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Examing relationships between farming price and export price: the case of Pangasius in the Mekong Delta, Vietnam

Ludo Cuyvers[1]

Michel Dumont[2]

Tu Van Binh[3]

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[1] Professor of International Economics, Chairman of the Department of International Economics, International Management and Diplomacy, and Director of the Centre for ASEAN Studies, University of Antwerp, Belgium.
[2] Federal Planning Bureau (Belgium). Delft University of Technology, The Netherlands and University of Antwerp, Belgium.
[3] Lecturer, School of Economics and Business Administration, Can Tho University, Vietnam, and Research Fellow, Centre for ASEAN Studies and Department of International Economics, International Management and Diplomacy, University of Antwerp, Belgium.

Abstract

Cointegration is used to investigate the short-run and long-run dynamics of the Vietnamese pangasius market. The aim of this study is to determine whether long-run relationships exist between the farm price of live pangasius fish at the farm gate on the one hand and the export price of pangasius fillets for the European Union and the United States of America on the other. Monthly data from 2003 to 2007 suggest that there is a long-run (cointegration) relationships between the prices considered. The Granger causality method also finds that the export price to the USA is affected by both the fish farm price and the export price to the EU. The price transmission elasticity for the farm price to the price for the EU is large. In addition, the result of forecast error variance decomposition suggests that the shocks to the Vietnamese pangasius market originate mostly from the farm level. The EU is leading the export price for the USA, while the farm price is leading for the price for the EU and the USA.

Key words: Pangasius market dynamics, Error correction model.

1. Introduction

Many studies have investigated the price transmission in the food marketing systems, in order to better assess the implications for market efficiency (Williams and Bewley, 1993). Market efficiency implies that in a competitive market with perfect information, arbitrage will ensure that price differentials in related spatial, temporal or product transformation markets reflect the costs of providing market services[4] (Chang and Griffith, 1998).

Relationships between prices among markets have been investigated in many papers. Most of these studies used time series methods to find out causality between prices (Spriggs et al. 1982; Ardeni 1989; Goodwin and Schroeder 1991; Goodwin 1992; Mohanty et al. 1995). Spriggs et al. (1982) examined the price leadership roles of the USA and Canada, using Granger causality tests. Mohanty et al (1995) also used Granger causality tests to determine the exogeneity of the USA in the export price formation of competing exporters. Mohanty et al. (1996) used cointegration and an error correction approach to examine relationships between the USA and Canadian prices, and found that the long run relationship between the USA and Canadian wheat markets is uni-directional. Bessler et al. (2003) examined dynamic relationships among wheat prices from five countries: Canada, the European Union, Argentina, Australia, and the United States, with the empirical results showing that Canada and the U.S. are leader in the pricing of wheat in the five markets.

Unlike studies on the market dynamic analysis of agricultural products mentioned above, Quagrainie and Engle (2002) performed a dynamic analysis on the American catfish market, using a cointegration approach to estimate long-run and short-run relationships between the producer price, the domestic processed price and the import price.

Pangasius is a family of catfish which is very popular in the Mekong Delta (MD) of Vietnam. The catfish industry has experienced rapid growth in the recent past, basically due to its attractive product meeting demand in the world market. Few studies have investigated long-run and short run-relationships between the farming price and the export price of Vietnamese pangasius. To our knowledge only the study by Quagrainie et al. (2002) examined the market dynamics of American catfish, i.e. the relationships between the American producer price, the America domestic frozen catfish fillet price and the import price of frozen catfish fillets from Vietnam. The authors found that a positive price transmission exists between the American catfish grower price and the price of American domestic frozen fillets, implying that an increase in the price of one is associated with or accompanied by an increase in the other. In this paper we want to investigate the relationship between the Vietnamese catfish grower price and the Vietnamese frozen catfish fillet price exported to the USA and the EU. This allows us to compare the results of catfish raised in Vietnam to the results reported by Quagrainie et al (2002) for catfish raised in the US.

