Impact of government intervention on price integration between Polish and world wheat markets

Szczepan Figiel*

Abstract

Market reforms implemented in Poland, especially broader openness to international trade, should result in increasing price integration between Polish and world markets for such internationally traded commodities like wheat. However, in a period of economic transformation, Polish agricultural prices have been very volatile which led to government intervention in the market. Mainly because of such practises, Polish monthly wheat prices were found, using regression and cointegration analysis, to be generally unrelated to selected world prices over the period of 1990/91 through 1996/97. The intervention also caused such market distortions as deviations of prices from a normally expected seasonal pattern.

Keywords: grain market, pricing efficiency, intervention price

Introduction

Introduction of free market reforms in Poland at the beginning of the 90's led to numerous economic adjustments. Price fluctuations began to occur naturally in many sectors of the economy. Agricultural sectors were among the first to be exposed to free market mechanisms. At the same time, the Polish economy became much more open to international trade. As a result, world agricultural markets should have an increasing impact on the prices of agricultural commodities in Poland. This is supposed to be especially noticeable during 1994-97, when after a 4-year recession period (1989-93) GDP has grown at an average rate of over 6% and the volume of agricultural foreign trade in Poland increased by almost 50%.

Under a free market oriented transformation, the price volatility of agricultural commodities has become a major source of risk for both farmers and agribusiness firms. Unfortunately, the market infrastructure and institutions have remained relatively underdeveloped and risk hedging market mechanisms are still practically unavailable. Under such circumstances there has been growing political pressure on the government to assume responsibility for stabilising agricultural prices. This is now reflected in various state intervention measures, which were undertaken in major Polish agricultural markets such as, for example, grain. The main intervention policy instrument used in this market, and at the same time considered a very controversial one in terms of market distortion effects, is the so-called intervention price.

The purpose of this paper is twofold. First, to examine whether the broader openness of the Polish economy to the international economy and trade linkages have led to a greater price integration between Polish and Western grain markets. Second, to analyse the impact

* Department of Marketing and Market Analyses, University of Warmia and Mazury in Olsztyn, ul. Oczapowskiego 4/210 C, 10-957 Olsztyn, POLAND. E-mail: sfigiel@icbpm.uwm.edu.pl

of the market interventions adopted by the Polish government on domestic grain prices and their integration with selected international prices.

Theoretical and conceptual background

Price analysis is an indirect approach for determining market efficiency. Efficient marketing systems are characterised by a high degree of price integration – closely correlated movements of connected series of prices – over space, form and time (Timmer et al., 1983, p. 170). In general, economic efficiency of the marketing system takes place when a set of agents existing in the market delivers the correct product, in the correct form, to the correct place, at the correct time. Efficiency in the marketing system entails doing this at minimum cost, hence price differences should be minimised costs of marketing activities in general (Kohls and Uhl, 1990, pp. 31-33). Such an approach seems to be reasonable also when considering price relationships between geographically different markets, for example, domestic and international markets. In this case a perfectly efficient situation would exist if prices on these markets differed only in the transportation and transaction costs. This view refers to the law of one price (LOP) which states that, under competitive market conditions, all prices within a market tend to equality when allowances are made for the costs of storage, processing and transportation (Kohls and Uhl, 1990, p. 147; Padberg et al., 1997, p. 56). Strong empirical evidence supporting existence of the LOP in the context of international trade can be found in Officer (1986) and Goodwin et al. (1990a, 1990b).

The commodity selected for analysis is wheat as it is the most widely traded grain in Poland. The total size of the wheat market, which is one of the most important agricultural markets in Poland, accounts for 9-11 million MT. Poland is a net importer of wheat with import quantities varying widely year to year from several hundred to over 2 million MT. This implies the possible existence of wheat price linkages between the Polish market and some international markets. According to basic international trade theories Poland is a "small country case" when considering production of wheat. Therefore, it would not benefit from policies, which, in effect, separate domestic from international wheat prices. A related argument would also be that, allowing for the justifiable cost of transferring the commodity between markets, prices received by farmers shouldn't be lower, and prices paid by agribusinesses shouldn't be higher, than respective world prices.

