PRICE TRANSMISSION FROM MARKET TO FARM GATE: AN IRISH DAIRY STUDY

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Abstract

This paper explores the vertical transmission between the farm gate price of raw milk in Ireland and World, EU and Irish Dairy Board (IDB) butter and SMP wholesale prices. While a priori it may appear reasonable to assume transmission from individual commodities prices to the farm gate price, the cointegration analysis undertaken here fails to support this hypothesis. This finding results from the fact that Irish farmers are paid for their milk on the basis of the combination of its milk fat and protein content. In contrast the individual commodity prices reflect a value for milk fat in isolation as derived from butter prices or protein in isolation as derived from SMP prices. However by considering a portfolio approach involving composite prices based on a combination of butter and SMP prices, a more accurate reflection of price transmission is presented. This extension shows that price transmission is clearly evident between the composite price series and the farm gate price.

Introduction

Intuition would suggest that the return milk processors receive for their products should be reflected in the farm gate milk price. As Ireland exports approximately 70% of its dairy produce, with much of it as bulk wholesale product, the link in the supply chain between the farm gate price and wholesale product prices is considered most relevant. While the EU is the main destination for Irish exports of butter (circa 90%), the world market is more important for milk powders. Consequently price transmission from both European and World product prices to farm gate price is initially considered using the Johansen cointegration methodology. The results show no evidence of price transmission from the seven chosen commodity prices to the farm gate price with a single exception, where weak evidence is reported. These findings may be explained by the fact that Irish farmers are paid for their milk on the basis of a combination of the milk fat and protein content of their milk. In contrast the individual commodity prices reflect a value for milk fat in isolation as may be derived from butter prices or protein in isolation as may be derived from SMP prices. While butter and SMP are joint products derived from milk, butter and SMP prices evolve independently of each other so it is their combined rather than individual effect which should be reflected in the farm price.

By combining butter and SMP prices using a set of milk equivalent factors it is possible to calculate composite price series which better reflect the dynamics of the Irish dairy industry. This approach also allows the analysis to be extended to consider the role of the Irish Dairy Board (IDB) in the price transmission mechanism. The Board accounts for circa 60% of Irish dairy exports and, with an annual turnover in excess of 1.8 billion euro, its role in the Irish dairy industry is immense. Four composite price series based on the price of both butter and SMP are derived. These reflect a return on a portfolio of

commodities rather than individual commodities and are thus a more realistic representation of the trading environment as most processors produce a portfolio of dairy commodities.

The results using the composite series approach indicate that a long run relationship exists between the farm gate price and each of these composite series, with the exception of the series derived from the World prices. This finding is anticipated, as part of the EU Commission's remit has been the insulation of EU commodity prices, and hence farm gate prices, from the lower and more volatile World prices, through the administration of export refunds. When the World prices are adjusted to include export refunds, price transmission is evident. In each case, as expected, the farm price alone adjusts to deviation from equilibrium with the exception of the relationship with the IDB series where both series adjust. These results show that price transmission studies which consider transmission from single commodities to a raw material may be misleading in cases where there is more than one end use for the raw material.

The Irish dairy industry and the role of butter and SMP

The dairy processing industry is one of the more important indigenous industries in the Republic of Ireland with exports of dairy products reaching almost €2 billion in 2005. Over 9,100 are employed in processing related activities, with over 22,000 dairy farmers supplying raw milk to the sector (Department of Agriculture Annual Review and Outlook for Agriculture and Food 2005/2006). Ireland accounts for almost 4.5% of EU-15 production and just less than 1% of world cows' milk production.

The Irish dairy product portfolio is strongly influenced by the seasonal production of milk[1]. The emphasis has been on the production of Cheese, Butter, Wholemilk Powder (WMP), Skim Milk Powder (SMP) and Casein (Table 1)[2]. These five products account for over 85% of wholemilk utilisation, and circa 80% of skimmilk utilisation. These bulk commodities are easier to store and export, while the absence of an all year round supply of high quality milk in sufficient quantity has inhibited large scale production of short shelf life consumer products. In addition intervention support for butter and SMP has provided a guaranteed and profitable outlet for these commodities.

