Assessing the Market Integration of Domestic and Imported Catfish in the U.S.

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Abstract

This study assesses the market integration of domestically produced and imported catfish products in the United States. In 2003, the U.S. adopted legislation that established anti-dumping tariffs for Vietnamese catfish products entering the country. One goal of this analysis is to determine how these tariffs have impacted the relationship between foreign and domestically produced catfish products. Cointegration tests confirm the existence of a long-run price relationship between domestic and imported catfish products, which has persisted despite the legislative change. This finding enables the estimation of vector error correction models to describe this price relationship in the periods before and after import tariffs went into effect. Results from these models suggest that Vietnamese catfish fillet prices do not significantly influence or react to domestic catfish prices. However, the price of catfish fillets imported from countries other than Vietnam has continued to respond to domestic prices, and to influence the prices received by domestic catfish farmers and processors.

Introduction

The production of channel catfish (*Ictalurus punctatus)* represents the largest sector of the aquaculture industry in the United States, accounting for over 51% of total food fish sales (2013 USDA Aquaculture Census). Of this production, the vast majority is purchased by processors and then sold in the form of boneless fillets (USDA Catfish

Inventory). In 2014 U.S. farm-raised catfish ranked eighth on the list of fish and seafood most commonly consumed by Americans, with per capita consumption of 0.56 pounds per year (2014 U.S. Catfish Database). However, the U.S. catfish industry has been shrinking since reaching its high point in 2003. In fact, the 334 million pounds of catfish produced in 2014 represents a 54% decrease from 2003 peak production levels (2014 U.S. Catfish Database).

Meanwhile, U.S. markets have experienced a rapid increase in imports of frozen catfish fillets over the past decade. Many supporters of the U.S. catfish industry point to these foreign imports as a major cause of the domestic industry's decline (Martin, 2014; Quagrainie & Engl 2002). Foreign catfish imports have gone from representing only 20% of the U.S. market for frozen catfish fillets in 2005, to comprising 80% of the market share in 2014 (2014 U.S. Catfish Database). The vast majority of these imported fillets originate in Vietnam, and a great deal of controversy has arisen in recent years regarding the labeling and pricing of these products (Brambilla *et al.* 2009).

The term catfish refers to the order *Siluriformes*, which is comprised of 39 families of catfish. The U.S. catfish industry produces mostly a high quality variety known as *channel catfish* (*Ictaluris punctatus*), belonging to the family *Ictaluridae*. These fish are mostly raised in man-made ponds in the states of Mississippi, Arkansas, Alabama and Louisiana (Brambilla *et al.* 2009). Before the introduction of Vietnamese catfish, this variety accounted for almost all of domestic consumption. There are two varieties of Vietnamese catfish, both belonging to the family *Pangasiidae*. These species are known as *basa* (*Pangasius bocourti*) and *tra* (*Pangasius hypophthalmus)*. The Hau and Tien rivers, located in the Mekong region of Vietnam, are the main areas of cultivation for both of these species. Small farmers use cages placed directly in the rivers to raise both of these species. *Tra* is considered to be of lower quality than *basa* in terms of texture and flavor. However *tra* is faster, easier and less costly to raise compared to *basa*. Thus *tra* has become the more popular species among Vietnamese producers (Brambilla *et al.* 2009).

Vietnam started exporting frozen fillets of both *basa* and *tra* to the U.S. in 1995, shortly after the end of the U.S. embargo. At first names such as *River Cobbler* and *China Sole* were used in an attempt to popularize Vietnamese catfish species (Brambilla *et al.* 2009). Eventually, retailers began to label both species as simply catfish. Attempts were also made to make Vietnamese catfish seem like a domestic product; these included adopting names such as *Cajun Delight Catfish*, and using packaging similar to those in which domestic catfish were distributed (Brambilla *et al.* 2009). By 2000-2002, about 50% of the total Vietnamese production of catfish was being exported to the U.S., and by 2002 the market share of Vietnamese catfish reached 19.6%. Figure 1 shows the market share of domestic and foreign catfish fillet producers from 1986 – February 2013. Most of this product was sold to distributors and chain restaurants, with the supermarket supply consisting of mostly fresh catfish supplied by domestic producers. During this time period (2000-2002) the price of domestic catfish fell by about 18% from $2.75 to $2.25 per pound. This led the Association of Catfish Farmers of America (CFA) to blame the introduction of Vietnamese catfish for the fall in prices (Brambilla *et al.* 2009). They lobbied Washington, and in October of 2001 the House of Representatives adopted a bill

(H.R. 2964) that stated that only catfish belonging to the family *Ictaluridae* (American catfish) could be labeled as catfish in the U.S. However, this did not lead to a recovery in the price of domestic catfish, likely because most Vietnamese catfish was being sold to wholesale distributors rather than directly consumers (Brambilla *et al.* 2009).

