European Journal of Business and Management
ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online)
Vol.6, No.33, 2014
www.iiste.org

Economic Analysis of Spatial Integration of Pulse Market in Ethiopia; A case of Selected Pulse Market in Ethiopia

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The research is funded by DAAD[1] for partial fulfilment of MSc in Agricultural and applied Economics in Egerton University, Njoro, Kenya

Abstract
In order to solve the problem of food insecurity the Government of Ethiopia has adopted different strategies since the introduction of agricultural extension services in the early 1970s, to improve the performance of the agricultural sector. However, most of this strategy has focused on how to increase agricultural productivity at the farm level through the dissemination of improved production technologies, while the marketing aspect has been given less attention. Considering this, in order to improve the market efficiency, significant numbers of empirical studies have been conducted on market integration but they focused mainly on cereal[2] market while pulse market has not been given adequate attention. Yet pulse is the third largest export crop in the country and generates USD 232.5 million annually and it has been showing a significant growth in export and production in the last decade. The study assesses the price transmission of selected pulse market in Ethiopia using monthly wholesale price data in Birr/Quintal covering the period January 2003 to December 2013 for Horse beans and Chickpeas from Ethiopian Grain Trade Enterprise. The stationarity of the price data was tasted using Augmented Dickey-Fuller (ADF) and Phillips-Perron tests. To test the co integration level Engle and Granger (Engle and Granger, 1987) test were applied. To identify which market price change will cause a price change in other market, Granger Causality model was used. The selected markets are Addis Ababa as a central market; Adama as closest market based on distance form central market; Diredewa as remotest both for Horse beans and Chickpeas. While Desse and Gonder as main producing market of Horse beans and Chickpeas respectively. The finding indicates that all the selected markets are co integrated. However, Addis Ababa- Desse for the case of Horse beans and Addis Ababa- Gonder for Chickpeas markets have strongly integrated. Concerning causality, Addis Ababa - Desse, Addis Ababa - Adama, Desse - Diredawa markets are unidirectional while Desse - Adama are bidirectional for horse bean. However, for Chickpeas, all the selected markets do not Granger Cause each other in both directions except between Diredawa - Adama which were unidirectional. This implies that there is a need of improvement in market information systems especially to producing markets, and also timely accurate price information for trade participant to distribute commodities from surplus area to deficit markets.
Key Words: Pulse, Ethiopia, Granger Causality, price transmission

1. Introduction

More than 80% of the population in the country lives in rural areas, and their main source of income is agriculture. Agriculture accounts for 45% of the Gross Domestic Product (GDP), employs 85% of the labour force, and generates 90% of export earnings (MoARD, 2010). Among the agricultural commodities Pulse is the third- largest export crop behind coffee and oil seed, and generate USD 232.5 million annually. It contribute to small holder income as a higher value crop than cereals and a cost effective source of protein that accounts for approximately 15% of protein intake to their diet (Shahidur *et al.*, 2010).

Pulse[3] have been cultivated and consumed in large quantities in Ethiopia for many years. Pulse crops are important components of crop production in Ethiopia's smallholder's agriculture, providing an economic

[1] We would like to thank Deutscher Akademischer Austausch Dienst (DAAD) for funding the research project where this paper is drawn.
[2] Studies focused mainly on cereal market: Maize, Wheat, Sorghum and *Teff* (Negassa, 1998; Negassa *et al*., 2004; Getnet *et al*., 2005; Getnet, 2007; Tadesse and Shively, 2009 and Sinishaw, 2013).
[3] There are twelve pulse species grown in the country. Of these, Horse beans (Vicia *faba* L.), Field pea (*Pisum sativum* L.), Chickpeas (*Cicer arietinum* L.), Lentil (*Lens cultinaris Medik.*), Grass pea (*Lathyrus sativus* L.), Fenugreek (*Trigonella foenum-graecum* L.) and Lupine (*Lupinus albus L.*) are categorized as highland pulses and grown in the cooler highlands.

advantage to small farm holdings as an alternative source of protein, cash income, and food security (ECX, 2012).