Table 1: Wholemilk and skim milk utilisation (%) in Ireland

% Wholemilk utilisation						% Skim milk utilisation		
Year	Cheese	Butter	WMP	Total		Casein	SMP	Total
1994	17.6	61.7	5.9	85.2		36.8	44.0	80.8
1996	17.8	67.3	4.8	89.9		41.6	40.0	81.6
1998	19.1	64.9	5.2	89.2		44.6	36.6	81.2
2000	18.8	64.5	5.5	88.8		46.4	30.9	76.3
2002	23.0	63.0	5.0	91.0		49.0	34.0	83.0
2004	21.0	61.0	5.0	87.0		51.0	24.0	75.0

Source Irish Dairy Board Annual reports.

The internal EU butter market accounts for at least 90% of export revenue in most years considered (Table 2). Both the German and UK markets are of primary importance from an Irish perspective with the former accounting for almost one third of export revenue.

[1] This seasonal pattern of production translates to a monthly peak to trough ratio of approximately 6:1 and a capacity utilisation of 60% (Prospectus 2003).

[2] Liquid milk accounts for circa 10% of output, with the remaining 90% used to manufacture dairy products such as cheese, butter, SMP etc.

Table 2: Irish butter and exports

	1994	1996	1998	2000	2002	2004
Exports (Tonnes)	110.3	118.7	135.9	121	104.2	132.9
Exports €	334.5	349	428.4	356.4	319.1	361.9
% to EU	94	90	95	94	94	87
% Non EU	6	10	5	6	6	13

Source CSO Trade Statistics.

Irish SMP exports tend to fluctuate considerably both by value and destination, with sales to non EU countries accounting for 15% to 56% of sales revenue (Table 3). In terms of markets, the Netherlands and the UK are the largest within the EU. The Netherlands is used as a transit point for powder leaving the EU. Hence as global trade increases, the market in this country becomes more active. This may in part explain the large volatility in the quantities shipped to this country from Ireland.

Table 3: Irish skim milk powder exports by value (Million €)

	1994	1996	1998	2000	2002	2004
Exports (Tonnes)	79.9	58.8	51.5	124.9	35.2	42.1
Exports €	157	115.8	95.1	248	63.2	83.8
% to EU	85	44	67	63.5	57	65.5
% Non EU	15	56	33	36.5	43	34.5

Source CSO Trade Statistics.

Price transmission

Within the industry there is a strong focus on the price paid to farmers for raw milk. Indeed it would appear reasonable to assume that the return the processors receive for their commodities and ingredients should be reflected in the farm gate milk price. This assumption is reinforced by the fact that the ownership of a large proportion of the milk processing facilities in the Republic of Ireland rests in the hands of farmer cooperatives[3]. Furthermore Ireland, as part of the EU dairy industry, is regulated by the common agricultural policy (CAP). The framing of the CAP was motivated by a desire to provide an adequate income for farmers within the EU. Rather than directly supplementing farm incomes, the EU has traditionally sought to achieve its goal by regulating and supporting its agricultural commodity markets[4]. By providing a minimum floor price and a guaranteed market (through intervention buying) along with other market supports, it was believed that farm incomes could be maintained at the desired level. This policy assumed that the benefits of this policy would be transmitted from the commodity markets to farmers. This assumption is tested empirically in this paper as the price transmission from the European Union (EU) butter and skim milk powder (SMP) markets to the farm gate price for milk in the Republic of Ireland is considered.

As Ireland exports much of its dairy produce as bulk wholesale product, the link in the supply chain between the farm gate and wholesale is considered most relevant in an Irish context. While the EU is the main destination for Irish exports of butter, the world market is more important for milk powders.

[3] While approximately 50% of milk is processed by public limited companies in Ireland farmer cooperatives retain large shareholdings in these companies and also maintain a strong presence on the Boards of these companies.

[4] The Mac Sharry refom in 1992 saw a departure from market support to direct farmer support in many of the non dairy sectors (e.g. beef and arable crops). This departure has continued in the Luxembourg (2003) agreement which now encompasses the dairy sector.

Consequently the transmission from both European and World individual product prices to farm gate is initially considered. As exports of these commodities onto the world market attract export refunds, price series which include these refunds are also considered. The price series considered initially in this study are now presented.