In the present paper we intend to investigate the long-run and short-run relationships between the grower price and the export price of frozen pangasius fillets in Vietnam, using an error correction model. The results of the analysis of these price relationships provide information on the existence of price leadership. An understanding of price leadership is important in explaining the structure of the market and also helps researchers in correctly specifying the relevant price linkage equations.

The paper starts with a brief introduction of the main concepts involved in the econometric time series literature on error correction models and cointegration. In the next section, the theoretical framework is derived, followed by the presentation of the data used. The results are presented and discussed in the last section.

2. Method

Although the EU quickly became a target market for the Vietnamese exporters during the catfish war (Binh, 2006). the traditional USA market remained important. Hence, the exporters' pricing strategy towards the EU and the USA markets is crucial for the growth of the Vietnamese pangasius exports, both in volume and in market share. The total share of the two markets accounted on average for more than 50% of the total export volume during the 2003–2007 period. More than 90% of the live pangasius fish in the MD is processed and exported to the international market (Cuyvers and Binh, 2008). As a consequence, the fish farmer is much influenced by the export markets and sensitive for international shocks.

In this paper we will explore the relationships between the pangasius producer price and the export price of frozen pangasius fillets for the USA and for the EU market, using cointegration and error correction techniques. To specify the price formation process, we will use the model developed by the Engle and Granger (1987) in order to establish the long run equilibrium relationship and identify the short run dynamic specification.

Engle and Granger (1987) have pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be *cointegrated*. The stationary linear combination is called the *cointegrating equation* and may be interpreted as a long-run equilibrium relationship among the variables. As pointed out by Engle and Granger (1987). cointegration is a necessary and sufficient condition for representing the series in an error correction model, which permits to discriminate between short-run and long-run relationships.

In this paper, both Engle and Granger's bivariate and cointegration technique and the maximum likelihood cointegration procedure developed by Johansen (1988) and Johansen and Julius (1990) are used.

The causality test of Granger (1983, 1988) and Engle and Granger (1987) is based on an error correction representation. In this paper, the final analyses of the price series will involve an error correction model for each of the price series, accounting for seasonality since monthly data are being used. The error correction equation is based on Quagrainie and Engle (2002):

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[4] Price differentials in spatially related markets should reflect the cost of transportation while in temporally related markets, the cost of storage (Faminow and Benson, 1990; Goodwin and Schroeder, 1991).

$$\Delta p_{it} = \lambda_{i0} + \sum_{n=1}^{N} \lambda_i \Delta p_{it-n} + \sum_{n=1}^{N} \sum_{j=1}^{3} \gamma_{ij} p_{ijt-n} + \sum_{s=1}^{11} \delta_{is} D_s + \varepsilon_t \ , \qquad (1)$$

where Δ indicates the first difference (e.g. $p_{it} - p_{it-1}$ for the price series). *i* being 1 (= pangasius fillet export price for the EU). 2 (= pangasius fillet export price for the USA).or 3 (= farming price of live pangasius); *D* a dummy variable for months, and *s* an index ranging from 1 to 11 for January up to November. The λs and γs and δs are parameters to be estimated, where the $\lambda_i s$ and the $\gamma_{ij} s$ are the short-run and long-run price transmission parameters respectively. Ceteris paribus, λ_i and γ_{ij} characterize and measure the transmission of a change in the pangasius price between price *i* and *j*.

Many economic variables are not stationary in levels but in (first) differences. To proceed with modeling it is important to determine the order of integration, i.e. the number of times a time series needs to be differenced to achieve stationarity. The order of integration of time series can be determined with unit root tests. The null hypothesis of these tests is that a given time series has a unit root which implies that it is not stationary. If the null hypothesis can be rejected the time series can be assumed to be stationary. In this paper, Dickey-Fuller (1979) and Phillips-Perron (1998) tests are used to identify the order of integration of the time series of the prices and a Granger causality test (Granger, 1988) for examining causal relationships between the prices.