Since Polish domestic and international wheat markets are examples of spatially different markets, examining the possible existence of their being integrated should provide some insight into the pricing efficiency of the emerging Polish wheat market viewed from the perspective of international markets. Theoretically, the integration of Polish and international wheat prices, if found, could be seen as an indication of improving pricing efficiency of the Polish wheat market during the period of economic transition.

Selection of wheat price series and methods of analysis

Despite the beginnings of a free market system, finding a representative price series in Poland to compare against world prices is somewhat problematic. While several grain exchanges exist where physical cash is traded, the volume of trade is erratic and quoted prices might not be representative of the overall market. In addition, most of these exchanges were created in the last few years, thereby limiting the time frame available for analysis.

The Polish price series chosen for this analysis was the average monthly wheat prices for Poland as reported by the Main Statistical Office (GUS). It represents prices paid to farmers by commercial enterprises. These prices, expressed in US dollar terms, were com-

pared with selected international cash and futures prices. Two cash price series, French export wheat (Rouen) and US export wheat (Gulf of Mexico), were chosen as the most relevant from the point of view of location and type of wheat traded. Additionally, in order to determine whether the price information provided by international futures contract exchanges has any impact on Polish wheat price behaviour, prices quoted for wheat nearby contracts traded at the CBOT and LIFFE (London International Financial Futures Exchange)[1] were also considered.

The analysis was carried over a period of 7 crop years (i.e. from 1990/91 to 1996/97). This period represents the time during which Poland experienced a liberalised economic structure. Price calculations were performed in US dollars for 84 points apart from French wheat and LIFFE[2] futures where the numbers of available observations were 76 and 70 respectively. Regression analysis and testing for cointegration were used to study the relationship between Polish and selected world wheat prices.

Results of the price integration analysis

Wheat price variation over time and correlation of prices

The primary objective of examining variation over time was to gain insight into the degree of Polish price volatility. A great deal of variation is observed over time in Polish wheat prices (Table 1, Graph 1). Prices tend to be very volatile, especially in years of relative shortages, when the supply of wheat is considerably lower compared to average years. When compared with the benchmark world prices, Polish wheat prices exhibited even stronger variation in certain years.

Table 1. Variation over time of monthly Polish and selected world wheat price

Year	Coefficient of Variation [%]				
	Polish Wheat	US Wheat	French Wheat	CBOT	LIFFE
1990/91	6.6	4.8	12.5	6.1	NA
1991/92	12.2	11.3	19.9	12.3	6.1
1992/93	8.7	10.4	9.1	8.7	4.1
1993/94	7.1	8.8	5.8	7.3	6.0
1994/95	17.2	8.0	9.0	6.6	7.7
1995/96	23.2	10.4	10.3	8.7	3.7
1996/97	12.9	7.8	8.3	8.9	4.2

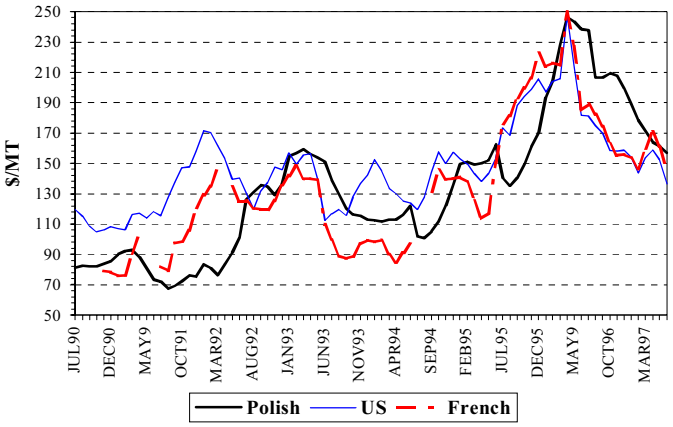
Table 2 presents correlation of Polish wheat prices against the selected world prices calculated for three time periods: 1990/91 through 1993/94, 1994/95 through 1996/97, and 1990/91 through 1996/97. In general, as it can be seen in the table, the correlation among price series was rather poor. In fact, in the first period 3 out of 4 correlation coefficients have negative signs. In the second period there is a considerable improvement in correlations, particularly regarding the French, US and CBOT prices. The same is also true for the third time period. This suggests that some price convergence has been occurring in recent marketing years. Graph 1 shows in a visual fashion what the correlation statistics implied.

