nationale de la Recherche Agronomique. 1-26.

Houck, P.J., 1977, *"An approach to specifying and estimating nonreversible functions"*, American Journal of Agricultural Economics 59: 570-572.

Institute for Economic Research and Policy Consulting in Ukraine. *"Drawing the right conclusions from the current situation on Ukrainian grain markets"*. April, 2003

Institute for Economic Research and Policy Consulting in Ukraine. *"Grain Market Regulation in Ukraine: Options and Evaluation"*. July, 2002.

Kinnucan, H.W. and Forker, O.D. (1987) *"Asymmetry in Farm-Retail Price Transmission for major Dairy Products"*, American Journal of Agricultural Economics, Vol. 69, pp. 285-292.

Laping Wu. *"Price Linkages between Chinese and World Main Food Markets"*, College of Economics and Management, China Agricultural University.

Schroeder T. *"Price Linkages between Wholesale and Retail Pork Cuts"* (1988), Agri-business, Vol. 4, No. 4, 359-369.

Ward R.W. (1982) *"Asymmetry in Retail, Wholesale and Shipping Poing Pricing for fresh Vegetables",* American Journal of Agricultural Economics, Vol. 62, 205-212.

http://apps2.fao.org:8000/monikers/ESC/WeeklyPricesServlet.js

APPENDICES

Appendix 1: Descriptive Statistics for Ukrainian and World price series.

	UkPRICE	WPRICE
Mean	537.8463	528.5105
Median	499.6500	552.8900
Maximum	1240.000	907.5000
Minimum	163.2000	189.9700
Std. Dev.	260.9495	166.4828
Skewness	0.613776	-0.224635
Kurtosis	2.514045	2.422525
Jarque-Bera	21.49744	6.602288
Probability	0.000021	0.036841
Observations	296	296

Appendix 2.
Checking prices for the presence of unit root.

Presence of Unit Root in Ukrainian Price

Null Hypothesis: UPRICE has a unit root
Exogenous: Constant
Lag Length: 4 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.102761	0.9655
Test critical values:	1% level	-3.452674	
	5% level	-2.871263	
	10% level	-2.572023	

*MacKinnon (1996) one-sided p-values.

ADL Equation for Ukrainian Price

Dependent Variable: UPRICE
Method: Least Squares
Date: 01/28/04 Time: 16:11
Sample(adjusted): 1/29/1998 8/28/2003
Included observatio292 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UPRICE(-1)	1.233681	0.058515	21.08319	0.0000
UPRICE(-2)	-0.245755	0.093026	-2.641774	0.0087
UPRICE(-3)	0.136662	0.093041	1.468837	0.1430
UPRICE(-4)	-0.121023	0.058958	-2.052700	0.0410

R-squared	0.991950	Mean dependent var	541.6627
Adjusted R-squared	0.991866	S.D. dependent var	260.6703
S.E. of regression	23.50955	Akaike info criterion	9.166294
Sum squared resid	159177.3	Schwarz criterion	9.216661
Log likelihood	-1334.279	Durbin-Watson stat	2.002105

Null Hypothesis: D(UPRICE) has a unit root
Exogenous: None
Lag Length: 4 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.106697	0.0000
Test critical values:	1% level	-2.572960	
	5% level	-1.941921	
	10% level	-1.615968	

*MacKinnon (1996) one-sided p-values.

Presence of Unit Root in World Price

Null Hypothesis: WPRICE has a unit root
Exogenous: None
Lag Length: 4 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.243720	0.9457
Test critical values:	1% level	-2.572933	
	5% level	-1.941918	
	10% level	-1.615971	

*MacKinnon (1996) one-sided p-values.

ADL Equation for World Price

Dependent Variable: WPRICE
Method: Least Squares
Date: 01/28/04 Time: 16:14
Sample(adjusted): 1/15/1998 8/28/2003

Included observatio294 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	21.82164	6.271199	3.479659	0.0006
@TREND	0.147119	0.042903	3.429103	0.0007
WPRICE(-1)	1.045069	0.058886	17.74727	0.0000
WPRICE(-2)	-0.124278	0.058873	-2.110943	0.0356

R-squared	0.982506	Mean dependent var	530.4362
Adjusted R-squared	0.982325	S.D. dependent var	165.3927
S.E. of regression	21.98882	Akaike info criterion	9.032458
Sum squared resid	140217.4	Schwarz criterion	9.082574
Log likelihood	-1323.771	F-statistic	5428.880
Durbin-Watson stat	1.958288	Prob(F-statistic)	0.000000

Null Hypothesis: D(WPRICE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.564985	0.0000
Test critical values:	1% level	-3.990019	
	5% level	-3.425397	
	10% level	-3.135832	

*MacKinnon (1996) one-sided p-values.