A well-integrated market system is central to a well-functioning market economy (Dercon, 1995). Spatial price relationships have been widely used to indicate overall market performance. The usual definition for spatial market integration in different literature is that of markets which are in different places where prices are determined interdependently or situation in which the prices of a commodity in spatially separated markets move together and price signals and information are transmitted smoothly.

A better integrated market may experience more volatility, if the price in one market is higher than the price in another market and given the transaction cost that would be involved if one had to move the product from the market with a low price to the market with a high price, unexploited profits would exist. Rational traders would therefore enter the market and capitalize on these arbitrage[1] opportunities, increasing demand in the market where prices are low and increasing supply in the location where prices are high. These latter two forces will, *ceteris paribus*, drive up the price in the market that had initially a low price and reduce the price in the market that had initially a high price. The result will be that prices adjust up to the point where trade becomes unprofitable again, that is, until the price difference becomes equal to the transaction cost (Bjorn, 2012).

2. Literature review

2.1 Theoretical Framework

Barret and Li (2002) defined market integration as tradability or contestability between markets. Market integration can be interpreted as the extent to which price shocks are transmitted between spatially separate markets (Goodwin and Piggott, 2000).

In the classical works of Takayama and Judge (1971) with free flow of information and goods, prices of a homogeneous good in two spatially separated markets should only differ by the transaction costs.

$$p_{1t} = p_{2t} + c \quad \ldots\ldots (1)$$

Where: p_{1t} is the price in market1 at time t and p_{2t} is the price in market 2 at time t.

This is so because, if the price in one market is larger than the price in another market plus the transaction cost that would be involved if one had to move the product from the market with the low price to the market with the high price, unexploited profits would exist.

2.1.1 Testing Stationarity of Price Serous

To demonstrate the conditions for stationarity[2], let us see the following first order autoregressive model.

$$p_{it} = \varphi\beta p_{i\,t-1} + \mu_t \quad \ldots\ldots (2)$$

Where: t =1….. T

If φ < 1, the series $p_{i\,t}$ is stationary and if φ = 1, the series is non-stationary and is known as random walk. $p_{i\,t}$ can be made stationary after differencing once but it is not necessary that it become stationary after first difference. The number of times series needs to be differenced in order to achieve stationarity depends upon the number of unit roots it contains. If a series becomes stationary after differencing d times, then it contains d unit roots and it is said to be integrated of order d, denoted by I(d) in (1) where φ = 1, $p_{i\,t}$ has a unit root and thus $p_{i\,t}$ ≈ I(1). Since most price series have trends in them is only because of inflation, they are usually I(1) and thus they need differencing once to obtain I(0).

The first step in dealing with time series data is to test for the presence of a unit root in the individual time series of each model. There are a number of methods to test the unit root hypothesis but this study used Augmented Dickey Fuller (Dickey and Fuller 1979) and Phillips-Perron tests (PP) (Phillips and Perron, 1988) on

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Conversely, Haricot bean (*Phaseolus vulgaris* L.), Soya bean (*Glycine max* L.), Cowpea (*Vigna unguiculata* L.), Pigeon pea (*Cajanus cajan L.*) and Mung beans are predominantly grown in the warmer and low land parts of the country (Shahidur *et al.*, 2010).

[1] Arbitration is defined as the process of exchange between actors and the various segments of the market with the objective to draw an advantage from the differences in price exceeding the transaction costs (packing, storage, transformation, handling, costs of transport, etc.).

[2] A series is said to be stationary if its mean and variance remain constant over the time and the value of the covariance between the two time periods depends only on the distance or lag between the two time periods and not the actual time at which the covariance is computed or in other words remain constant over time (Gujrati, 2005).

testing for a unit root in time series. The numbers of lags in the Augmented Dickey–Fuller (ADF) equation are chosen to ensure that serial correlation. The DF-test requires us to estimate the following by OLS:

$\Delta p_{i_t} = b_0 + b_1 p_{i_{t-1}} + e_t$ ..... (3)

Where, Δp_{i_t} is the difference of price in markets i, $p_{i_{t-1}}$ is the lagged price in market i, b_0 and b_1 are parameters to be estimated. e_t is the error term.

