Phosphate Fertilizers’ Domestic Price Movement in Vietnam

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Abstract
This research analyses long-run and short-run co-movements among the three variables “international prices,” “domestic prices,” and “import prices” of phosphate fertilizers using co-integration test, Granger causality test, and VEC model. The findings revealed that the domestic phosphate fertilizer market in Vietnam has well integrated into the international phosphate market since shifts in the domestic phosphate fertilizer price have been in long-run equilibrium with those in the international phosphate fertilizer price. Furthermore, changes in the domestic phosphate fertilizer price were brisker than those in the import price and were uncorrelated with the import prices.

Keywords: Phosphate fertilizers, Domestic prices, International prices, Co-integration, Granger causality test, VEC model

1. Introduction
In 2004-2005, the domestic prices of steel in Vietnam were sharply soaring in proportion to its international prices. The governmental officials inspected steel plants and concluded that steel plants had earned super profits from the import of cheap steel billet and the sales of finished steel products at high prices (Nam Quoc 2005), so in their view, the steel market should be controlled via the stipulations on selling prices and commissions at steel distributors the way the petrol distribution was (Tran 2005).

The domestic price movement in the fertilizer market is analogous to that in the steel market; consequently, this market control measure was extended to the fertilizer segment (Nguyen 2005).

For traders in import materials, it is not unusual that domestic prices and international prices tend to go hand in hand. Since there is a parallel between domestic prices and international prices, when international prices rise, domestic prices rise accordingly notwithstanding low-price inventory or on-the-way cargoes. On the contrary, the fall of international prices tends to pull domestic prices down despite high-price inventory or coming cargoes. Thus, there stays a tradeoff between profit and risk. The proof is that steel plants, in 2006, faced the risk of bankruptcy as the international steel prices dramatically dropped (Mai Phuong 2006).

The primary objective of this paper is to explore the possible pattern of cointegration and causal relationships among domestic prices, international prices, and import prices in the phosphate fertilizer market through the two subsequent hypotheses:

(1) The domestic phosphate fertilizer market integrates into the international phosphate fertilizer market in a sense that the international price movement spreads into the domestic market without being distorted by policy factors.

(2) The domestic phosphate fertilizer prices move in proportion to the international phosphate fertilizer prices without being impacted by import phosphate fertilizer prices.

2. Review of previous empirical studies
Ghosh et al. (1999) contends: “Economic theory posits that certain pairs of financial time series are expected to move together in the long run. In the short run they may deviate from each other, but investors’ tastes and preferences, market forces and government regulations will bring them back to their equilibrium.” In this regard, cointegration is a reliable approach to modeling short- and long-run dynamics in a multivariate system. It is a long term measure of price co-movement within an equilibrium model. It initially sets up long-run equilibrium between prices, thereby identifying a long term relationship. Then in the second step, dynamic correlations within an error correction model are estimated. Consequently, common stochastic trends between time series are discerned before correlation analyses are implemented. The existence of a long-term cointegrating vector implies that series will not drift away from each other and will revert to their long-run equilibrium.

Myriad researches have employed the cointegration measure to analyze long-term relations between developed markets, between developed and emerging markets, and on regional basis. Nonetheless, majority of these
empirical researches examine the long-run relationships between stock markets. These researches can be categorized into three groups. Firstly, certain researches revolve principally around developed markets in the US, Canada, Europe and Japan (such as Kasa 1992; Richards 1995; Choudhry 1996; Kanas 1998; Hamori and Imamura 2000; Ahlgren and Antell 2002) and encounter some proof that there exist interdependent bonds among the stock markets of developed countries. Secondly, other researches which investigate the stock price links among merely emerging stock markets, without capturing the crucial impact of stock markets in developed countries, find purely weak proof of a relationship among the Asian stock markets (see Chaudhuri 1997; Sharma and Worthington 2002; Worthington et al. 2003; Yang et al. 2003). The final cluster of researches explore the interplays between developed and emerging markets but they do not include the impact of potential structural changes in the long-run relationships such as the Asian financial crisis in 1997. No consensus is reached among previous researches as regards whether international stock markets are interdependent. Whereas Masih and Masih (1999) and Syriopoulos (2004) find certain pair-wise long-run relationships between stock markets in developed countries and those in emerging countries, Chang (2001), Ng (2002), and Climent and Meneu (2003) do not find any proof indicating that stock market dependence subsists among such countries.