Table 2. Correlation between Polish and selected world wheat prices

Time period	Correlation coefficient of Polish price against			
	US Wheat	French Wheat	CBOT	LIFFE
1990/91 - 93/94	-0.25*	0.31**	-0.35**	-0.09
199 4/95 - 96/97	0.56***	0.59***	0.56***	0.08
1990/91 - 96/97	0.58***	0.74***	0.60***	-0.24**

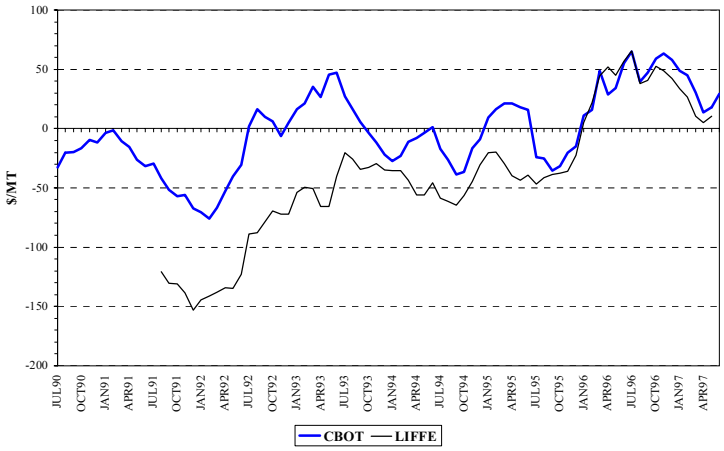
Note: * means 10% level of significance; ** means 5% level of significance; *** means 1% level of significance.

Graph 1: Polish, US and French wheat prices



Another useful way of looking at price relationships, especially when futures prices are considered, is to calculate a price basis. In our case the basis was calculated as the difference between the Polish cash wheat price and CBOT and LIFFE futures prices used respectively as a base. A graphical display of these relationships is shown in Graph 2. It can be seen that the magnitude of the basis appears to be declining during recent years.

Graph 2: Basis between Polish wheat cash and CBOT and LIFFE wheat futures prices



Price transmission elasticities

Price transmission elasticities were estimated to measure the percentage change in the Polish domestic price associated with a percentage change in the world prices (FAO, 1996). The following regression model was used to estimate the elasticity coefficients:

$$\log(PLW) = \log(a) + e_1\log(PLW(-1)) + e_2\log(PLW(-2)) + e_3\log(SWP) \quad (1)$$

where PLW denotes Polish wheat price, PLW(-1) and PLW(-2) are their values lagged by 1 and 2 months respectively, and SWP is a selected world price. The parameters of the equation were estimated separately for each world wheat price considered namely: US wheat cash price (USW), French wheat cash price (FRW), CBOT wheat futures (CBOTW) and LIFFE wheat futures (LIFFEW). The results are shown in Table 3. For the period of 1990/91-93/94 the elasticity estimates were positive, but not statistically significant. In the period of 1994/95-96/97 they were also positive and became highly significant for both the US cash wheat price and CBOT futures. This might be evidence of Polish prices changing in this period toward being more in line with the world markets. The elasticities for the overall period 1990/91-96/97 are lower than in the second time period, however, they are statistically highly significant apart from LIFFE futures.

Table 3. Price transmission elasticities

Variable	Elasticity (e_3)	t-statistic	R^2	DW statistic
Period 1990/91-93/94:				
USW	0.08 (0.06)	1.37	0.96	2.09
FRW	0.06 (0.04)	1.24	0.96	2.09
CBOTW	0.08 (0.06)	1.32	0.96	2.10
LIFFEW	0.10 (0.07)	1.38	0.96	1.94
Period 1994/95-96/97:				
USW	0.27 (0.08)	3.48***	0.95	1.74
FRW	0.10 (0.06)	1.89*	0.95	2.21
CBOTW	0.23 (0.08)	2.70***	0.95	1.74
LIFFEW	0.24 (0.15)	1.66	0.94	1.56
Period 1990/91-96/97:				
USW	0.13 (0.04)	3.14***	0.97	2.10
FRW	0.08 (0.03)	2.75***	0.98	2.12
CBOTW	0.12 (0.04)	2.84***	0.97	2.12
LIFFEW	0.11 (0.06)	1.70*	0.97	1.97

Notes: a) values in parentheses are standard errors. b) * means 10% level of significance; ** means 5% level of significance; *** means 1% level of significance.