If the price is not stationary the order of integration test will be repeated with Δp_{i_t} in place of p_{i_t} thus regressing $\Delta\Delta p_{i_t}$ on a constant $\Delta p_{i_{t-1}}$ and several lags of $\Delta\Delta p_{i_t}$ ADF and PP test will be used to test the hypothesis. The process will continue until we establish the order of integration.

2.1.2 Co-integration Test

The basic idea of co-integration is to identify the long run relationship between variables, then divergence from the long run equilibrium path is bounded, and the variables are co-integrated. For co-integration, two conditions must be satisfied. First, the series for at least two of the individual variables are integrated of the same order and second, a linear combination of the variables exist which is integrated to an order lower than the individual variables. Consider the co-integration regression:

$p_{i_t} = b_2 + b_3 p_{j_t} + E_t$ ..... (4)

where, p_{i_t} is the price in i[th] market , p_{j_t} is the price in j[th] market and E_t is the disturbance term

If the series p_{i_t} and p_{j_t} are integrated of order one I (1), their linear relationship in equation (4) is also I(1). Therefore, their residuals are stationary I(0) then the series are co-integrated of order I (1). In (4), b_3 measures the equilibrium relationship between the series p_{i_t}=and p_{j_t}, and E_t is the deviation from long run equilibrium path.

The Engle and Granger (1987) co-integration test is based on residuals

$e_t = p_{i_t} - \beta_1 p_{j_t} - b_2$ ..... (5)

For testing co-integration, the following equation was used

$\Delta e_t = \mu + \eta e_{t-1} + e_t$ ..... (6)

2.1.3 Granger Causality Test

When two price series are stationary of the same order and co-integrated, causality test can be carried out on the series. This is because at least one granger causal relationship must exist in a group of co-integrated series, according to Chirwa (2000). So that to find out which market causes the change of price on other market, see the magnitude of causality and the long run effect between to market we will apply Granger Causality Model. To apply this model the price of the markets should be stationary. Since our prices are stationary after differencing ones and we are only interested to see whether the last year price of market j determine the current price of market i (one year lagged price) we write the model as:

$\Delta p_{i_t} = b_7 + \Sigma\beta_r \Delta p_{i_{t-1}} + \Sigma c_r \Delta p_{j_{t-1}} + u_{t-1}$ ..... (7)

Where: Δp_{i_t} and Δp_{j_t} = price in market i and j after we differencing once respectively. And β_0, β_r and c_r are parameters to be estimated, while u_{t-1}= one year lagged error term.

To find the magnitude of causality we calculated Σc_r ..... (8)

To check whether last year price of market j determine current price of market i, (j Granger causes i) we tested hypothesis that $H_0: c_r = 0$ Vs $H_1 : c_r \neq 0$. In the same way in testing whether past price of market i Granger causes the current price of market j,

3. Research Methodology

3.1 Study Area

This study was conducted in three different regional markets and one central market for both commodities. The selected markets were Desse, Gonder, Adama and Diredawa regional markets, Addis Ababa market is the central market. The selection of this market was based on the following criteria: Desse and Gonder

are the major producing market of Horse beans and Chickpeas respectively based on their volume of production. Adama and Diredawa were selected both for Horse beans and Chickpeas based on close proximity and remotest distance from the central market respectively.

3.2 Sampling Procedure

This study used purposive sampling to select the markets: Gonder, Desse, Adama, Diredawa were the regional markets while Addis Ababa was the central market. The selection criteria for the regional market were based on volume of production, distance from Addis Ababa which is the consuming market and availability of data.

3.3 Methods of Data Collection

The study used average monthly price (Birr[1]/ Quintal[2]) of Horse beans and Chickpeas from Ethiopian Grain Enterprise (EGTE) covering the period January 2003-December 2013.