Empirical studies of market linkages in other industries remain modest in number. David (1994) studied the market links using likelihood based tests for cointegration with special application to data from US natural gas spot markets. The findings indicated that the natural gas spot markets at dispersed locations in the pipeline network are strongly connected. Conforti (2004) analyzed price transmission in Latin America (Brazil, Chile, Costa Rica, Mexico and Uruguay), Africa and Asia. They spotted three common factors to all countries: (i) there is geographical regularity: price transmission is low in Africa, the evidence is mixed in Latin America and it is more complete in Asia; (ii) price transmission intra-country seems to be stronger than inter-countries; (iii) grains show a higher level of market integration than other agricultural products. The findings in Engler and Nahuelhual’s (2006) study concluded that there exists the integration between the Chilean wheat market and that of Argentina and the USA, the latter of which is the benchmark leader for the two Latin American markets. In their working paper, Si and Wang (2006), via the Johansen co-integration method, found that a long-run cointegration relationship exists between main domestic sugar markets in China, and between the world sugar spot market and China’s domestic sugar market in a sense that the world sugar market price is prone to lead price changes in China’s domestic sugar market. Bin (2007) conducted a study on integration of domestic and global steel markets. The data demonstrated that China’s steel price has one-way guidance role towards the global steel price, that is to say, ups and downs of China’s steel price will portend the global steel price. In the same vein, Jiao et al. (2007) find the bilateral Granger causality between Chinese and international crude oil prices, where the impact of international crude oil price on the Chinese crude oil price is more rapid and dramatic than the impact of the latter on the former.

3. Data sources and research methodology

3.1 Data sources

The data on domestic prices of phosphate fertilizers collected from the year 2000 through 2009 was the mean of domestic prices of phosphate fertilizers of a variety of origins such as China, Indonesia, Philippines, Russia, U.S.A, and Middle East countries. Prices collected were whole sale prices from first-level distributors. These prices were in US dollar (USD) converted from Vietnam dong (VND) predicated on the VND/USD exchange rate from the Bank for Foreign Trade of Vietnam (Vietcombank).

The data on prices of imported phosphate fertilizers was the mean of CFR prices (USD per metric ton) of phosphate fertilizers cargoes arriving at Ho Chi Minh City port.

The data on international prices of phosphate fertilizers was the mean of FOB prices (USD per metric ton) of phosphate fertilizers of such main origins as China, Indonesia, Philippines, Russia, U.S.A, and Middle East countries from such reports as Fertecon Phosphate Report, FMB Weekly Fertilizer Report, and Profercy Phosphates & NPKs. The calculations were implemented on log (abbreviated as l) using Eview and Jmulti softwares.

3.2 Research methodology

This research employed Granger’s (1981) cointegration method to explore short-run and long-run correlations of nonstationary economic time series. Granger (1981) defined the concept of degree of integration of a variable. If variable $z_t$ can be made roughly stationary by differencing it $d$ times, it is called integrated of order $d$, or $I(d)$. Weakly stationary random variables are thus $I(0)$. A number of macroeconomic variables can be regarded as $I(1)$ variables: if $z_t \sim I(1)$, then $\Delta z_t \sim I(0)$. If a linear combination of a set of $I(1)$ variables is $I(0)$, then the variables are cointegrated.
The significance of cointegration in the modeling of nonstationary economic series becomes clear in the so-called Granger representation theorem, first formulated in Granger and Weiss (1983). So as to illustrate this result, consider the subsequent bivariate autoregressive system of order $p$:

$$
\begin{align*}
    x_t &= \sum_{j=1}^{p} \gamma_{1j} x_{t-j} + \sum_{j=1}^{p} \delta_{1j} y_{t-j} + \varepsilon_{1t} \\
    y_t &= \sum_{j=1}^{p} \gamma_{2j} x_{t-j} + \sum_{j=1}^{p} \delta_{2j} y_{t-j} + \varepsilon_{2t},
\end{align*}
$$

where $x_t$ and $y_t$ are I(1) and cointegrated, and $\varepsilon_{1t}$ and $\varepsilon_{2t}$ are white noise. The Granger representation theorem says that in this case, the system can be written as:

$$
\begin{align*}
    x_t &= \alpha_1 (y_{t-1} - \beta x_{t-1}) + \sum_{j=1}^{p-1} \gamma_{1j} \Delta x_{t-j} + \sum_{j=1}^{p-1} \delta_{1j} \Delta y_{t-j} + \varepsilon_{1t} \\
    y_t &= \alpha_2 (y_{t-1} - \beta x_{t-1}) + \sum_{j=1}^{p-1} \gamma_{2j} \Delta x_{t-j} + \sum_{j=1}^{p-1} \delta_{2j} \Delta y_{t-j} + \varepsilon_{2t},
\end{align*}
$$

where at least one of parameters $\alpha_1$ and $\alpha_2$ deviates from zero. Both equations of the system are “balanced”, that is, their left-hand and right-hand sides are of the same order of integration, since $y_{t-1} - \beta x_{t-1} \sim I(0)$.