Data and methodology

Farmers in the Republic of Ireland are paid on a monthly basis for the milk they supply to milk processors. The Irish Central Statistics Office (CSO) publishes a price series which record the price paid by creameries to producers for milk which is standardised at 3.7% butterfat. This series derived from data collected from 12 of the larger creameries and processors is taken as a proxy for the Irish farm gate price in this study. This series as published however reflects the actual protein content of the milk delivered to the dairies. The use of a price series which is based on actual protein content rather than a standardised protein content may lead to a potential problem. This series may contain a seasonal component to reflect the seasonal nature of the protein content of cows' milk in Ireland. The farm gate price should reflect the value of protein in the raw milk and any change in the protein content of the milk should be reflected in a change in price at the farm gate[5]. The production of milk protein at farm level in Ireland is distinctly seasonal so, to remove this seasonality, this series is further standardised to reflect a protein content of 3.3%. This adjusted farm gate price is henceforth referred to as the CSO series[6].

Transmission from both the German and Dutch butter prices is considered. The German branded butter series represents the main destination for Irish butter exports while the Dutch series is seen as a more appropriate proxy for European butter prices (O' Connor 2006). The SMP (edible) price for the Netherlands is used as the European SMP proxy as it represents the largest revenue market for SMP from an Irish perspective and is seen as a representative price for the EU SMP market prices (O' Connor 2006). All series are published on a monthly basis by Agra Europe[7]. It was not necessary to adjust the series for Monetary Compensation Amounts (MCA's) as they were phased out in Germany, Netherlands and Ireland by the start of 1990[8].

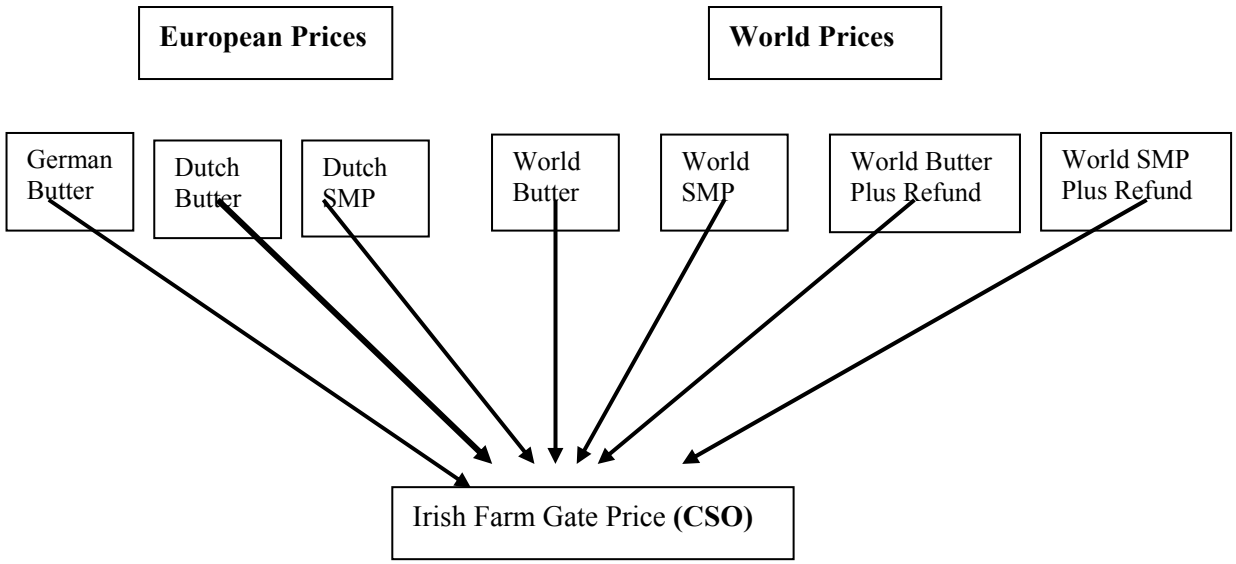
The USDA (United States Department of Agriculture) provides a North Europe FOB (Free On Board) series for both Butter and SMP. These prices are taken as representative World prices and are published monthly by the USDA in "Dairy: World Markets and Trade". Both a high and low FOB price is quoted for each product and a simple average of these high and low prices is used in this study. These average prices are also converted from Dollars to Euro.