The Augmented Dickey and Fuller (ADF) test is given as:

$$\Delta y_t = \alpha_0 + \alpha T + \beta_0 y_{t-1} + \sum_{j=1}^{k} \beta_j \Delta y_{t-i} + e_{tk} \qquad (2)$$

with Δ the difference operator and *T* a time trend (Dickey and Fuller, 1979). The null hypothesis is that the series is not stationary. For the implementation of the ADF test it is important to specify the lag length *k*, which if taken too small will bias errors due to remaining serial correlation, whereas if taken too large will reduce the power of the test.

Schwert (1989) argued that the ADF and the Phillips-Perron (PP) tests are asymptotically equivalent but can differ substantially in finite samples as they correct for serial correlation in different ways. Schwert (1989) found that if Δy_t follows an ARMA process with a large and negative moving average (MA) component, the ADF and PP tests are severely size-distorted, resulting in the over-rejection of the null hypothesis of no stationarity, with the PP tests being more distorted than the ADF tests.

3. Data

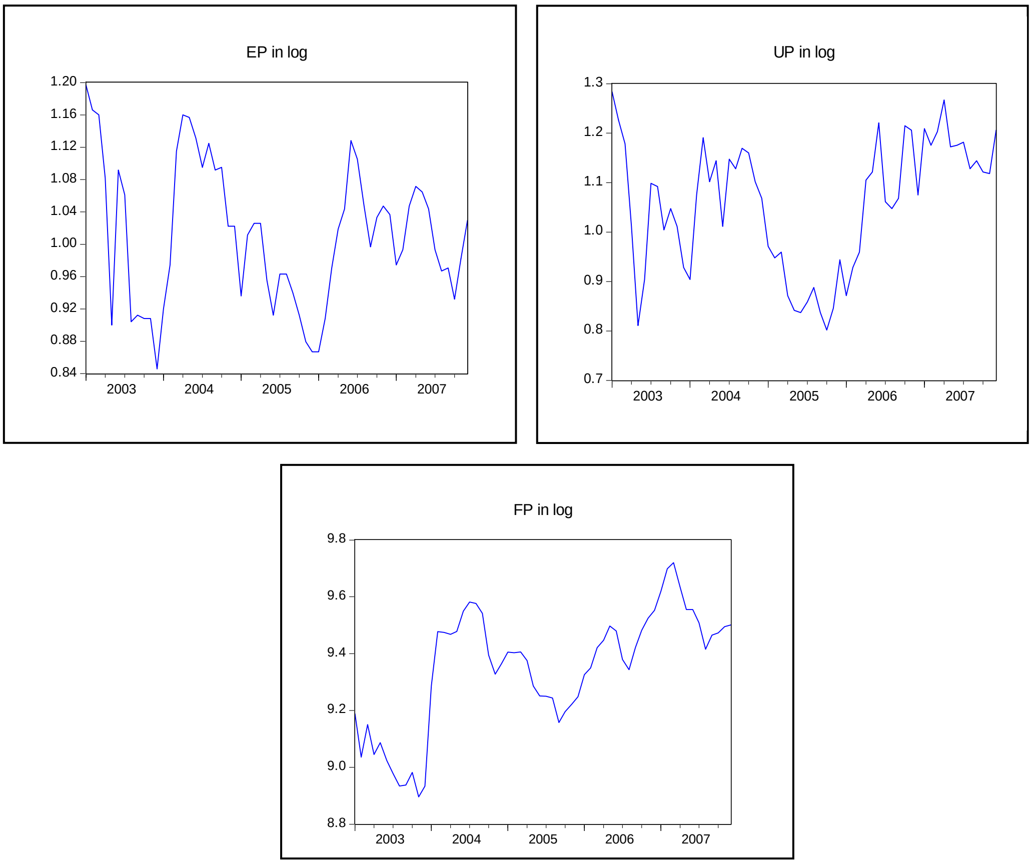
The data used in our analysis are monthly time series covering the period from January 2003 to December 2007. We are considering the following variables:

- EP: Pangasius fillet export price for the EU, in USD per kg;
- UP: Pangasius fillet export price for the USA, in USD per kg;
- FP: Farming price of live pangasius at the farm gate, in Vietnamese Dong per kg (VND/kg).