Appendix 3.
Long-Run equilibrium relationship between Ukrainian and World Prices:

Table 3.1.

Dependent Variable: UPRICE
Method: Least Squares
Date: 05/13/04 Time: 14:23
Sample(adjusted): 1/01/1998 8/28/2003
Included observations: 296 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D_IMPORT	176.6743	25.78937	6.850666	0.0000
D_EXPORT	-146.8839	26.11069	-5.625430	0.0000
WPRICE	1.022573	0.044901	22.77410	0.0000

R-squared	0.760362	Mean dependent var	537.8463
Adjusted R-squared	0.758726	S.D. dependent var	260.9495
S.E. of regression	128.1775	Akaike info criterion	12.55479
Sum squared resid	4813836.	Schwarz criterion	12.59219
Log likelihood	-1855.109	F-statistic	464.8380
Durbin-Watson stat	0.253712	Prob(F-statistic)	0.000000

Table 3.2.1.

Wald Test:
Equation: EQ_COINT2

Null Hypothesis:	C(3)=1		
F-statistic	0.252744	Probability	0.615527

Chi-square	0.252744	Probability	0.615149

Table 3.2.2.

Wald Test:
Equation: EQ_COINT2

Null Hypothesis:	C(1)=C(2)		
F-statistic	464.4766	Probability	0.000000
Chi-square	464.4766	Probability	0.000000

Appendix 4. Checking for cointegration.

Table 1

Dependent Variable: D(RESIDCOINT)
Method: Least Squares
Date: 05/16/04 Time: 23:03
Sample(adjusted): 1/22/1998 8/28/2003
Included observations: 293 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESIDCOINT(-1)	-0.226945	0.057845	-3.923318	0.0001
RESIDCOINT(-2)	-0.042724	0.073504	-0.581242	0.5615
RESIDCOINT(-3)	0.174918	0.058137	3.008739	0.0029

R-squared	0.099997	Mean dependent var	1.229719
Adjusted R-squared	0.093790	S.D. dependent var	64.66044
S.E. of regression	61.55353	Akaike info criterion	11.08788
Sum squared resid	1098763.	Schwarz criterion	11.12556
Log likelihood	-1621.374	Durbin-Watson stat	1.981572

Null Hypothesis: RESIDCOINT has a unit root
Exogenous: None
Lag Length: 3 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.257325	0.0000
Test critical values:	1% level	-2.572878	
	5% level	-1.941910	
	10% level	-1.615976	

*MacKinnon (1996) one-sided p-values.

Appendix 5. Error Correction Model

Table 1b.

Dependent Variable: D(UPRICE)

Method: Least Squares
Date: 05/16/04 Time: 00:45
Sample(adjusted): 4/02/1998 8/28/2003
Included observations: 283 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UPRICE(-1))	0.264764	0.057208	4.628123	0.0000
D(UPRICE(-6))	0.110814	0.057359	1.931934	0.0544
D(UPRICE(-12))	0.146712	0.058960	2.488344	0.0134
D(WPRICE)	0.128934	0.061879	2.083644	0.0381
RESCOINT1	-0.019191	0.011356	-1.689985	0.0922

R-squared	0.104135	Mean dependent var	3.453004
Adjusted R-squared	0.091245	S.D. dependent var	24.64468
S.E. of regression	23.49344	Akaike info criterion	9.168830
Sum squared resid	153439.8	Schwarz criterion	9.233237
Log likelihood	-1292.389	Durbin-Watson stat	2.027788

Table 1c.

Wald Test:
Equation: ECMTHRESHOLFINAL

Null Hypothesis: C(1)=0
C(2)=0
C(3)=0
C(4)=0
C(5)=1

F-statistic	1637.400	Probability	0.000000
Chi-square	8187.001	Probability	0.000000

Table 1d.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.649534	Probability	0.523086
Obs*R-squared	0.000000	Probability	1.000000

Table 1e.

White Heteroskedasticity Test:

F-statistic	0.433059	Probability	0.929684
Obs*R-squared	4.435112	Probability	0.925591

Table 1f.

Ramsey RESET Test:

F-statistic	2.188738	Probability	0.113999
Log likelihood ratio	4.453277	Probability	0.107891

Appendix 5. Asymmetry model

Results obtained using the threshold value of 0

Table 2a.