Analysis of cointegration between Polish and selected world prices

Cointegration is considered to be a particularly attractive method for analysis of prices if markets are spatially linked (Bessler and Fuller, 1993). In general, there are four major steps in applying unit root and cointegration techniques. First, unit root tests are applied to determine if the variables in the regression are stationary or nonstationary. Second, cointe-

grating regressions are estimated if the variables satisfy certain conditions. These cointegration regressions are the long run or equilibrium relationships between these variables. Third, the short run or the dynamic disequilibrium relationships are estimated utilising the estimates of the long-run parameters within the error correction framework. Finally, the robustness of the estimated dynamic disequilibrium relationships is determined subject to the standard diagnostic tests (Rao, 1994, pp. 5-6). In this paper only the results of the two first steps are presented, as the testing for cointegration between the analysed variables did not provide sufficient evidence of them being cointegrated.

Tables 4 and 5 contain the augmented Dickey-Fuller (ADF) test statistics calculated for series levels and first differences as well as residuals from pairwise cointegrating regressions. There are two types of specification included in Table 4 (i.e. with trend and without trend) to which the ADF test was applied. In addition to the residuals, Table 5 also includes ADF tests on the contemporaneous price difference between each world market price and the Polish price over the same period (this is labelled as basis).

Table 4. Augmented Dickey-Fuller (ADF) tests (with and without trend) on levels and first differences of monthly Polish and selected world prices

Series	ADF (Trend)		ADF (No Trend)	
	Levels	1st Differences	Levels	1st Differences
PLW	-2.30	-5.58	-1.62	-5.59
USW	-2.32	-7.78	-2.22	-7.78
FRW	-1.45	-6.21	-2.07	-6.05
CBOTW	-2.07	-7.71	-2.05	-7.71
LIFFEW	-2.77	-5.27	-2.06	-5.31

Note: Calculations for levels were performed with both one lag on the dependent variable and its difference. No lags included for 1st differences. MacKinnon critical values for the calculations with trend are -4.07 (1%) and -3.16 (10%), and for the calculations without trend-3.51 (1%) and -2.59 (10%). The coefficient on the time trend was not significantly different from zero (at the 5% level) in all above ADF tests with trend.

Table 5. Augmented Dickey-Fuller statistics on the residuals from the pairwise cointegrating regressions: Polish wheat on selected world prices

Price	Residuals	Basis
USW	-2.28	-2.14
FRW	-2.07	-2.23
CBOTW	-2.26	-2.05
LIFFEW	-2.11	-1.60

Note: Calculations were performed with both one lag on the dependent variable and its difference. MacKinnon critical value for the calculations at 10% level is -2.59.

The analysed price series were nonstationary in levels but first differences showed no evidence of non-stationary behaviour. Results for time trend and no-time-trend specifications are consistent. The ADF statistics (shown in Table 5) for wheat price pairs tested are, in absolute values below the 90% critical level thus the hypothesis of cointegration is rejected. The basis results also do not offer support for cointegration between each selected world price and Polish wheat price. This means that according to the ADF test and for the

period tested, Polish and the analysed world wheat prices do not move together in the long run[3].

Discussion of possible reasons for the low level of price integration

The lack of a stable long run relationship between Polish and world wheat prices suggests the existence of domestic factors as potentially responsible for this kind of distortion. Among the numerous possibilities typical for transition economies are market inefficiencies, due to underdeveloped market infrastructure and information dissemination, currency exchange rate risk, and government intervention (Loy and Wehrheim, 1999; Schmitz and Noeth, 1999). In Poland it is strongly believed that the domestic wheat market is particularly heavily affected by government intervention (Figiel et al., 1997; Gardner, 1996). Western markets are also influenced by such practices to a certain extent[4].

Polish government intervention in the wheat market

The Agency for Agricultural Markets (the Polish acronym is ARR) is the primary government agency charged with implementing agricultural policies in Poland. With regard to wheat, one of the key objectives of the ARR is to assure a minimum wheat price through direct intervention purchases in the wheat market. The minimum price that goes into effect in August of a particular crop year is typically announced during the preceding March. In order to keep prices from falling below this minimum price, the ARR is allowed to pay an intervention price that can be up to 20% higher than the minimum price depending on the market situation. In order to keep prices from falling below the established minimum level the ARR acts by regulating the supplied quantity of grains. This is based on isolating surpluses from the domestic market in the years of relative overproduction through intervention purchases and building buffer stocks (Gutkowski, 1995; Urban, 1996).