With the new labeling laws not proving effective at increasing domestic catfish prices, the CFA decided to file a dumping lawsuit against Vietnam in June 2002 (Martin 2014). In January 2003, the U.S. Department of Commerce (DoC) ruled in favor of U.S. producers, and in July 2003, the U.S. International Trade Commission (ITC) applied anti-dumping import duties equivalent to a dumping margin of 37-64%. These tariffs were subject to a "sunset" review after 5 years, and in June 2009, the ITC renewed the antidumping duties, finding that a revocation would likely lead to further dumping activities by Vietnamese producers (Martin 2014).

Literature Review

A great deal of literature has been produced in the last several decades that attempts to describe the manner in which the U.S. catfish industry operates. Common themes that have been explored include price transmission, market structure and dynamics, and the competitiveness of the domestic industry. The catfish market is dynamic, experiencing shifts in demand from changing consumer preferences, as well as changes in supply due to advances in technology and increased foreign competition. Thus periodic updates have been necessary to ensure that the current body of literature accurately describes the true structure of the catfish market.

Many attempts have been made to explain the market structure of the domestic catfish industry. A study by Kinnucan and Sullivan (1986) found that the monopsonistic structure of the Western Alabama catfish processing sector at the time was having a negative impact on the prices received by farmers. Kouka (1995) later suggested that catfish processors still held some degree of market power. Hudson (1999a) found instead that entry by new firms into the processing industry had made pricing very close to competitive.

Some of the most interesting and important findings have come from investigating price spreads and margins in the catfish market. Nyankori (1991) showed that changes in prices at the farm level tend to precede changes in wholesale prices. This finding is important because it suggests that changes in farm prices can potentially trigger wholesale price changes. Zidack *et al.* (1992) studied price transmission within the catfish industry, as well as the effects of generic advertising. The authors concluded that there was significant price transmission between the farm and wholesale level, and also that advertising led to increased margins for catfish producers. Kinnucan & Miao (1999) extended this work to investigate media specific returns to generic advertising within the industry, concluding that the historical media allocation was inefficient. Hudson (1999b) also examined price transmission between farm and wholesale prices in the catfish industry. Through the use of cointegration techniques, this study provided evidence that farm and wholesale catfish prices had begun to move together through time. Hudson and Hanson (1999) attempted to disaggregate the price margins for wholesale fish into product types, as well as to investigate the impact of firm entry into the catfish industry.

Their significant findings were that increased competition alone did not appear to impact margins for catfish producers significantly, and that technology growth was tending to decrease margins over time. Research by Buguk *et al*. (2003) indicates that price volatility from inputs to catfish feed can have strong spillover effects on the farm and wholesale prices of catfish.

Recent studies have tended to focus on the competitiveness of the U.S. catfish industry and determining the impact of imports on domestic prices. Quagrainie and Engle (2002) found evidence that the price of domestic catfish fillets plays a significant role in determining the price of imported catfish. Engle (2003) noted that while U.S. catfish production still remained profitable at the time, increases in production efficiency had not kept pace with increasing input costs. Engle predicted significant challenges for the U.S. catfish industry in terms of remaining competitive in the future. Quagraine (2006) used a flexible logistic model to forecast the market share for domestically produced frozen catfish fillets. This research suggests that the relatively high price of domestic fillets (compared to imported fillets) have and will continue to diminish the market share for U.S. products. The author also provides evidence that catfish functions as a necessary good, and thus demand remains stable through changes in the economy. Muhammad *et al.* (2010) performed an analysis which suggests that import tariffs on Vietnamese catfish would increase prices received for domestic catfish, and would therefore provide a benefit for the U.S. catfish industry. Singh and Dey (2011) assert that U.S. catfish production has declined in competitiveness as compared to other catfish producing nations that import their products into the United States. They also contend that the 2003 tariffs on Vietnamese catfish imports to the U.S. have not benefitted domestic producers, but rather have led to increased profits for producers in more competitive countries that are not subject to tariffs such as China and Thailand. Hanson *et al.* (2013) produced results that indicate that U.S. catfish producers are losing their comparative advantage. The authors suggest that while import tariffs improve comparative advantage position of domestic producers, improvement in areas such as feed efficiency and product differentiation will be required to increase the profitability of the industry. Dey *et al.* (2014) investigated retail prices of different product forms of catfish by utilizing retail scanner data. Their results indicate that U.S. catfish producers can potentially remain competitive with lower priced imports by offering differentiated products such as breaded forms or prepared entrées, which command a higher price in outlets such as supermarkets.

Previous studies have concluded that the prices of domestic and imported catfish fillets were integrated before the establishment of import tariffs on Vietnamese catfish products in 2003. However, market integration of these products has not been investigated since this legislation went into effect. This study adds to the current body of work by re-examining and updating the relationship between domestic and imported catfish fillets with more recent data and investigating the impact of the 2003 legislation.