The data are from various sources such as the Vietnam Association of Seafood Exporters and Producers (VASEP) and daily market price information published by the Department of Trade and the Department of Agriculture and Rural Development of the An Giang province in the MD.

There are three price series shown in figure 1, the co-movements in these series suggest that there may be potential cointegration among the variables. The price for the EU (EP). the price for the USA (UP) and the farm price (FP) peak in the first months of 2003, because of the impact of the anti-dumping duties imposed by the USA. In the second half of 2003 all three prices fell dramatically as Vietnamese exporters used low prices as a strategy to enter new markets in the EU, urged by falling imports from the USA. At the same time, the export price for the USA decreased, though it was still higher than the period before the anti-dumping tax was imposed, because the exporters wanted to maintain their traditional market. In parallel, at the farming level, there is a high stock of the live pangasius fish due to the trade dispute between Vietnam and the USA, as this the fish farmer is not easy to sell its own crop, because of the company's carefullness. Consequently, the price at the farming level is down.

Figure 1: The export price for the EU, the USA and the farming price of pangasius product



Source: VASEP, Department of Agriculture and Rural Development and Department of Trade in An Giang province

4. Stationarity tests, causality tests and estimation results

The results of the unit root tests (Augmented Dickey and Fuller (ADF) and Phillips-Perron (PP)) are reported in table 1. In both tests the null hypothesis of a unit root is not rejected, which implies that the three variables are non-stationary. As the first differences of these variables are found to be stationary with a statistical error level below 1%, the three variables appear to be integrated of order 1.

Table 1: Unit Root Tests

Variable	Level in log		First difference	
	ADF	PP	ADF	PP
EP	-2.82(0.06)*	-3.31(0.02)**	-7.51(0.00)***	-7.53(0.00)***
UP	-2.76(0.07)*	-2.75(0.07)*	-7.70(0.00)***	-8.70(0.00)***
FP	-1.21(0.20)	-1.65(0.45)	-4.83(0.00)***	-5.94(0.00)***

Note: EP = fillet pangasius export price for the EU
UP = fillet pangasius export price for the USA
FP = producer price of live pangasius
P-Value is given in the brackets
*; **; *** significant at 10%; 5% and 1% respectively

According to Engle and Granger (1987) and Selover and Round (1996). the findings that the variables are non-stationary and are not cointegrated suggest the use of a VAR model in first differences. However, if they are cointegrated, an unrestricted VAR in levels can be used. The results of the Johansen-Juselius cointegration test shown in table 2 indicate that there is cointegration among the variables. Thus, the trace and maximum eigen value (Max-Eigen) test both reject the null hypothesis at the five percent significance level, indicating that there is a statistically significant cointerating vector, i.e., one linear long-run equilibrium relationship among the prices.

Table 2: Johansen-Juselius Cointegration Tests

Hypothesized No. of CE(s)	Trace Statistic	Max-Eigen Statistic	Critical Values (5%)	
			Trace	Max-Eigen
None	26.66	12.88	29.79	21.13
At most 1	13.78	9.59	15.49	14.26
At most 2*	4.19	4.19	3.84	3.84

Note: Trace and Max-Eigen tests indicate no cointegration at the 5% level.
* denotes rejection of the hypothesis (the null hypothesis, no cointegration) at the 5% level.