4. Result and Discussion

The result of Augmented Dickey Fuller (ADF) and Phillips-Perron[3] as showed in Appendix 1 and Appendix 2 for Horse beans and Chickpeas respectively, all the selected market price serous are non-stationary at level both for Horse beans and Chickpeas. But become stationary after first differences. See Appendix 3 and Appendix 4.

A test for stationarity of residual was also done using Engel Granger test by comparing the value of the test statistics against the set of critical values provided by Davidson and MacKinnon (1993) which is given in Appendix 5 and found that the null hypothesis is rejected at 1% level of significant for all selected market prices. This means, the wholesale market pairs are co-integrated. Regarding co-integration level PP result shows that ADDWHB and DESWHB market for Horse beans, ADDWCP and GONWCP market pair for Chickpeas have better degree of integration than others as showed in Table 1.and Table 1.2

Table 1: Unit Root Test of Residual for Wholesale Price (Birr/Quintal) of Selected Horse Bean Markets

	Phillips-Perron	
Residuals	P-value	Test statistics
Residual for market ADDWHB and DESWHB	0.0000	-9.202***
Residual for market ADDWHB and ADMWHB	0.0000	-5.759***
Residual for market ADDWHB and DDWHB	0.0000	-5.247***
Residual for market DESWHB and ADMWHB	0.0000	-5.247***
Residual for market DESWHB and DDWHB	0.0000	-7.457***
Residual for market ADDWHB and DDWHB	0.0000	-6.309***

* Significant at 10%, ** significant at 5%, ***significant at 1%
Source: Author calculation based on data from EGTE from 2003-2013
Where ADDWHB=Addis Ababa wholesale price of Horse beans.
ADMWHB=Adama wholesale price of Horse beans.
DDWHB=Diredawa wholesale price of Horse beans.
DESWHB= Desse wholesale price of horse bean.

[1] Ethiopian currency. (1 $=19.86 birr)
[2] One hundred kilogram.
[3] The study gives more priority to Phillips and Perron than Augmented Dickey-Fuller test because, the ADF test is a parametric test (pre-determined parameters) and it has low power whereas PP test is based on non- parametric modification of Augmented Dickey-Fuller tests.

Table 2: Unit Root Test of Residual for Wholesale Price (Birr/Quintal) of Selected Chickpea Markets

	Phillips-Perron	
Residuals	P-value	Test statistics
Residual for market ADDWCP and GONWCP	0.0000	-6.910***
Residual for market ADDWCP and ADMWCP	0.0026	-3.942***
Residual for market ADDWCP and DDWCP	0.0000	-4.864***
Residual for market GONWCP and ADMWCP	0.0024	-4.864***
Residual for market GONWCP and DDWCP	0.0000	-5.556***
Residual for market ADMWCP and DDWCP	0.0003	-4.270***

* Significant at 10%, ** significant at 5%, ***significant at 1%
Source: Author calculation based on data from EGTE from 2003-2013

Where ADDWCP= Addis Ababa wholesale price of Chickpeas.
ADMWCP= Adama wholesale price of Chickpeas.
DDWCP= Diredawa wholesale price of Chickpeas.
GONWCP= Gonder wholesale price of Chickpeas.

The result of Granger causality of the selected Horse beans markets is unidirectional: Addis Ababa market Granger causes Desse, Adama market Granger causes Addis Ababa, and Diredawa market Granger causes Desse. For the cases of Adama –Desse, the relationship was bidirectional. The relationship between Addis Ababa- Diredawa and Diredawa - Adama, the markets does not granger cause each other. For Chickpeas markets, except Adama-Diredawa (Adama Granger causes Diredawa) all the other markets does not Granger cause each other.