Data and Methodology

The data sources that are utilized for this study include the United States Department of Agriculture Economic Research Service's catfish data tables, which consist of monthly totals of the quantity of catfish sold to processors by domestic producers, the average price received by producers from processors, the quantity of catfish sold by processors, and the average price received by processors. These monthly observations span from January 1986 to February 2013, and thus give a sample size of 326 data points for each category. Information on catfish imports was obtained from the National Marine Fisheries Service Fisheries Statistics and Economics Division. This dataset consists of monthly totals for the quantity of catfish imported into the U.S. as well as the value of these imports. This data was collected for the timeframe specified earlier, providing 326 data points. Figure 2 depicts all of the price series utilized in this analysis.

When a linear combination of two non-stationary series produces a stationary series, these two series are said to be cointegrated (Engle and Granger 1987). This implies that two series exhibit a long-term relationship, and thus display coordinated movement through time. Cointegration also indicates a causal relationship of some kind exists between the two series (Granger 1969). Many previous studies have used cointegration techniques to examine the relationship between the prices of various agricultural or seafood products (see Goodwin 1996, Asche *et al*. 1999, Quagrainie and Engle 2002, Asche *et al*. 2004, Nielson *et al.* 2007, Asche *et al*. 2012 among many others). The goal of these studies is generally to determine whether these products are part of the same market, and thus are subject to the Law of One Price (LOP). The logic behind this method is as follows: if the prices of two products are cointegrated, then these products can be considered to exist in one integrated market, where consumers substitute between the two products in response to price changes. Finding cointegration of two products implies that these products are indeed viewed as substitutes by consumers, and further that the market that is being investigated is efficient. We employ the cointegration techniques outlined by Johansen (1991,1995) to examine whether a long-term price relationship exists between domestically produced and imported catfish fillets in U.S. markets.

Before a determination is made as to whether two price series are cointegrated, the stationarity of each the series must first be assessed. Logically two series must be non-stationary in order to display a long-term relationship; that is to say that each series must be moving over time if the series are to move in coordination with one another. Further, two series must be integrated of the same order to be considered cointegrated (Johansen 1988). The Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1979) is used to determine the order of integration of each price series considered in this analysis.

Next cointegration tests are conducted following the methods outlined by Johansen and Juselius (1990) and Johansen (1991, 1995). This test uses maximum likelihood to determine the number of significant cointegrating vectors present between several time series variables. This technique allows us to determine whether there is a long-term relationship among the included catfish price series, as well as to estimate an equation to describe this relationship.

Finally, we produce a vector error correction model using the methods of Johansen (1995). This methodology involves estimating the cointegrating coefficients and error correction coefficients simultaneously through the use of maximum likelihood. Estimating a vector error correction model allows us to determine which catfish price variables significantly adjust to disequilibrium in the cointegrated system, and which are weakly exogenous (Engle *et al.* 1983).

We have chosen to separate the price series into those that occur before the introduction of import tariffs on Vietnamese catfish products into the U.S. and those that occur after these tariffs were imposed. Before the tariffs are introduced, we aggregate foreign catfish products from all countries, and report their average price and total sales. After the tariffs are established, we distinguish between catfish imports produced in Vietnam, which are subject the tariffs, and those coming from the rest of the world, which are not. This allows us to examine the integration of different catfish products both before the tariffs are introduced, as well as afterwards. By splitting these series into two periods, we hope to determine how the adoption of these import tariffs have changed the price relationship between domestically produced catfish and catfish fillets imported from Vietnam and the rest of the world.

Analysis and Results

In order to determine whether a long-term price relationship exists between two price series, it is first necessary to assess the stationarity of each series. Stationarity was evaluated using the Augmented Dickey Fuller test procedure ADF tests were performed on each price series for the periods before and after the introduction of the 2003 import tariffs. ADF tests statistics are reported for each series for different specifications: one that includes only an intercept term and another that includes both an intercept and a trend term. The optimal number of significant lags to include in each of these tests was determined using the Schwartz Information Criterion (SIC). This optimal number of lags is presented in parentheses next to each price series. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test was used to confirm all ADF results. For this test, the Bartlett kernel was selected as the spectral estimation method, and the bandwidth was automatically selected following the Newey-West procedure. Results from this test are only presented in cases that they are inconsistent with the results obtained from ADF tests.

The results of stationarity tests for the period before the tariffs were enacted are presented in table 1. The ADF test fails to reject the null hypothesis of a unit root in the level of each of the price series at a 5% significance level. This indicates that each of these price series is non-stationary in level form. The null hypothesis of a unit root is rejected for the first differences of each of the price series at a 1% significance level. This indicates that the first-differencing transformations have induced stationarity, and that each first-differenced price series is I(0) i.e. integrated of order one. Results of KPSS stationary tests corroborate all of these findings. The fact that these series are integrated of the same order means that cointegration techniques can be used to determine the relationships between each of these prices.