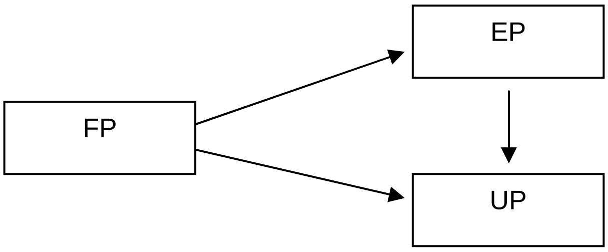
The results of the Granger causality tests are presented in table 3. There are 3 pairs of significant causal relationships, and evidence of uni-directional causality from FP to EP and to UP. This means that the fillet pangasius export price for the EU and the USA are affected by the farm price in Vietnam. In addition, there is uni-directional causality from EP to UP, it can be concluded that the pangasius export price for the EU precedes the pangasius export price for the USA market, although only at the 10 % significance level. In other words, the export price to the USA market is affected by both the farming price in Vietnam and its export price to the EU, while the farming price has an evident uni-directional causality on the export price to the EU (figure 2).

Table 3: Results of Granger causality tests between pairs of variables

Null hypothesis	F-Statistic	Prob.
FP -------x-------> EP	15.72	0.00***
EP -------x-------> FP	1.33	0.25
UP -------x-------> EP	0.52	0.47
EP -------x-------> UP	3.59	0.06*
UP -------x-------> FP	2.01	0.16
FP -------x-------> UP	11.58	0.00***

Note: EP = fillet pangasius export price to the EU market
UP = fillet pangasius export price to the USA market
FP = live pangasius price at farming gate
*** significant at 1%
* significant at 10%.
-------x-------> means does not Granger Cause

Figure 2: Causal relationships between pangasius prices



As indicated in table 4, the estimated cointegrating relation or long-run equilibrium relationship, normalised by the β associated with the price for the EP, can be written as

$$0.004 + EP - 0.44UP - 0.22FP = 0$$

Table 4: Estimated long-run parameters, α s and β s

	EP	UP	FP	Constant
Estimated β s	1.00 (---)[a]	-0.44 (---)	-0.22 (---)	0.004 (---)
	Δ EP	Δ UP	Δ FP	
Estimated α s	-1.29 (-4.69)[b]	0.63 (1.29)	0.35 (0.94)	

Notes: [a] t-ratios for β coefficients are not calculated
[b] figures in parentheses are t-values

In the first row of table 4, the sum of the estimation coefficients associated with UP and FP is 0.66, meaning that a one percent increase in the price for the EU is associated with a 0.66 percent increase in the farming price FP and the price for the USA. Moreover, since the three series are shown to be cointegrated, the system can be expected to respond to exogenous shocks and return to equilibrium after being perturbed.

Table 5 shows the estimation results of the error correction model for each of the price series. It is expected that the parameter estimates associated with the lagged dependent variable in each of the three equations are between zero and one in absolute terms (Quagrainie and Engle, 2002). The coefficients of the price for the USA and the farm price have significant values of -0.40 and -0.26 respectively, and present the respective short-run adjustment to the own price due to changes in other prices or costs. However, the coefficient of the lagged export price to the EU is positive, but not statistically significant.

Table 5: Estimated parameters from the error correction models of each price series

Variable	Changes in fillet pangasius export market for the EU (Δ EP)	Changes in fillet pangasius export for the USA (Δ UP)	Changes in live pangasius price at the farming gate (Δ FP)
Constant			
Δ EP(-1)	0.16 (0.93)	0.04 (0.13)	-0.20 (-0.86)
Δ UP(-1)	-0.27 (-2.98)***	-0.40 (2.43)***	0.004 (0.04)
Δ FP(-1)	0.02 (0.18)	0.48 (2.63)***	-0.26 (-1.86)**
EP	-1.29 (1.23)	0.63 (-3.98)***	0.35 (2.69)***
UP	0.57 (-1.21)	-0.28 (-1.20)	-0.15 (1.11)
FP	0.28 (1.69)**	-0.14 (1.27)	-0.08 (-4.99)***
January	-0.01 (-0.26)	0.004 (-0.23)	0.08 (1.52)*
February	0.03 (0.61)	0.05 (0.70)	-0.06 (-0.98)
March	0.05 (1.25)	0.05 (0.73)	-0.09 (-1.66)*
April	0.003 (0.07)	-0.07 (-1.02)	-0.12 (-2.27)**
May	-0.02 (-0.39)	-0.02 (-0.24)	-0.05 (0.89)
June	0.07 (1.73)**	0.07 (0.95)	-0.03 (-0.54)
July	0.002 (0.05)	0.04 (0.50)	-0.05 (-0.99)
August	-0.03 (-0.87)	-0.002 (-0.03)	-0.05 (-0.91)
September	-0.01 (-0.38)	0.009 (0.14)	0.01(-0.14)
October	-0.0004 (-0.01)	0.03 (0.51)	-0.02 (-0.34)
November	-0.007 (-0.17)	-0.003 (-0.04)	-0.04 (-0.79)