To fully reflect the actual return to Irish processors, further series based on the World prices were derived. For these series, export refunds were added to the world commodity prices. The availability of prefixing and advance payment arrangements complicate the modelling of these refunds. The effect of these arrangements is to make it almost impossible to match the timing of setting of the export refund with the

[5] As a counter argument protein delivered in the autumn is of a lower quality and not as suitable for the production of cheese and the higher value added short shelf life products. In addition the reduced volume of milk during the off peak season leads to increased processing cost per litre.
[6] The series is published as VAT inclusive however for the purpose of this study VAT is deducted.
[7] The butter series is published in "Milk Products" while the SMP series are published in "Preserved Milk." Both of these periodicals are published by Agra Europe.
[8] Monetary compensation amounts (MCA's) were compensatory amounts paid under the CAP to cover the difference between the common price structure and actual prices determined by existing exchange rates. These were border taxes and subsidies applied to intra-community trade. These are discussed in detail in Ritson and Swinbank (1997). MCA's were abolished from January 1993, but were phased out in most EU countries by January 1990. The exceptions were Italy, Greece, Spain, Portugal and the UK.

actual payment of the refund9. These arrangements reduce risk as the rate of the refund on a given date is known and can be prefixed at that date. As these refunds are transparent to both buyer and seller they can be factored into the quoted price on the date the price is set. For this reason, the export refund that is quoted for a particular month is added to the commodity price for that month in the following analysis10. As the analysis considers transmission to Irish farm gate milk price it is necessary to use green rates11 relevant to Irish exporters to calculate the value of these export refunds. The hypothesised relationships between Irish farm gate and these selected commodity price series are presented in Figure 1.

Figure 1: Hypothesised relationships between farm gate and commodity price series



In this study the Johansen cointegration methodology is applied to test for price transmission. This approach considers the time series properties of the data and allows the simultaneous modelling of both the long run and short run dynamics of the system. In addition this methodology allows one to empirically test a number of hypotheses including test of exogeneity and perfect price transmission. This methodology and detailed results are presented in O Connor 2006 but may be summarised as follows.

Results

The results show that of the seven series considered, only price transmission from the Dutch SMP price series was reported (Appendix Table 1). When this relationship was examined it was found that this price transmission is perfect with the SMP series exogenous with the farm price responding to deviations from equilibrium (Appendix Table 2).

[9] This is further complicated by those traders who do not avail of these arrangements. Anecdotal evidence suggests that payments in these instances may occur more than a year from the date of export.

[10] Ideally a composite forward exchange rate should be used to provide a present value for these refund amounts however the complexity of these payments make the timing of such rates impossible to judge.

[11] Green rates are accounting currencies used when assessing payments to farmers within the EU's Common Agricultural Policy. Under CAP, farmers are paid in agricultural units of account and green rates were devised to convert these units of account payments into national currencies. Green rates now only exist for those countries that remain outside the single currency.