Separate ADF tests were also performed on each of the price series for the period after the import tariffs were enacted, and these results are presented in table 2. The results are generally consistent with those found in table 8 above, indicating that each price series is stationary in first-differences and thus is integrated of order one. There is some evidence that the domestic farm-gate price series may be stationary in level form when specified with a constant but no trend term. The ADF test statistic calculated for this specification of farm-gate price has a p-value of 0.045, and thus rejects the null of a unit root at the 5% significance level. Conversely, a KPSS test on this specification of farm gate price yields an LM statistic of 0.681, indicating that the null of stationarity can be rejected at the 5% significance level by this test. We take this result, along with the fact that farm-gate price was clearly non-stationary in level form for the period before the tariffs were introduced, as compelling evidence that the variable is indeed I(1).

Thus we have found evidence that each price series is non-stationary when evaluated in level form, but exhibits stationarity when a first-differencing transformation is applied. This suggests that each price series is integrated of order one, and thus cointegration is the appropriate method to investigate the relationship between these price series over time (Johansen 1988). However, KPSS tests performed on each of the variables in table 2 specified with a constant and trend term cannot reject the null hypothesis of stationarity at the 10% significance level. These results indicate that these variables may be trend stationary during this later period. This finding impacts our choice of assumptions when running our Johansen cointegration tests, and will be discussed in greater detail in the following section.

Cointegration tests were then performed to determine the relationships among all of the included catfish price variables. Again, separate tests were performed for the periods before and after the implementation of the import tariffs on Vietnamese catfish products in July 2003. By comparing the results of the cointegration tests for these two periods, we hope to determine the impact that these tariffs have had on the price relationship between domestic catfish and imported catfish fillets. These tests were implemented following the methods outlined by Johansen (1991, 1995). Two separate measures, trace statistic and max eigenvalue, are compared to critical values produced by Johansen and Juselius (1990) in order to determine the number of cointegrating vectors that exist between series included in the test. Finding at least one significant cointegrating vector allows us to estimate a vector error correction model (VECM) using maximum likelihood in order to extract more information on the nature of the relationship between these price variables. A general VECM is presented below, which has been reproduced from Pesaran (2015).

$$\Delta y_t = a_0 + a_1 \mathrm{t} - \Pi y_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + u_t \tag{1}$$

where y_t represents a (n x 1) vector of the included price series, a_0 is the unrestricted constant term, Π is a long-run impact matrix, Γ_j are short-run impact matrices, and u is a white noise error term (Johansen 1995; Zivot and Wang 2007).

Due to the fact that each of the price series in this analysis is seen to have a non-zero mean as well as clear positive trend over each of the sample periods, we specify the cointegration tests and vector error correction to allow for non-zero intercepts as well as linear trends. Since there is evidence that some of the price variables may be trend-stationary over the later the sample period, we choose a set of assumptions that restrict the trend coefficients to appear within the cointegrating relations. This is equivalent to amending equation 1 above so that $a_0 \neq 0$, and $a_1 = \Pi\gamma$, where γ is a linear trend term (Persaran 2015). Under these assumptions the VECM becomes:

$$\Delta y_t = a_0 + [y_{t-1} - \gamma(t-1)]\Pi + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + u_t \qquad (2)$$

Although we have chosen this specific set of assumptions, we note that our findings of cointegration hold in all cases for each of the five deterministic trend assumptions considered by Johansen (1995). The Schwarz Information Criterion was used to select the number of significant lags to include in all cointegration tests and VECMs performed in this analysis. Two significant lags were found in all cases.

The results from table 3 indicate that one significant cointegrating equation exists which relates domestic fillet, farm gate and imported fillet prices before the introduction of the July 2003 tariffs. The cointegrating equation for these price series is presented in equation 3, and has been normalized so that the coefficient on the domestic fillet price equals unity. This normalization allows a for a clear illustration of how changes in the other included price variables impact domestic fillet price, which is the main variable of concern in this analysis.

Dom = 3.903*Farm - 2.721*Imp + 0.010*Trend + 2.103 (3)

This equation can be thought of as the equilibrium state between each of these prices. Estimating a VECM allows us to determine which of the included variables are actively adjusting to disequilibrium in the system, and which do not.

The full results of the VECM estimated for this first period is included as table 4 in the appendix to this paper. The coefficients on the cointegrating equation, estimated as part of the VECM, indicate the speed of adjustment of each of the price variables in the system. An examination of these coefficients reveals that imported fillet price is significantly adjusting to disequilibrium in the system, while domestic and farm prices are not. This indicates that the price of imported catfish was significantly responding to domestic prices in the period before the U.S. tariffs on catfish imports were established.