Note: EP = fillet pangasius export price for the EU market
UP = fillet pangasius export price for the USA market
FP = live pangasius price at farming gate
*** significant at 1%
** significant at 5%
* significant at 10%.

There is a negative and statistically significant price transmission elasticity (-0.27) from the price for the USA to the price for the EU in the short run, while the farm price to the price for the EU price transmission elasticity (0.28) in the long run is positive and significant at the 5% level. The result of a positive price transmission from Vietnam's farm price to its export price for the EU in the long run is consistent with the earlier finding from the causal relationship mentioned and is as expected since an increase in the farm price (due to increasing input prices, such as these of feed or general aquatic drugs) will normally lead to an increase in the export price. On the other hand, a negative transmission from the USA to the EU market is found as the EU has been a major market of Vietnamese pangasius exporters during the last years, particularly after the catfish war between Vietnam and the USA in 2002. The share of the EU in the total export volume has been increasing between 2003 and 2007 from 20.06% in 2003, 25.71% in 2004, 38.38% in 2005, 43% in 2006 and 48% in 2007, while the share of the USA has been gradually decreasing between 2003 and 2006, from 26.37% in 2003, 17.03% in 2004, 10.27% in 2005, 8.47% in 2006, 7% in 2007[5].

Similarly, the farm price coefficient with respect to the export price for the USA is significantly positive (0.48). providing evidence for a positive transmission elasticity in the short run. This result is in

[5] Vietnam Association of Seafood Exporters and Producers (VASEP)

accordance with the evidence from the causality tests. In addition, the price for the EU to the price for the USA price transmission elasticity has a significantly positive value (0.63) in the long run, which is also consistent with our earlier finding on the causal relationships.

The long-run price transmission elasticity of 0.35 is significant for the price for the EU suggests that an increase in the price of one is associated with or accompanied by an increase in the other. In addition, since the main destination of Vietnamese pangasius is the export market, it can be expected that the farm price is influenced by the international market as well (Cuyvers and Binh, 2008). particularly the EU market.

To investigate interrelationships between variables in dynamic models, impulse response or dynamic multiplier analysis is also helpful. It is therefore applied in cointegration systems (Lütkepohl and Reimers, 1992). Based on Williams and Bewley (1993). Chang and Giffith (1998) used cointegration and impulse response analysis to investigate the short-run and the long-run dynamics of the Australian beef market based on monthly data.

Figure 3, 4, 5 show impulse response functions for a period of 36 months. For example, in figure 3, a one unit (a one standard deviation) shock in the change in the price for the EU brings about an initial increase (response) of 0.055 units in the price for the EU, but no change in the farm price nor in the price for the USA. Further, a one unit shock in the change in the price for the USA leads to an initial response of a 0.073 units and a 0.026 units increase in the price for the USA and the price for the EU, respectively (figure 4). Finally, a one unit shock in the change in the farm price brings about an initial response of a 0.074 units increase in this price, and a 0.005 units increase in the price for the EU and 0.003 increase in the price for the USA (figure 5). Despite the differing responses to shocks, the changes in the three price series stabilize after four months and settle down to approximately zero eventually, which is as can be expected from a cointegrated system (Change and Giffith, 1998).