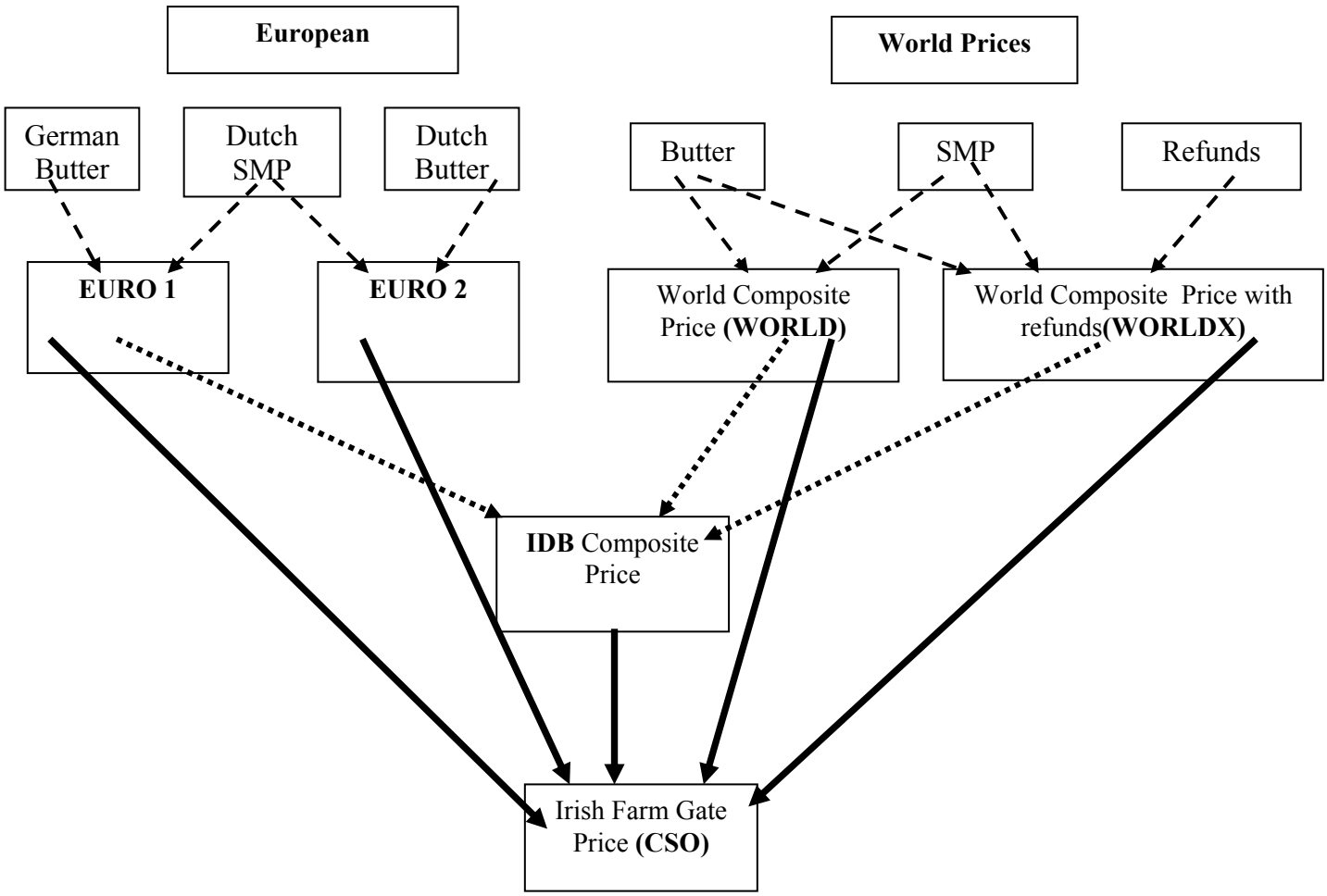
While initially these results may be considered surprising, on further reflection they can be readily explained. Farmers in Ireland receive payment for their milk based on its milk fat and milk protein content. This reflects the fact that these constituents are considered the more valuable components of milk and also the fact that processors in general sell a portfolio of products which contain differing proportions of these constituents. While butter prices reflect a valuation for milk fat and SMP prices reflect a valuation for milk protein, it is their combined, rather than individual, effect which should be reflected in the farm price. While butter and SMP are joint products derived from milk, their prices evolve independent of each other.

In light of the above results and explanation the study was extended as follows. Firstly the supply chain was lengthened to include the Irish Dairy Board (IDB) thereby increasing the dynamics and providing for a more complete analysis of farm to wholesale price transmission. The Irish Dairy Board (IDB) is a second tier cooperative which markets a wide range of dairy products internationally and accounts for circa 60% of Irish dairy exports. The membership of the Board is representative of all sectors of the Irish dairy industry. The Board publishes the price it pays its member manufacturing co-operatives for butter and SMP and these prices are converted to an equivalent cent per gallon price using milk equivalent conversion factors. This equivalent price series is published and monitored closely by the Irish dairy industry.