Impulse responses were produced for this VECM, which illustrate the response of each variable to a one standard deviation positive shock to another variable in the system. Each individual graph shows the predicted response of one of the catfish price variables to the specified shock, along with 95% confidence interval bands. These results are presented in Figure 3. Both the domestic fillet and farm-gate price series appear to respond quickly to shocks to one another. It is unsurprising that domestic fillet price would respond to farm price, given the fact that live catfish is the main input to the production of catfish fillets. It also appears that catfish farmers are able to take advantage of increases in domestic fillet prices, and demand higher prices for their whole fish in response. Positive shocks to either of these price series tend to lead to sustained increases both series. Neither of these price series appears to respond significantly to shocks in imported fillet price. Imported fillet price responds to shocks to both domestic fillet and farm-gate prices, although there is uncertainty about the sign of these responses. An important finding is that when imported fillet price is shocked, it very quickly returns to its mean. Thus, unlike domestic fillet and farm-gate prices, shocks to imported price do not tend to lead to sustained price changes.

Vietnamese imports are separated from the imported catfish fillets originating from the rest of the world in the second sample period, since only Vietnamese catfish products are subject to special U.S. import tariffs beginning in July 2003. The cointegration test results for this later period, reported in table 4, suggest that there are two cointegrating equations that exist between the four included catfish price series. The most likely equation was chosen by log-likelihood, and is reported below as equation 4. Once again this equation was normalized by setting domestic fillet price equal to unity.

$$Dom = 7.208*Farm - 1.333*ROW + 1.070*Viet. - 0.007*Trend + 0.031 \qquad (4)$$

A separate VECM was estimated for this later period and the results are reported in table 6. The estimated coefficients for both the domestic farm-gate price and ROW imported fillet price terms of the cointegrating equation are significant, indicating that these price series adjust to disequilibrium in the cointegrated system. Domestic and Vietnamese fillet prices appear to be weakly exogenous in this model. Impulse responses were calculated for this model as well, and appear in figure 4.

This model yields some interesting insights into the dynamics of the U.S. catfish market. The price of catfish fillets originating in countries other than Vietnam appears to adjust in response to changes in the prices of other catfish products, and the magnitude of this adjustment is greater than observed in the previous period. Positive shocks to both domestic catfish price series lead to significant and sustained increases in non-Vietnamese imported fillet prices. This suggests that the producers of fillets in these countries are able to base their selling price on the observed prices for these other products. Vietnamese fillet price does not appear to significantly respond to shocks to any of the other catfish price series. Thus Vietnamese fillet producers, who are subject to anti-dumping tariffs, do not seem to adjust their prices in response changes in the prices of other catfish products. The relationship between domestic farm-gate prices and fillet prices remains the same as in the pre-tariff period, with both price series responding positively to shocks to the other series, and these positive shocks leading to sustained increases in both prices. Farm-gate prices also appear to respond positively to shocks to imported fillet prices originating from countries other than Vietnam, with these shocks also leading to a sustained increase in farm-gate prices. This suggests that catfish farmers are able to exhibit some market power, and demand higher prices for their product when they notice price increases in related products. A similar result is noticed for domestic fillet price's response to increases in fillet prices from non-Vietnamese producers, although this result is not as highly significant as for farm-gate price. There is some evidence that increases to Vietnamese catfish prices lead to decreased prices for domestic catfish products, although these responses are not highly significant.

These results indicate that a significant price relationship does still exist between domestic and imported catfish fillet prices. There is evidence that the adoption of anti-dumping tariffs on Vietnamese catfish imports may have diminished the impact that the prices of these products can have on domestic catfish prices. However, the price of imported fillets originating from the rest of the world still has significant impacts on the prices received by U.S. catfish producers and processors.

Conclusions

This analysis has yielded some interesting and important findings. Cointegration testing confirms that there was a significant long-term relationship between domestic catfish prices and imported fillet prices before the establishment of anti-dumping tariffs on Vietnamese catfish products by the U.S. in July 2003. Further, a VECM constructed for this period indicates that the price of imported catfish fillets were responsive to disequilibrium within this cointegrated system, while domestic prices were weakly exogenous. This finding is consistent with the results reported by Quagrainie and Engle (2002).

A second cointegration test was performed for the period following the adoption of the aforementioned tariffs. During this period, Vietnamese catfish fillets were separated from those originating from the rest of the world, in order to examine what impact these tariffs had on the price relationship that was discovered for the previous period. In this later period, we find that a significant price relationship still remains between domestic catfish prices and imported fillet prices. Findings from a VECM for this later period indicate that the price of catfish fillets from countries other than Vietnam is still significantly adjusting in response to changes in domestic prices. In fact, the magnitude of this adjustment is even greater than in the previous period. Vietnamese fillet price does not appear to significantly impact the prices received for domestic catfish products once import tariffs have been established. These anti-dumping tariffs were intended to protect the U.S. catfish industry from underpriced imports, and this finding provides some evidence that these measures are achieving their intended outcome. However, we also find evidence that the price of imported catfish fillets from other countries are still impacting the prices received for domestic catfish products in this later period, especially the prices received by catfish farmers. Thus import tariffs enforced on just a single catfish producing country do not appear to be enough to protect the domestic catfish industry.