Dependent Variable: D(RESCOINT)
Method: Least Squares
Date: 05/17/04 Time: 22:53
Sample(adjusted): 1/22/1998 8/28/2003
Included observations: 293 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESCOINT1*DPCHAN	-0.069188	0.033190	-2.084596	0.0380
RESCOINT1*DNCHAN	-0.152508	0.050671	-3.009778	0.0028
D(RESCOINT(-2))	-0.198576	0.057365	-3.461626	0.0006

R-squared	0.093755	Mean dependent var	0.221207
Adjusted R-squared	0.087505	S.D. dependent var	62.23304
S.E. of regression	59.44786	Akaike info criterion	11.01826
Sum squared resid	1024874.	Schwarz criterion	11.05594
Log likelihood	-1611.175	Durbin-Watson stat	2.056679

Table 2b.

Wald Test:
Equation: P33

Null Hypothesis:	C(1)=0 C(2)=0		
F-statistic	6.648349	Probability	0.001503
Chi-square	13.29670	Probability	0.001296

Table 2c.

Null Hypothesis:	C(1)=C(2)		
F-statistic	1.907215	Probability	0.168336
Chi-square	1.907215	Probability	0.167273

Table 2d.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.629903	Probability	0.533376
Obs*R-squared	1.271567	Probability	0.529521

Results obtained using the threshold value of plus/minus 5,37704

Table 3a.

Dependent Variable: D(RESCOINT)
Method: Least Squares
Date: 05/20/04 Time: 15:25
Sample(adjusted): 1/22/1998 8/28/2003
Included observations: 293 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESCOINT1*DPCHAN	-0.058509	0.033666	-1.737941	0.0833
RESCOINT1*DNCHAN	-0.125673	0.053906	-2.331326	0.0204
D(RESCOINT(-2))	-0.205344	0.057653	-3.561739	0.0004

R-squared	0.078848	Mean dependent var	0.221207
Adjusted R-squared	0.072495	S.D. dependent var	62.23304
S.E. of regression	59.93480	Akaike info criterion	11.03458
Sum squared resid	1041732.	Schwarz criterion	11.07226
Log likelihood	-1613.566	Durbin-Watson stat	2.093157

Table 3b. Checking the null hypothesis $\rho_1 = \rho_2 = 0$

Wald Test:
Equation: P33

Test Statistic	Value	df	Probability
F-statistic	4.194199	(2, 290)	0.0160
Chi-square	8.388397	2	0.0151

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.058509	0.033666
C(2)	-0.125673	0.053906

Table 3c. Checking for the symmetry of coefficients

Wald Test:
Equation: P33

Test Statistic	Value	df	Probability
F-statistic	1.125221	(1, 290)	0.2897
Chi-square	1.125221	1	0.2888

Null Hypothesis Summary:		
Normalized Restriction (= 0)	Value	Std. Err.
C(1) - C(2)	0.067164	0.063316

Restrictions are linear in coefficients.

Table 3d.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.103872	Probability	0.123854
Obs*R-squared	4.214595	Probability	0.121566

Table 4.

Estimated Asymmetry Model under threshold value of plus/minus 5,37704

Dependent Variable: D(UPRICE)
Method: Least Squares
Date: 05/20/04 Time: 15:27
Sample(adjusted): 2/19/1998 8/28/2003
Included observations: 289 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UPRICE(-1))	0.262399	0.056600	4.636059	0.0000
D(UPRICE(-3))	0.131018	0.056780	2.307464	0.0218
D(UPRICE(-6))	0.111229	0.056864	1.956039	0.0514
D(WPRICE)	0.135639	0.061284	2.213273	0.0277
RESCOINT1*DPCHAN	-0.032799	0.012999	-2.523086	0.0122
RESCOINT1*DNCHAN	0.008123	0.022143	0.366814	0.7140

R-squared	0.109737	Mean dependent var	3.410727
Adjusted R-squared	0.094008	S.D. dependent var	24.39018
S.E. of regression	23.21546	Akaike info criterion	9.148056
Sum squared resid	152525.0	Schwarz criterion	9.224176
Log likelihood	-1315.894	Durbin-Watson stat	2.005977

Table 4a. Symmetry in adjustment coefficients.

Wald Test:
Equation: TARFORTHESIS

Test Statistic	Value	df	Probability
F-statistic	2.578888	(1, 283)	0.1094

Chi-square	2.578888	1	0.1083

Table 4b.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.015444	Probability	0.984675
Obs*R-squared	0.000000	Probability	1.000000

Table 4c.

White Heteroskedasticity Test:

F-statistic	0.541931	Probability	0.886252
Obs*R-squared	6.652725	Probability	0.879684

Table 4d.

Ramsey RESET Test:

F-statistic	4.079010	Probability	0.044365
Log likelihood ratio	4.150318	Probability	0.041627

Table 4e. Restrictions on coefficients.