Secondly this milk equivalent approach[12] is also used to also calculate returns from the EU and World markets. These composite price series present a more accurate reflection of the trading environment faced by the Irish dairy industry as most processors produce a portfolio of dairy commodities/products. In addition these series reflect a return for both milk fat and milk protein, the more valuable constituents of raw milk. Five series are derived using milk equivalents in the manner outlined. Firstly the on account butter and SMP prices quoted by the IDB are combined in the manner described to produce a return paid by the Board[13]. For the second series German butter and Dutch SMP prices are combined to produce a European milk price. These markets are the most significant from an Irish perspective as discussed. A further series based on the Dutch SMP and butter prices is derived. This series reflects general European market conditions as determined from the spatial transmission study presented in O' Connor 2007. World FOB (free on board) prices published by the USDA (United States Department of Agriculture) are used to produce an equivalent World price. Finally export refunds are added to the World prices to produce a price series which better reflects the return to the IDB and Irish processors from the world market. . The hypothesised relationships amongst the six series are represented by the solid lines in Figure 2.

[12] The milk to product conversion factors used in this study are based on those used to calculate the intervention milk price equivalent (IMPE) by the EU Commission and differ slightly from those used by the IDB for its published series.
[13] This series will differ from the "on account" price series quoted by the IDB. Both series are calculated in a similar manner however the conversion factors differ slightly.

Figure 2: Hypothesised relationships between milk price series (Represented by solid lines)



The results now indicate a long run relationship between the CSO and each of the composite series with the exception of the World series. These findings are as anticipated, as part of the EU Commission's remit has been the insulation of EU commodity prices, and hence farm gate prices, from the lower and more volatile World prices through the administration of export refunds. Likewise no long run relationship was reported between the IDB and World series while relationships are present between the IDB series and all remaining series. In each case the CSO alone adjusts to deviation from equilibrium with the exception of the relationship with the IDB series where both series adjust. In the remaining models the IDB series adjusts with the European and WorldX (World price plus export refunds) series deemed weakly exogenous. In all models both series enter the long run relationship with proportional transmission in many cases. These results show that price transmission studies which consider transmission from single commodities to a raw material may be misleading in cases where there is more than one end use for the raw material.

Conclusion

This paper explores the price transmission from dairy commodity prices to the Irish farm gate price for milk in Ireland. The underlying assumption is that the price paid to farms should reflect the price realised by these commodities on the wholesale markets. The empirical evidence runs counter to this intuition with a single exception. The Johansen cointegration results suggest perfect transmission from the Dutch SMP price to the farm gate price. In this paper it is acknowledged that the farm gate price reflects a valuation for both milk fat and milk protein. This suggests that transmission from these individual commodities may not capture this dynamic and the use of composite price series is more appropriate. When the supply chain was lengthened to include the IDB price series, and the composite series, the results show long run relationships in all models with the exception of those which include the World composite prices. This result is anticipated as the greater proportion of Irish dairy exports are to EU destinations, with all other exports to the world market attracting export refunds. The fact that transmission to both the farm gate and IDB is recorded when export refunds are added to the World price may be taken as proof of the EU Commissions' success in insulating Irish farm gate prices from the normally lower and more volatile World prices. In essence these results show that the modelling of price transmission is sometimes more complex than basic economic theory suggests.

References

The Irish Central Statistics Office (CSO) *"Trade data"* Various issues

Department of Agriculture and Food *"Annual review"* Various years.

O' Connor, D. (2006) *"Price Transmission in European Dairy Markets"* Unpublished PhD thesis presented to University College Cork

Appendix

Table 1: Tests of cointegration rank for farm and commodity price series based on trace statistic (restricted constant).

Model	Additional explanatory variables	r[1] = 0	r = 1	AR 1-7 test	Normality test:	Hetero test
1. CSO-GBUTM [3][2]	Centered Seasonal	17.64 (0.111)[3]	5.906 (0.205)	0.832 (0.725)	87.10 (0.000)	1.33 (0.100)
2. CSO-NBUTM [5]	Centered Seasonal 97(1)	14.577 (0.257)	7.020 (0.129)	0.817 (0.733)	28.861 (0.000)	1.195 (0.166)
3. CSO-WBUTM [7]	Centered Seasonal	15.367 (0.210)	7.090 (0.125)	1.169 (0.260)	28.665 (0.000)	0.902 (0.712)
4. CSO-WBUTMX [8]	Centered Seasonal	15.217 (0.219)	4.233 (0.390)	0.987 (0.488)	33.85 (0.000)	0.964 (0.575)
5. CSO-NSMPM [3]		32.23 (0.000)	8.26 (0.075)	0.727 (0.844)	68.15 (0.000)	1.000 (0.472)
6. CSO-WSMPM [3]	Centered Seasonal	11.676 (0.487)	5.06 (0.287)	1.536 (0.045)	44.94 (0.000)	0.814 (0.731)
7. CSO-WSMPMX [13]		21.42 (0.033)	9.495 (0.043)	0.678 (0.891)	52.25 (0.000)	0.912 (0.735)

[1] r = number of cointegration vectors being tested under the null hypothesis.
[2] Estimated VAR lag in Brackets.
[3] P-values in parentheses.