Suppose that $y_t - \beta x_t = 0$ defines a dynamic equilibrium relationship between the two economic variables, $y$ and $x$. Then $y_t - \beta x_t$ is an indicator of the degree of disequilibrium. The coefficients $\alpha_1$ and $\alpha_2$ represent the strength of the disequilibrium correction, and the system is now said to be in error-correction form. A system characterized by these two equations is hence in disequilibrium at any given time, but has a built-in tendency to adjust itself towards the equilibrium.

The research underwent the subsequent phases:

- Stationarity of the time series was tested by applying the Augmented Dickey-Fuller (ADF) unit root test to levels and first differences.
- Co-integrating relations among time series were investigated. The existence of these co-integrating relations implies time series are in long-run equilibrium. Since import phosphate fertilizer price encompasses international phosphate fertilizer price plus transaction charge and transport charge, so if there is no significant shift in transaction charge and transport charge, it is expected that import prices and international prices co-integrate. Thus, in case international prices and import prices are co-integrated with domestic prices, it is concluded that the domestic phosphate fertilizer market integrates into the international phosphate fertilizer market.
- Granger causality test was used to explore the temporal sequencing of the three time series: “international prices,” “domestic prices,” and “import prices” of phosphate fertilizers. According to Granger’s definition of causality, a stationary time series $Y_t$ is said to ‘cause’ another stationary time series $X_t$ if – under the assumption that all other information is irrelevant – the inclusion of past values of $Y_t$ significantly reduces the predictive error variance of $X_t$. In econometric practice, Granger-causality tests are carried out by regressing $X_t$ on its own lags and on lags of $Y_t$. If the lags of $Y_t$ are found to be jointly statistically significant, then the null hypothesis that $Y_t$ does not Granger-cause $X_t$ can be rejected (Lütkepohl & Krätzig 2004).
- Finally, vector error correction (VEC) model developed by Johansen (1988) was employed to explore adjustments on long-run as well as short-run relationships among the time series.

4. Findings and discussion

4.1 Graph description

As portrayed in Figure 1, the changes in the domestic phosphate fertilizer price and those in the international phosphate fertilizer price occurred virtually at the same time and amplitude, whereas the changes in the import price correspondingly transpired, but slightly lagged.

Percentages of shifts from month to month in domestic prices and international prices are displayed in Figure 2. These shifts practically coincided in terms of time and intensity.
4.2 Unit root test of domestic prices, import prices, and international prices of phosphate fertilizers

As numerous economic time series have non-stationary properties, the variables must be tested for stationary process. The problem with non-stationary data is that the Ordinary Least Squares (OLS) regression procedures can readily give rise to erroneous conclusions. Hence, so as to evade the spurious regression, the Augmented Dickey-Fuller (ADF) test proposed by Dickey and Fuller (1981), whose null hypothesis is that there is a unit root, is adopted. The data in Table 1 displays that unit root test values of the level series are greater than the critical values, indicating that the null hypothesis of non-stationary could not be rejected. Nonetheless, after first differencing of these variables, the ADF test statistics are significantly less than the corresponding critical values at both 0.01 and 0.05 significance levels, which implies that the null hypothesis of non-stationary should be rejected and the alternative hypothesis of stationary be accepted. Put differently, the variables (lnIntPFP, lnDPFP, and lnImpPFP) are integrated of order 1 or I(1), that is, these variables become stationary after being first differenced.

4.3 Co-integration test

As the variables are integrated of order one, the test for co-integration is proceeded. The co-integration test, formulised by Engle and Granger (1987), was further improved by Johansen (1988). The test is given by the following equation:

$$
\lambda_{\text{trace}} (r | n) = -T \sum_{i=[r+1]}^{n} \log(1 - \lambda_i)
$$

where $r$ is the number of cointegrating relations, and $n$ is the number of variables. The null hypothesis is that the number of cointegrating vectors is less than or equal to $r$ against the alternative hypothesis of $r>0$.