Domestic production of catfish has continued to decline since its peak in 2003, and the prices received by both domestic processors and producers have not significantly increased as a result of import tariffs (2014 U.S. Catfish Database). While these tariffs may have been effective at eroding the price relationship between domestic catfish products and Vietnamese fillets, the policy is likely not enough to ensure the long-term survival of the domestic catfish industry. As Singh and Dey (2011) point out, U.S. import tariffs on Vietnamese products may be of greater benefit to catfish producers in other countries such as China and Thailand, who still hold a comparative over domestic producers. We are in agreement with Hanson *et al.* (2013) that more research should be dedicated to increasing production efficiency in the domestic catfish industry, and to differentiating domestically produced catfish products from similar foreign products. We also support the suggestion by Dey *et al.* (2014) that the domestic industry consider producing value-added catfish products, which command a price premium over unprepared catfish products.

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Tables and Figures

Table 1. T-Statistics from ADF Tests; Sample: January 1986 - June 2003

Price Series	***Level***	***First Difference***
Domestic Fillet Price		
Intercept only	-2.358753 (1)	-9.270104*** (0)
Intercept and trend	-2.300268 (1)	-9.278282** (0)
Farm Gate Price		
Intercept	-2.268825 (2)	-8.745504** (1)
Intercept and trend	-2.300972 (2)	-8.738958** (1)
Imported Fillet Price		
Intercept only	-2.349145 (5)	-14.98940*** (4)
Intercept and trend	-2.778182 (5)	-14.97629** (4)

Note: * and ** indicate significance at the 5% and 1% levels, respectively

Table 2. T-Statistics from ADF Tests; Sample: July 2003 – February 2013

Price Series	***Level***	***First Difference***
Domestic Fillet Price		
Intercept only	-2.388780 (2)	-3.655028* (1)
Intercept and trend	-3.271264 2)	-3.673811* (1)
Farm Gate Price		
Intercept	-2.933281* (1)	-3.991165* (0)
Intercept and trend	-3.446250 (1)	-4.032301* (0)
ROW Fillet Price		
Intercept only	-2.337903 (0)	-10.20561** (0)
Intercept and trend	-2.536439 (0)	-10.18508** (0)
Vietnam Fillet Price		
Intercept only	-2.409745 (1)	-15.87964** (0)
Intercept and trend	-3.095146 (1)	-15.82326** (0)

Note: * and ** indicate significance at the 5% and 1% levels, respectively

Table 3. Cointegration Test Results (January 1986 – June 2003)

Price Series	*Cointegrating Vectors*	*Trace Statistic*	*Max Eigenvalue*
Domestic Fillet **Farm Gate** **Imported Fillet**	None	66.14903**	48.08306**
	At most 1	18.06597	11.49219
	At most 2	6.573773	6.573773

Note: * and ** indicate significance at the 5% and 1% levels, respectively

Table 4. Cointegration Test Results (July 2003 – February 2013)

Price Series	*Cointegrating Vectors*	*Trace Statistic*	*Max Eigenvalue*
Domestic Fillet **Farm Gate** **ROW Fillet** **Vietnamese Fillet**	None	100.0197**	51.42664**
	At most 1	48.59302*	28.43938*
	At most 2	20.15363	11.01446
	At most 3	9.139175	9.139175

Note: * and ** indicate significance at the 5% and 1% levels, respectively

Table 5. Full VECM Results, Sample Period: January 1986 – June 2003

Error Correction:	**D(DOM_P)**	**D(FARM_P)**	**D(IMP_P)**
CointEq1	-0.002222	-0.000954	-0.283453**
	(0.00270)	(0.00142)	(0.04052)
D(DOM_P(-1))	-0.005190	0.101766*	0.192860
	(0.08447)	(0.04443)	(1.26930)
D(DOM_P(-2))	0.032731	0.067340	0.444667
	(0.07834)	(0.04121)	(1.17720)
D(FARM_P(-1))	1.203401**	0.611914**	1.712257
	(0.15163)	(0.07976)	(2.27843)
D(FARM_P(-2))	-0.137742	-0.422739**	-3.025800
	(0.17152)	(0.09022)	(2.57731)
D(IMP_P(-1))	0.005869	0.004561	-0.129202
	(0.00634)	(0.00333)	(0.09522)
D(IMP_P(-2))	0.004652	0.003517	-0.049955
	(0.00472)	(0.00248)	(0.07087)
Constant	-0.000535	-0.000418	0.002850**
	(0.00192)	(0.00101)	(0.02886)

Note: * and ** indicate significance at the 5% and 1% levels, respectively.
Standard errors are reported in parentheses