The accumulated stocks are used to stabilise market when an insufficient supply of grains causes prices to increase rapidly. In such cases the ARR offers grain through an auction system thereby trying to influence the market to prevent domestic prices from rising above the import prices.

Impact of the market interventions on the formation of wheat prices

Graph 3 shows ARR intervention prices and nominal Polish wheat prices. As can be seen, they tend to move together over the period of the study. In order to better capture its impact on the market price of wheat in Poland the intervention price was incorporated as one of the explanatory variables into the following regression model:

$$PLW = a + \sum_{i=1}^{6} b_i PLW(-i) + b_7 USW + b_8 FRW + b_9 CBOTW + b_{10} LIFFEW + b_{11} IP \qquad (2)$$

where PLW(-i) are 1 to 6 month lagged values of PLW, IP is Polish intervention price and the other variables as denoted earlier.

The results contained in Table 6 indicate that the intervention price levels have had a statistically significant influence on the Polish wheat market price. The positive sign of the coefficient indicates that intervention prices contributed to higher market prices of wheat during the period analysed.

Graph 3: Polish wheat cash prices and ARR intervention price levels

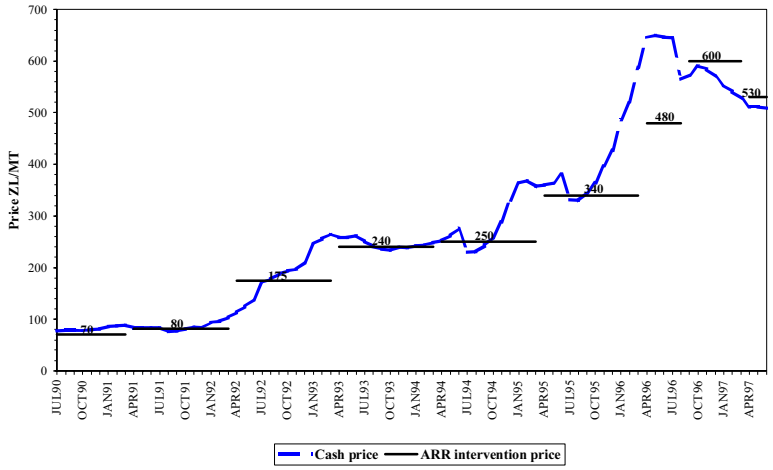


Table 6. Regression results estimated from the equation including Polish intervention price levels

Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
Constant	26.45 (18.61)	1.42	PLW(-6)	-0.18 (0.13)	-1.35
PLW(-1)	1.13 (0.14)	8.33***	FRW	0.14 (0.08)	1.71*
PLW(-2)	-0.21 (0.20)	-1.06	USW	0.27 (0.19)	1.43
PLW(-3)	0.03 (0.19)	0.15	LIFFEW	-0.14 (0.07)	-1.82*
PLW(-4)	-0.21 (0.19)	-1.12	CBOTW	-0.31 (0.19)	-1.61
PLW(-5)	0.16 (0.18)	0.84	IP	0.16 (0.07)	2.08**
Number of observations included: 67 after adjusting endpoints					
R^2 0.98	Durbin-Watson statistic 2.09			F-statistic 193.22	

Notes: a) values in parentheses are standard errors. b)* means 10% level of significance; ** means 5% level of significance; *** means 1% level of significance.

Under normal market conditions a seasonal pattern should be observed that reflects costs of handling and storage from the harvest period forward as described by Padberg et al. (1997, pp. 57-58) and Tomek and Robinson (1995, pp.160-162). A reverse market situation is usually very devastating for all businesses involved in storing grain. According to the theory of efficient commodity markets the rate of return from holding commodity stocks must equal the rate of return from holding financial assets (Benirshka and Binkley, 1995). Major departures from this reduce or eliminate incentives for private businesses to get involved in storing grain on a larger scale.