Table 2: Results of hypotheses test for commodity price relationships.

Model	**Hypotheses**				
	$\alpha_{11}=0$	$\alpha_{21}=0$	$\beta_{11}=0$	$\beta_{21}=0$	$\beta_{11}=-\beta_{21}$
1. CSO-NSMPM [3]	15.675 (0.000)	0.007 (0.929)	13.006 (0.000)	11.62 (0.001)	2.47 (0.116)

Table 3: Tests of cointegration rank for farm and composite price series based on trace statistic.

Model	Additional explanatory variables	r[1] = 0	r = 1	AR 1-7 test	Normality test:	Hetero test
1. CSO – IDB [3][2]	Centered Seasonals	33.649 (0.000)[3]	5.902 (0.205)	0.936 (0.561)	185.13 (0.000)	0.922 (0.600)
2. CSO - EURO1 [3]		40.684 (0.000)	9.64 (0.040)	1.085 (0.354)	74.55 (0.000)	0.894 (0.649)
3. CSO - EURO2 [3]		37.73 (0.000)	6.84 (0.139)	0.768 (0.797)	56.349 (0.000)	1.055 (0.386)
4. CSO - WORLD [3]		16.713 (0.145)	5.825 (0.212)	0.668 (0.900)	36.306 (0.000)	1.014 (0.449)
5. CSO - WORLDX [4]	Centered Seasonals	22.611 (0.021)	6.89 (0.136)	1.434 (0.077)	62.15 (0.000)	1.139 (0.251)
6. IDB - EURO1 [4]		37.84 (0.000)	7.13 (0.123)	1.073 (0.374)	169.14 (0.000)	0.952 (0.568)
7. IDB - EURO2 [3]	Centered Seasonals	38.085 (0.000)	7.15 (0.122)	1.255 (0.181)	124.96 (0.000)	1.139 (0.271)
8. IDB - WORLD [7]		13.044 (0.368)	2.349 (0.709)	0.781 (0.781)	110.93 (0.000)	1.263 (0.075)
9. IDB- WORLDX [5]		22.145 (0.025)	5.916 (0.204)	1.181 (0.247)	127.05 (0.000)	1.184 (0.176)

[1] r = number of cointegration vectors being tested under the null hypothesis.
[2] Estimated VAR lag in Brackets. [3] P-values in parentheses.

Table 3: Results of hypotheses test for composite price relationships.

Model	Hypotheses				
	$\alpha_{11}=0$	$\alpha_{21}=0$	$\beta_{11}=0$	$\beta_{21}=0$	$\beta_{11}=-\beta_{21}$
1. CSO – IDB [3][2]	7.134 (0.007)	9.26 (0.002)	21.22 (0.000)	15.40 (0.000)	3.80 (0.051)
2. CSO - EURO1 [3]	24.43 (0.000)	0.671 (0.412)	19.895 (0.000)	20.80 (0.000)	0.064 (0.800)
3. CSO - EURO2 [3]	23.99 (0.000)	0.619 (0.431)	20.07 (0.000)	20.197 (0.000)	0.426 (0.514)
5. CSO - WORLDX [4]	6.35 (0.012)	0.967 (0.325)	6.396 (0.011)	8.422 (0.004)	0.00003 (0.995)
6. IDB - EURO1 [4]	16.035 (0.000)	2.79 (0.095)	21.99 (0.000)	22.87 (0.000)	5.641 (0.017)
7. IDB - EURO2 [3]	23.760 (0.000)	1.356 (0.244)	23.553 (0.000)	17.615 (0.000)	15.207 (0.000)
9. IDB- WORLDX [5]	5.916 (0.015)	2.245 (0.134)	8.263 (0.004)	10.30 (0.001)	1.700 (0.192)