Table 6. Full VECM Results, Sample Period: July 2003 – February 2013

Error Correction:	D(DOM_P)	D(FARM_P)	D(ROW_P)	D(V_P)
Cointegrating	0.004346	0.010433*	-0.218326**	0.022753
Equation	(0.01191)	(0.00403)	(0.03437)	(0.02663)
D(DOM_P(-1))	-0.053635	0.058007	-1.020078**	0.133450
	(0.11047)	(0.03740)	(0.31871)	(0.24692)
D(DOM_P(-2))	0.042505	0.041498	-0.962546**	-0.095104
	(0.10901)	(0.03691)	(0.31451)	(0.24367)
D(FARM_P(-1))	2.295988**	0.654744**	2.783185**	0.817423
	(0.31213)	(0.10568)	(0.90051)	(0.69766)
D(FARM_P(-2))	0.063868	-0.036322	0.814228	0.203088
	(0.37558)	(0.12716)	(1.08357)	(0.83948)
D(ROW_P(-1))	0.022511	0.017735	0.067251	0.070476
	(0.02845)	(0.00963)	(0.08207)	(0.06358)
D(ROW_P(-2))	-0.030711	0.000573	0.097401	-0.050418
	(0.02766)	(0.00937)	(0.07980)	(0.06183)
D(V_P(-1))	0.011640	0.002557	-0.171195	-0.339670**
	(0.04388)	(0.01486)	(0.12659)	(0.09807)
D(V_P(-2))	0.004784	-0.016981	-0.442169**	0.005250
	(0.04297)	(0.01455)	(0.12399)	(0.09606)
Constant	0.003466	0.000152	0.010124	8.27E-05
	(0.00495)	(0.00167)	(0.01427)	(0.01105)

Note: * and ** indicate significance at the 5% and 1% levels, respectively.
Standard errors are reported in parentheses

Figure 1. Catfish Fillet Sales in U.S. (January 1986 – February 2013)