Wald Test:
Equation: TARFORTHESIS

Test Statistic	Value	df	Probability
F-statistic	1453.415	(6, 283)	0.0000
Chi-square	8720.490	6	0.0000

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.262525	0.056567
C(2)	0.131131	0.056767
C(3)	0.111222	0.056864
C(4)	0.136214	0.061187
-1 + C(5)	-1.032814	0.012999
-1 + C(6)	-0.992374	0.020327

Restrictions are linear in coefficients.

Table 4f. TAR model with common coefficient of asymmetric adjustment.

Dependent Variable: D(UPRICE)
Method: Least Squares

Date: 05/22/04 Time: 13:45
Sample(adjusted): 4/02/1998 8/28/2003
Included observations: 283 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UPRICE(-1))	0.261101	0.057079	4.574371	0.0000
D(UPRICE(-3))	0.137027	0.056753	2.414450	0.0164
D(UPRICE(-12))	0.151459	0.058400	2.593457	0.0100
D(WPRICE)	0.147011	0.061668	2.383914	0.0178
RESCOINT1*DCOMMONSIGMA	-0.021519	0.011617	-1.852430	0.0650

R-squared	0.111536	Mean dependent var	3.453004
Adjusted R-squared	0.098753	S.D. dependent var	24.64468
S.E. of regression	23.39619	Akaike info criterion	9.160533
Sum squared resid	152172.1	Schwarz criterion	9.224941
Log likelihood	-1291.215	Durbin-Watson stat	2.024617

Table 4f.

Ramsey RESET Test:

F-statistic	1.799372	Probability	0.167338
Log likelihood ratio	3.666166	Probability	0.159920

Table 4g.

White Heteroskedasticity Test:

F-statistic	0.357398	Probability	0.963497
Obs*R-squared	3.670286	Probability	0.960998

e 5h.

Breusch-Godfrey onTest:

F-statistic	0.619096	Probability	0.539177
Obs*R-squared	0.000000	Probability	1.000000

Appendix 6. Model specifications.

Table 5a.

Dependent Variable: D(UPRICE)
Method: Least Squares
Date: 05/16/04 Time: 16:51
Sample(adjusted): 1/29/1998 8/28/2003
Included observations: 292 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UPRICE(-1))	0.259679	0.059238	4.383670	0.0000
D(UPRICE(-2))	-0.002071	0.059917	-0.034557	0.9725
D(UPRICE(-3))	0.144085	0.058093	2.480246	0.0137
D(WPRICE)*DPWORLD	0.177392	0.077007	2.303587	0.0220
D(WPRICE)*DNWORLD	0.089256	0.102061	0.874538	0.3826
RESCOINT1*DPCHAN	-0.031280	0.013081	-2.391317	0.0174
RESCOINT1*DNCHAN	0.007958	0.019667	0.404647	0.6860

R-squared	0.099687	Mean dependent var	3.356164
Adjusted R-squared	0.080733	S.D. dependent var	24.27086
S.E. of regression	23.27051	Akaike info criterion	9.155932
Sum squared resid	154332.3	Schwarz criterion	9.244073
Log likelihood	-1329.766	Durbin-Watson stat	2.009786

Table 5b.

Test Statistic	Value	df	Probability
F-statistic	0.118795	(1, 285)	0.7306
Chi-square	0.118795	1	0.7303

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3) - C(4)	-0.033307	0.096637

Restrictions are linear in coefficients.

Table 5c.

Test Statistic	Value	df	Probability
F-statistic	1.349722	(1, 285)	0.2463
Chi-square	1.349722	1	0.2453

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5) - C(6)	0.120537	0.103752

Restrictions are linear in coefficients.

Table 6a.

Dependent Variable: D(UPRICE)
Method: Least Squares
Date: 05/16/04 Time: 16:00
Sample(adjusted): 1/29/1998 8/28/2003
Included observations: 292 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UPRICE(-1))	0.250967	0.058760	4.271049	0.0000
D(UPRICE(-2))	-0.014455	0.060178	-0.240198	0.8104
D(UPRICE(-3))	0.130541	0.058319	2.238391	0.0260
D(WPRICE)	0.143463	0.061929	2.316585	0.0212
DS1	0.736769	2.845429	0.258931	0.7959
DS2	4.467848	2.909035	1.535852	0.1257
DS3	4.173879	2.854673	1.462122	0.1448
DS4	-0.323003	2.646287	-0.122059	0.9029
RESCOINT1*DPCHAN	-0.033123	0.013204	-2.508593	0.0127
RESCOINT1*DNCHAN	0.013601	0.020990	0.647984	0.5175

R-squared	0.112596	Mean dependent var	3.356164
Adjusted R-squared	0.084275	S.D. dependent var	24.27086
S.E. of regression	23.22564	Akaike info criterion	9.162037
Sum squared resid	152119.4	Schwarz criterion	9.287954
Log likelihood	-1327.657	Durbin-Watson stat	2.001962