Figure 3: Impulse response to an innovation in the price for the EU

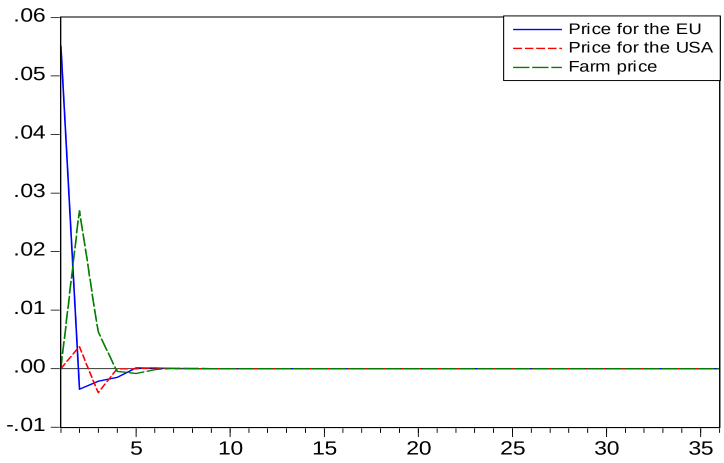


Figure 4: Impulse response to an innovation in the price for the USA

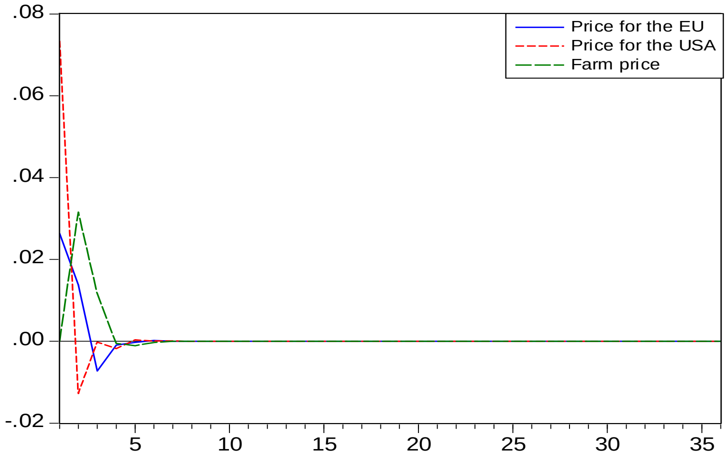


Figure 5: Impulse response to an innovation in the farm price

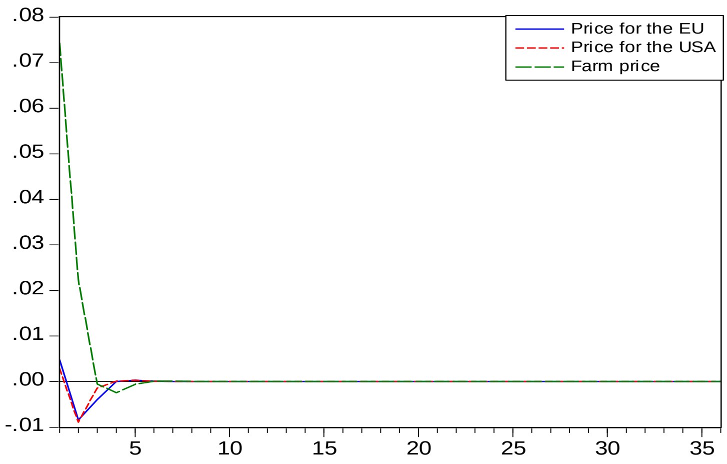


Table 6 : Variance decomposition of on-month and 36-month forecast error variance

	Percentage of forecast error variance explained by shocks in					
	Price for the EU		Price for the USA		Farm price	
	One-month	36 month	One-moth	36-month	One-month	36-month
Price for the EU	100.00	79.28	0.00	0.81	0.00	19.91
Price for the USA	11.40	12.28	88.60	72.81	0.00	14.91
Farm price	0.41	1.76	0.15	1.44	99.44	96.80