5. Conclusion

This study was conducted to assess the price transmission of selected pulse market in Ethiopia and two major pulse types were selected based on their volume of production: Horse beans and Chickpeas. For each commodity different markets were selected Addis Ababa as central market , Adama as the nearest market to the central market based on distance and Diredawa the remotest market from the central market both for Horse beans and Chickpeas. Desse as the main producing market of Horse beans while Gonder as the main producing market for Chickpeas. To analyse the Stationarity test Augmented Deke fuller test, Phillips-Perron test were applied, co integration test using Engle-Granger test and Causality test using Engle-Granger test has been used. All selected markets price are non-stationary at level but stationary after first difference. The co integration result showed that, the main producing markets have better level of market integration with the other both for Horse beans and Chickpeas market. The results of Granger causality of the selected Horse beans markets are unidirectional: Addis Ababa market Granger causes Desse, Adama market Granger cause Addis Ababa, and Diredawa market Granger cause Desse. For the cases of Adama –Desse, the relationship was bidirectional. The relationship between Addis Ababa- Diredawa and Diredawa - Adama, the markets does not granger cause each other. For Chickpeas markets, except Adama-Diredawa (Adama Granger causes Diredawa) all the other markets does not Granger cause each other.

Pulse market on selected Horse beans and Chickpeas markets are shown to be integrated. The producing markets were more integrated to the selected markets than others were. This is mainly because the producing markets are the main source of the commodity for the rest of the markets. For some markets, because of close proximity, good communication facilities and availability of good infrastructure among the market centres the level of integration was better comparing with markets which are distantly apart. However, our analysis does not consider the analysis of village level market where the producers have direct connection with the traders.

If markets are well integrated, government can easily affect all the integrated markets by intervening in only few important markets without worrying to intervening in all the markets. Accordingly, identifying those markets in the same integration circle would contribute a lot in proper implementation of any agricultural policy and in the effort to realize a well-developed agricultural sector. It has been mentioned in many articles (Negassa, 1998) that a well-integrated market is typified by a higher level of private sector participation in the arbitraging activity which helps in stabilizing prices across the surplus and deficit areas. Hence demonstrating the need for market development to enhance and encourage the private sector participation by providing access to credit, and strengthening legal enforcement rules is necessary.

It is believed that most of the problems associated with level and degree of market integration, in one way or another, are related to infrastructure, information and institutions. The development of the three will lift the level of market integration and avoids the trade barriers existing between markets.

The country also needs modernize way of trading specially for the most valuable assets and commodities. Ethiopia needs a change from the traditional means of trading by supporting the needs of all those involved in trading and production. All these may require the development of a well-functioning Commodity Exchange system which provides market integrity at three important levels: the integrity of the product, the integrity of the transaction and the integrity of the market actors. The exchange is currently trading only Haricot bean, Maize, Coffee, Wheat and sesame seed. Therefore, there is a need to include pulse commodity in the exchange to increase the benefit of all market actors who participate in pulse markets, farmers, traders, processors, exporters and consumers.

Lastly, the government need to provide for trade participant a smooth, efficient and effective way of service delivery system especially in custom area. From the result of the study, Diredawa market has less level of market integration than the others. This is because the city is bordered by Djibout, where is a high chance of finding contraband material especially electronics in the market. To protect the local manufacturers the Government puts a high restriction this discourages traders to trade with Diredawa market. So there is a need to put high taxation at the border to discourage those illegal importers.

Suggested future works include: in the country, there are twelve different type of pulse. However, due to time and availability of data the study considered only two pulse type. In the same way, this study considered only three regional markets and one central market. Hence, there is a need of study which will consider more pulse type and more markets; it is obvious that the market efficiency will come at better level of efficiency than the current level.