The results from Table 2 show that for the pairs of variables, the null hypothesis is rejected for $r = 0$ at the significance levels 0.05 or 0.01. Nonetheless, the null hypothesis is accepted for $r = 1$. It is concluded, thus, that there exist co-integration relationships among the pairs of time series “international prices” and “domestic prices”, “international prices” and “import prices”, and “domestic prices” and “import prices”, indicating that pairs of time series are of long-run equilibrium or there is symmetrical response of domestic phosphate fertilizer prices to international phosphate fertilizer prices.

4.4 Granger causality test

As displayed in Table 3, the null hypotheses, F-statistic, and probability p are encountered in the first, third, and fourth column of the table respectively. The null hypotheses can be rejected if $p$ is less than 0.05 (as highlighted by the sign *). The results from Granger causality test demonstrate this causal movement: international prices $\rightarrow$ domestic prices $\rightarrow$ import prices of phosphate fertilizers, or shifts in international prices lead to those in domestic prices, and shifts in domestic prices lead to those in import prices. In other words, the domestic phosphate fertilizer prices respond symmetrically to the international phosphate fertilizer prices, but not to the import phosphate fertilizer prices.

4.5 VEC model for pairs of variables

VEC model for the two variables “domestic phosphate fertilizer price” and “international phosphate fertilizer price”

VEC model for the two variables “domestic phosphate fertilizer price” and “international phosphate fertilizer price”

The variables are integrated of order 1 or I(1) and are of co-integration relationship. Although optimal lag order through Akaike Information Criteria (AIC) and Final Prediction Error (FPE) is 1, univariate Autoregressive Integrated Moving Average (ARIMA) model reveals that the correlation can be of lag order of 4, so VEC model is established as below:

d(domestic price) = -0.25 [DPFP(-1) -0.837IntPFP(-1)] – 0.164dDPFP(-4) (-5.4) (-17.8) + 0.151dIntPFP(-1) + 0.254 (-2.45) (-5.4)

d(international price) = 0.278 dIntPFP(-1) (3.0)

VEC model between domestic phosphate fertilizer price and international phosphate fertilizer price shows that international phosphate fertilizer price takes the role of exogenous variable with the VEC coefficient of 0, which implies the monodirectional impact of international prices on domestic prices without the opposite direction. Domestic phosphate fertilizer prices are adjusted to be in long-run equilibrium with international phosphate fertilizer prices at the pace of 25% (= 0.25). Short-run shifts in domestic prices are also adjusted in correspondence with international prices at the coefficient of 0.15. By and large, the domestic phosphate
fertilizer market harmoniously integrates into the international phosphate fertilizer market in long-run as well as short-run relationships and will be adjusted to the international prices when any price gaps emerge. 

VEC model for the two variables “domestic phosphate fertilizer price” and “import phosphate fertilizer price” 

Likewise, VEC model between domestic phosphate fertilizer price and import phosphate fertilizer price is displayed as 

\[
d(\text{import price}) = 0.75 \left[ \text{DPFP}(-1) - 0.933 \text{ImpPFP}(-1) \right] + 0.162 \text{ImpPFP}(-1) 0.24 (10.4) (-51.6) (2.4) (-10)
\]

There exists no equation depicting the correspondence between changes in domestic price and those in import price due to statistically insignificant coefficients. As a result, domestic prices of phosphate fertilizers play the role of exogenous variable and are not impacted by import prices, which further confirms the conclusion from Granger causality test in the section 3.4.

5. Concluding remarks 

The aforementioned findings demonstrated that the domestic phosphate fertilizer market in Vietnam has well integrated into the international phosphate market since shifts in the domestic phosphate fertilizer price have been in long-run equilibrium with those in the international phosphate fertilizer price.

The research additionally revealed that changes in the domestic phosphate fertilizer price were brisker than those in the import price and were uncorrelated with the import prices. Its macro-management implication is that the domestic price movement in phosphate fertilizer market does not pursue the law of import price movement.

This finding can be applicable to other imported materials due to their analogous market mechanism.

The reasons behind the proportional change between domestic phosphate fertilizer prices and international phosphate fertilizer prices can be: 

- According to efficient market theory, changes in prices of commodities stem from the information available in the market; hence, domestic prices vary instantly to the spread of the information on international prices despite the availability of the cargoes in the market. Domestic prices can vary instantaneously when new purchase contracts have been concluded, and the quantities from these contracts are counted into the supply-demand balance even before the arrival of the cargoes in the market. Thus, the advent of the cargoes at the port does not impact the domestic prices, but rather slightly adjusts them if the earlier price reactions have been too strong or too week.