The estimation results of forecast error variance decomposition (FEVD) are alternatively reported in table 6. The FEVD is closely related to Granger causality analysis as both tools provide evidence concerning the existence of a causal relationship among two variables. But analysis of the FEVD goes further than Granger causality tests. As the FEVD of an endogenous variable is considered for alternative horizons to shocks in each variable. The analysis of the FEVD not only provides evidence of the simple existence of a relationship among two variables, but also illuminates the strength and the dynamic timing of such a relationship (Bessler 1984; Babula and Ric 2001; Sagharian et al. 2002). The forecast error variance decomposition results consist of two different durations, one-month and 36-month. As a result, the price for the EU, the USA and the farm price explained 100, 88.6 and 99.44 percent, respectively, of their own forecast error variance in the first month. The corresponding figures for 36 months ahead are 96.80, 79.28 and 72.81percent, respectively. The cross price effects also show that a shock in the farm price explains about 20 and 15 percent of variation in the price for the EU and the USA respectively, contrary to a shock in the price for the USA which explains only little variation in the price for the EU (0.81 percent) and in the farm price (1.44 percent). By contrast, a shock in the price for the EU explains 12.28 percent of the variation in the price for the USA, but only 1.76 percent in the farm price variation. These results suggest that the shocks to the Vietnamese pangasius market originate mostly from the farm level.

According to Premaratne and Bala (2004). a leading market is one of which the variance of its price can explain a large percentage of the error variance of other markets while its own forecast error is not explained by shocks in other markets. Our results indicate that the farm price is a price leader for the price for the EU and the USA as it explains some 20% and 15% of price variations for the EU and the USA respectively. Similarly, the price for the EU appears to be a price leader for the price for the USA as it explains some 12.28% of price variation for the USA.

5. Conclusion

In this paper the cointegration and error correction model approach was used to investigate the Vietnamese pangasius market dynamics. Our analysis shows that there is a long-run cointegration relationship between the Vietnamese export price of fillet pangasius for the EU and the USA, and the farm price of live pangasius fish at the farm gate.

The Granger causality tests applied show that the export price to the USA is affected by both the fish farm price and the export price to the EU. At the same time, the farm price shows uni-directional causality to the export price to the EU, which means that the farm price plays a significant role in the price determination of the frozen fillet price for the EU market. The relationship between the farm price and the price for the EU market is strong and the price transmission elasticity for the farm price to the price for the EU is large. This seems in line with Quagrainie and Engle (2004) who found that the producer price uni-directional caused changes in the frozen catfish fillet price in the USA.

We can conclude that there is a reciprocal influence between the farm price and the export price for the EU. This meets our expectation, as the share in Vietnam’s exports of pangasius to the EU is the largest, compared with other shares of other markets, such as ASEAN, the USA or Russia.

We also performed an impulse response estimation, the results of which suggest that the export price for the EU is leading the export price for the USA, while the farm price is leading for the price for the EU and the USA. This is based on the concept of leading market, being a market with a variance of its price explaining a large percentage of the error variance of other markets while its own forecast error is not explained by shocks in the other markets. We also found evidence that the price series are influenced by seasonality.

Based on our findings, we can see that the Vietnamese pangasius industry has advantages of leading the market. This may be due to the fact that pangasius is a typical kind of freshwater fish species, that other countries are not able to produce because of unfavorable environment conditions. However, in order to take advantage of the product characteristics and the market of pangasius, the Vietnamese government should be concerned about: (i) developing a clear plan to build up live fish farming areas for farmers, instead of the freely and unorganizable production situation at present; (ii) supporting the fish farmer on improving the quality standard and the food safety assurance of pangasius, which will help the farmers to produce the pangasius product according to the requirements of the international market, but also to maintain their farming occupation; (iii) developing a good market information system to provide timely and accurate information on domestic and international market prices, as well as market forecast information, to the fish farmers and other stakeholders, e.g. input service providers.

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