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APPENDICES

Appendix 1: Unit Root Test for Wholesale Price (Birr/Quintal) of Selected Horse beans Markets in Ethiopia at level

Markets	**ADF**		**Phillips-Perron**	
	P-value	**Test statistics**	**P-value**	**Test statistics**
ADDWHB	0.7021	-1.132	0.6154	-1.330
DESWHB	0.7022	-1.132	0.7659	-1.965
ADMWHB	0.7526	-1.002	0.6830	-1.178
DDWHB	0.6621	-1.226	0.6032	-1.356

* Significant at 10%, ** significant at 5%, ***significant at 1%

Source: Author calculation based on data from EGTE from 2003-2013

Appendix 2: Unit Root Test for Wholesale Price (Birr/Quintal) of Selected Chickpeas Market in Ethiopia at level

Markets	**ADF**		**Phillips-Perron**	
	P-value	**Test statistics**	**P-value**	**Test statistics**
ADDWCP	0.8047	-0.848	0.8262	-0.776
GONWCP	0.7918	-0.888	0.7970	-0.872
ADMWCP	0.6944	-1.151	0.6569	-1.238
DDWCP	0.7858	-0.907	0.7475	-1.016

* Significant at 10%, ** significant at 5%, ***significant at 1%

Source: Author calculation based on data from EGTE from 2003-2013

Appendix 3: First Difference Unit Root Test for Horse Bean Price (Birr/Quintal) in Selected Markets

Markets	**ADF first difference**		**Phillips-Perron first difference**	
	P-value	Test statistics	P-value	Test statistics
ADDWHB	0.000	-9.716***	0.000	-9.832***
DESWHB	0.000	-15.206***	0.000	-14.637***

ADMWHB	0.000	-9.575***	0.000	-9.621***
DDWHB	0.000	-9.746***	0.000	-9.723***

* Significant at 10%, ** significant at 5%, ***significant at 1%
Source: Author calculation based on data from EGTE from 2003-2013

Appendix 4: First Difference Unit Root Test for Chickpea Price (Birr/Quintal) in Selected Markets

Markets	**ADF fi**		**Phillips-Perron first difference**	
	P-value	Test statistics	P-value	Test statistics
ADDWCP	0.000	-11.290***	0.000	-11.326***
GONWCP	0.000	-12.166***	0.000	-12.150***
ADMWCP	0.000	- 9.030***	0.000	- 9.674***
DDWCP	0.000	-10.185***	0.000	-10.311***

* Significant at 10%, ** significant at 5%, ***significant at 1%
Source: Author calculation based on data from EGTE from 2003-2013

Appendix 5: Davidson and MacKinnon (1993) Generated the Correct Critical Value for Co-integration Test-Engle-Granger Approach

Asymptotic critical values for co-integration tested

	1%	**5%**	**10%**
M=2			
Constant	-3.90	-3.34	-3.04
Constant + trend	-4.32	-3.78	-3.50
M=3			
Constant	-4.29	-3.74	-3.45
Constant + trend	-4.66	-4.12	-3.84
M=4			
Constant	-4.64	-4.10	-3.81
Constant + trend	-4.97	-4.43	-4.15
M=5			
Constant	-4.96	-4.42	-4.13
Constant + trend	-5.25	4.72	-4.43
M=6			
Constant	-5.25	-4.71	-4.42
Constant + trend	5.52	-4.98	-4.70

Source: Davidson and Mackinnon, 1993. Table 20.2.p.72

Appendix 6: Result of Granger Causality Test for the Case of Horse Beans Markets

$$\Delta ADDWHB_t = 3.885 + 0.258\Delta ADDWHB_{t-1} + 0.027\Delta DESWHB_{t-1} - 0.251e_{t-1}$$

$$\Delta DESWHB_t = 4.8852 - 0.194\Delta ASSWHB_{t-1} + 0.254\Delta ADDWHB_{t-1}** + 0.415e_{t-1}$$

$$\Delta ADDWHB_t = 2.917 + 0.121\Delta ADDWHB_{t-1} + 0.219\Delta ADMWHB**_{t-1} - 0.191e_{t-1}$$

$$\Delta ADMWHB_t = 3.991 + 0.237\Delta ADMWHB_{t-1} - 0.037\Delta ADDWHB_{t-1} + 0.272e_{t-1}$$

$$\Delta ADDWHB_t = 3.522 + 0.089\Delta ADDWHB_{t-1} + 0.109\Delta DDWHB_{t-1} + 0.027e_{t-1}$$