In the case of Poland wheat prices are expected to be the lowest in August (after the harvest) and then gradually rise till the next June when the crop year ends. Some insight into the seasonal pattern of the Polish wheat prices is provided by regression results included in Table 7 obtained using the following model:

$$PLW = a + \sum_{i=1}^{12} b_i PLW(-i) + \sum_{i=2}^{12} c_i S_i + c_{24} T + c_{25} IP \quad (3)$$

where PLW(-i) are 1 to 12 month lagged values of PLW, S_i are monthly seasonal dummy variables, T is the trend variable, and IP is the Polish intervention price.

Table 7. Regression results estimated from the equation reflecting seasonal price differences for the period of 1990/91-96/97

Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
Constant	6.45 (11.28)	0.57	S_2	-14.30 (12.21)	-1.17
PLW(-1)	1.21 (0.14)	8.36***	S_3	-9.50 (12.73)	-0.75
PLW(-2)	-0.19 (0.23)	-0.83	S_4	-25.80 (13.62)	-1.89*
PLW(-3)	-0.00 (0.23)	-0.01	S_5	-23.42 (13.37)	-1.75*
PLW(-4)	-0.26 (0.23)	-1.15	S_6	-16.41 (13.85)	-1.18
PLW(-5)	0.04 (0.23)	0.16	S_7	-34.98 (12.45)	-2.81***
PLW(-6)	0.11 (0.24)	0.46	S_8	-27.87 (12.37)	-2.25**
PLW(-7)	-0.10 (0.23)	-0.43	S_9	-6.25 (12.94)	-0.48
PLW(-8)	-0.12 (0.24)	-0.51	S_{10}	-5.14 (12.80)	-0.41
PLW(-9)	-0.14 (0.23)	-0.58	S_{11}	-9.32 (12.87)	-0.72
PLW(-10)	0.24 (0.23)	1.02	S_{12}	-11.78 (12.51)	-0.94
PLW(-11)	-0.12 (0.28)	-0.43	T	0.98 (0.47)	2.12**
PLW(-12)	0.04 (0.21)	0.20	IP	0.17 (0.11)	1.63*
Number of observations included: 72 after adjusting endpoints					
R^2	0.99	Durbin-Watson statistic	1.91	F-statistic	215.94

Notes: a) values in parentheses are standard errors. b)* means 10% level of significance; ** means 5% level of significance, *** means 1% level of significance

In the analysed period some clear deviations from the expected seasonal pattern can be observed. Compared to January, taken as the reference point in the calculations, there appears to be statistically significant price declines in April and May. This can be considered as a serious distortion of the Polish wheat market caused by the intervention price levels.

Conclusions

Generally speaking, Polish cash wheat prices were not very closely related to any of the selected world prices in the period of 1990/91-96/97. Results of the cointegration analysis do not indicate the existence of a stable long-run relationship between Polish and the analysed world wheat prices for the period covered. This seems to be mainly the effect of the Polish government's intervention in the wheat market. In particular, the so-called intervention price had a negative impact on domestic wheat market price behaviour.

From the Polish experience two general important lessons can be learned. First, at an early stage of the economic transition in Poland inefficiencies caused by underdeveloped agricultural market infrastructure and insufficient market information led farmers and agribusiness firms conclude that market failure existed in the agricultural sectors. This resulted in strong political pressure under which the government of Poland decided to implement

some market intervention programs. Unfortunately the established intervention agency (ARR) has become increasingly involved in market operations and eventually became a dominant player in the grain and other agricultural markets. Such a situation hampers the broader participation of private businesses in procurement and larger scale market transactions.

Second, excessive market intervention programs not only didn't help to stabilise agricultural markets, but also led to serious distortions and a political temptation to urge the government to take even more intensive interventions. Therefore, a successful transformation to a free market based economic system requires establishing, as soon as possible, necessary market institutions and regulations such as commodity exchanges, wholesale markets, grades and standards and market information systems. Otherwise, a lot of resources, which could possibly be spent on further development of the market infrastructure, is later wasted on costly and ineffective market intervention programs.

Notes

[1] In September 1996 merged with the London Commodity Exchange (LCE) which was trading the wheat futures contract.

[2] Calculations for LIFFE refer to the period of August 1991 through July 1997.

[3] It should be noted that the sample size might be too small for the ADF test to have adequate power.

[4] This refers mainly to distorting impacts of the EU's agricultural policies (CAP) on European wheat prices and the US EEP program on the US wheat prices in the beginning of the 90's.

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