- Traders import commodities predicated on capital preservation principle in terms of their quantity rather than their value, so if the international price rises, they have to bring the domestic price up, otherwise they are not in a position to import the same quantity of the commodity they have sold. If the international price falls, under competition pressure, they sell their commodity at a lower price and can import the similar quantity of the commodity they have sold, otherwise the cargo will linger in the warehouse due to the higher competitiveness of the cheaper arrivals.

References 


Profercy Phosphates & NPKs, weekly report, 2000-2009.


Table 1. Data from ADF test

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF statistic</th>
<th>Lags</th>
<th>0.01 Critical Value</th>
<th>0.05 Critical Value</th>
<th>Stationary or not</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnIntPFP</td>
<td>-1.23</td>
<td>2</td>
<td>-2.14</td>
<td>-2.76</td>
<td>No*</td>
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<tr>
<td>lnDPFP</td>
<td>-1.85</td>
<td>4</td>
<td>-2.14</td>
<td>-2.76</td>
<td>No*</td>
</tr>
<tr>
<td>lnImpPFP</td>
<td>-1.72</td>
<td>1</td>
<td>-2.14</td>
<td>-2.76</td>
<td>No*</td>
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<td>d²lnIntPFP</td>
<td>-6.24</td>
<td>1</td>
<td>-2.07</td>
<td>-2.88</td>
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<td>d²lnDPFP</td>
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<td>4</td>
<td>-2.07</td>
<td>-2.88</td>
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<td>d²lnImpPFP</td>
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<td>-2.07</td>
<td>-2.88</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: (1) The optimal lags for conduction ADF test were decided by AIC (Akaike information criteria)
(2) IntPFP, DPFP, and ImpPFP in turn refer to international prices, domestic prices, and import prices of phosphate fertilizers.
* Represents significance at 0.01 level.

Table 2. Co-integration test results

<table>
<thead>
<tr>
<th>Lags</th>
<th>r</th>
<th>ADF statistic</th>
<th>0.01 Critical Value</th>
<th>0.05 Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IntPFP-DPFP</td>
<td>2 (AIC, FPE)</td>
<td>r = 0</td>
<td>21.84</td>
<td>24.78</td>
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<tr>
<td></td>
<td></td>
<td>r = 1</td>
<td>1.56</td>
<td>11.42</td>
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<tr>
<td>IntPFP-ImpPFP</td>
<td>3 (FPE)</td>
<td>r = 0</td>
<td>37.51</td>
<td>24.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>r = 1</td>
<td>1.27</td>
<td>11.42</td>
</tr>
<tr>
<td>DPFP-ImpPFP</td>
<td>4 (AIC)</td>
<td>r = 0</td>
<td>21.78</td>
<td>24.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>r = 1</td>
<td>2.41</td>
<td>11.42</td>
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</table>

Table 3. Granger causality test results

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>Lags</th>
<th>F-statistic</th>
<th>Probability p</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnDPFP does not Granger Cause lnIntPFP</td>
<td>1</td>
<td>2.72</td>
<td>0.11</td>
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<tr>
<td></td>
<td>2</td>
<td>0.23</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.35</td>
<td>0.78</td>
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<td></td>
<td>4</td>
<td>0.75</td>
<td>0.54</td>
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<td>lnIntPFP does not Granger Cause lnDPFP</td>
<td>1</td>
<td>31.08</td>
<td>3.2E-7*</td>
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<td>17.50</td>
<td>3.5E-7*</td>
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<td></td>
<td>3</td>
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<td>5.9E-7*</td>
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<td>4</td>
<td>8.50</td>
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<td>3.40</td>
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<td></td>
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<td>0.89</td>
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<tr>
<td>lnIntPFP does not Granger Cause lnImpPFP</td>
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<td>137.5</td>
<td>0.0000*</td>
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<td></td>
<td>4</td>
<td>30.7</td>
<td>0.0000*</td>
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<td>lnImpPFP does not Granger Cause lnDPFP</td>
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<td>0.99</td>
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<td>2</td>
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<td>72.4</td>
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<td>3</td>
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<td>22.8</td>
<td>4.5E-13*</td>
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Figure 1. Series of domestic prices, import prices, and international prices of phosphate fertilizers in USD/mt during 2000-2009

Figure 2. Percentages of monthly shifts in domestic prices and international prices of phosphate fertilizers