$$\Delta DDWHB_t = 4.222 + 0.112\Delta DDWHB_{t-1} + 0.063\Delta ADDWHB_{t-1} + 0.452e_{t-1}$$

$$\Delta DESWHB_t = 3.605 - 0.256\Delta DESWHB_{t-1} + 0.414\Delta ADMWHB_{t-1}*** - 0.355e_{t-1}$$

$$\Delta ADMWHB_t = 5.287 + 0.316\Delta ADMWHB_{t-1} - 0.178\Delta DESWHB_{t-1}** + 0.445e_{t-1}$$

$$\Delta DESWHB_t = 5.752 - 0.364\Delta DESWHB_{t-1} + 0.235\Delta DDWHB_{t-1}*** + 0.005_{t-1}$$

$$\Delta DDWHB_t = 8.03546 + 0.136974\Delta DDWHB_{t-1} - 0.152432\Delta DESWHB_{t-1} + 0.62108e_{t-1}$$

$\Delta ADMWHB_t = 4.301 + 0.138\Delta ADMWHB_{t-1} + 0.031\Delta DDWHB_{t-1} + 0.0174e_{t-1}$

$\Delta DDWHB_t = 3.979 + 0.119\Delta DDWHB_{t-1} + 0.149\Delta ADMWHB_{t-1} + 0.452e_{t-1}$

* Significant at 10%, ** significant at 5%, ***significant at 1%

Source: Author calculation based on data from EGTE from 2003-2013

Appendix 7: Result of Granger causality test for the case of Chickpeas Markets

$\Delta ADDWCP_t = 4.822 + 0.029\Delta ADDWCP_{t-1} + 0.119\Delta GONWCP_{t-1} - 0.187e_{t-1}$

$\Delta GONWCP_t = 6.071 + 0.005\Delta GONWCP_{t-1} - 0.074\Delta ADDWCP_{t-1} + 0.398e_{t-1}$

$\Delta ADDWCP_t = 4.973 + 0.091\Delta ADDWCP_{t-1} - 0.027\Delta ADMWCP_{t-1} - 0.175e_{t-1}$

$\Delta ADMWCP_t = 2.619 + 0.166\Delta ADMWCP_{t-1} + 0.133\Delta ADDWCP_{t-1} + 0.037e_{t-1}$

$\Delta ADDWCP_t = 4.917 + 0.051\Delta ADDWCP_{t-1} + 0.091\Delta DDWCP_{t-1} - 0.107e_{t-1}$

$\Delta DDWCP_t = 4.137 + 0.041\Delta DDWCP_{t-1} + 0.095\Delta ADDWCP_{t-1} + 0.236e_{t-1}$

$\Delta GONWCP_t = 5.466 - 0.024\Delta GONWCP_{t-1} + 0.022\Delta ADMWCP_{t-1} - 0.190e_{t-1}$

$\Delta ADMWCP_t = 3.684 + 0.331\Delta ADMWCP_{t-1} - 0.133\Delta GONWCP_{t-1} + 0.144e_{t-1}$

$\Delta GONWCP_t = 5.629 + 0.024\Delta GONWCP_{t-1} - 0.055\Delta DDWCP_{t-1} - 0.137e_{t-1}$

$\Delta DDWCP_t = 4.169 + 0.067\Delta DDWCP_{t-1} + 0.051\Delta GONWCP_{t-1} + 0.2692e_{t-1}$

$\Delta ADMWCP_t = 3.023 + 0.262\Delta ADMWCP_{t-1} - 0.019\Delta DDWCP_{t-1} - 0.056e_{t-1}$

$\Delta DDWCP_t = 3.593 - 0.051\Delta DDWCP_{t-1} + 0.024\Delta ADDWCP_{t-1}{}^{***} + 0.234e_{t-1}$

* Significant at 10%, ** significant at 5%, ***significant at 1%

Source: Author calculation based on data from EGTE from 2003-2013

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