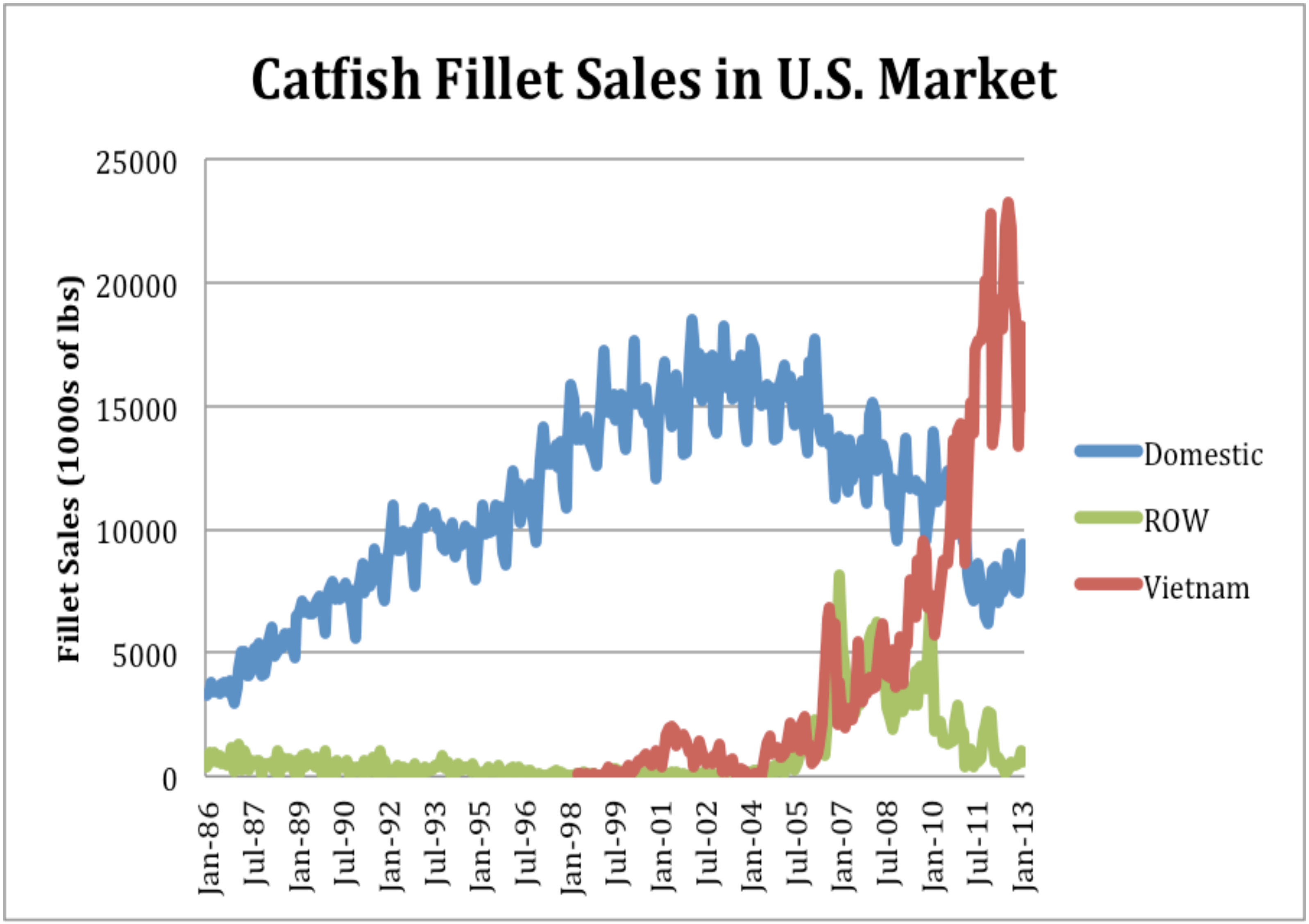

Figure 2. Catfish Sales in U.S. Market (January 1986 – February 2013)

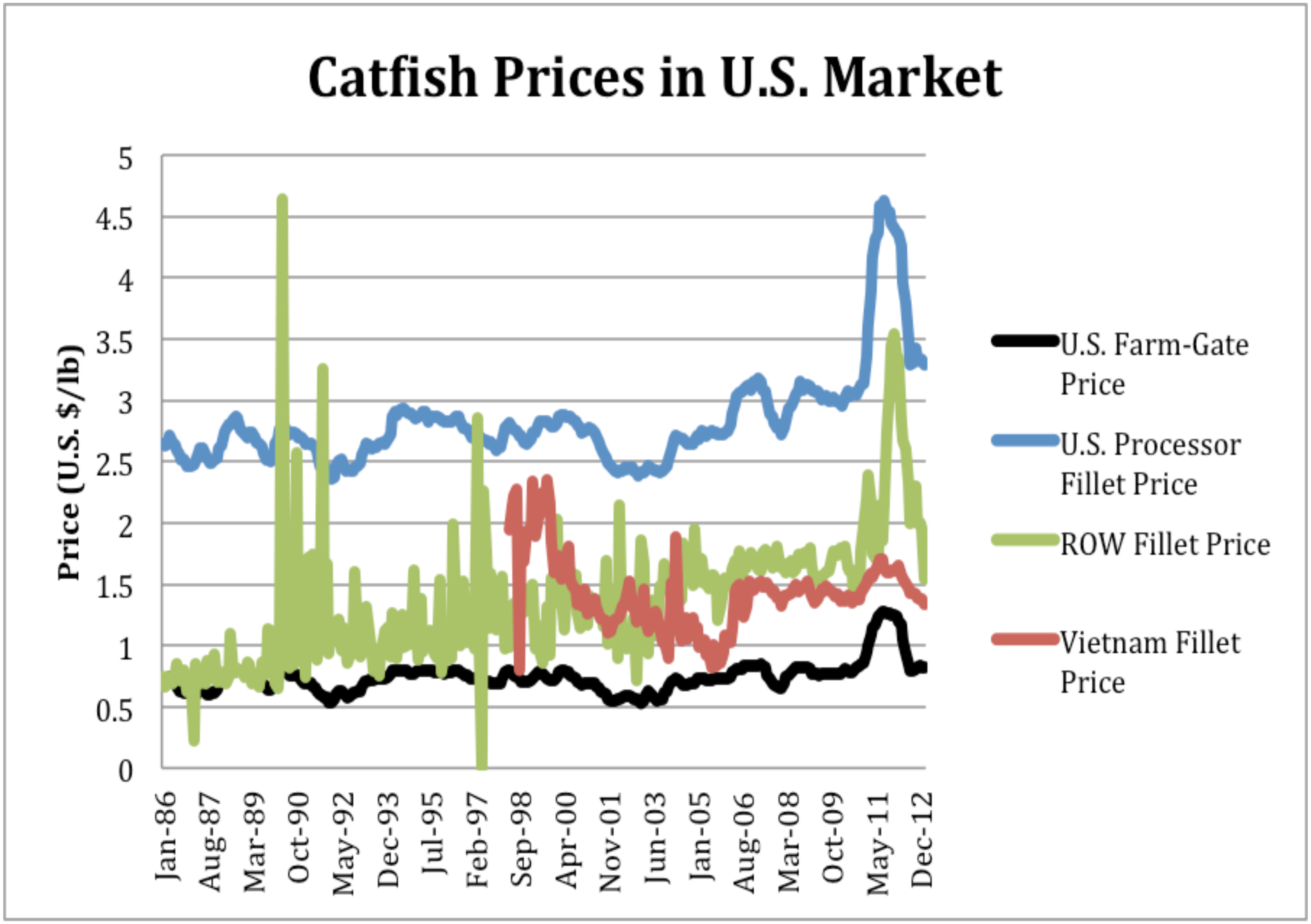

Figure 3. VECM impulse responses January 1986 – June 2003

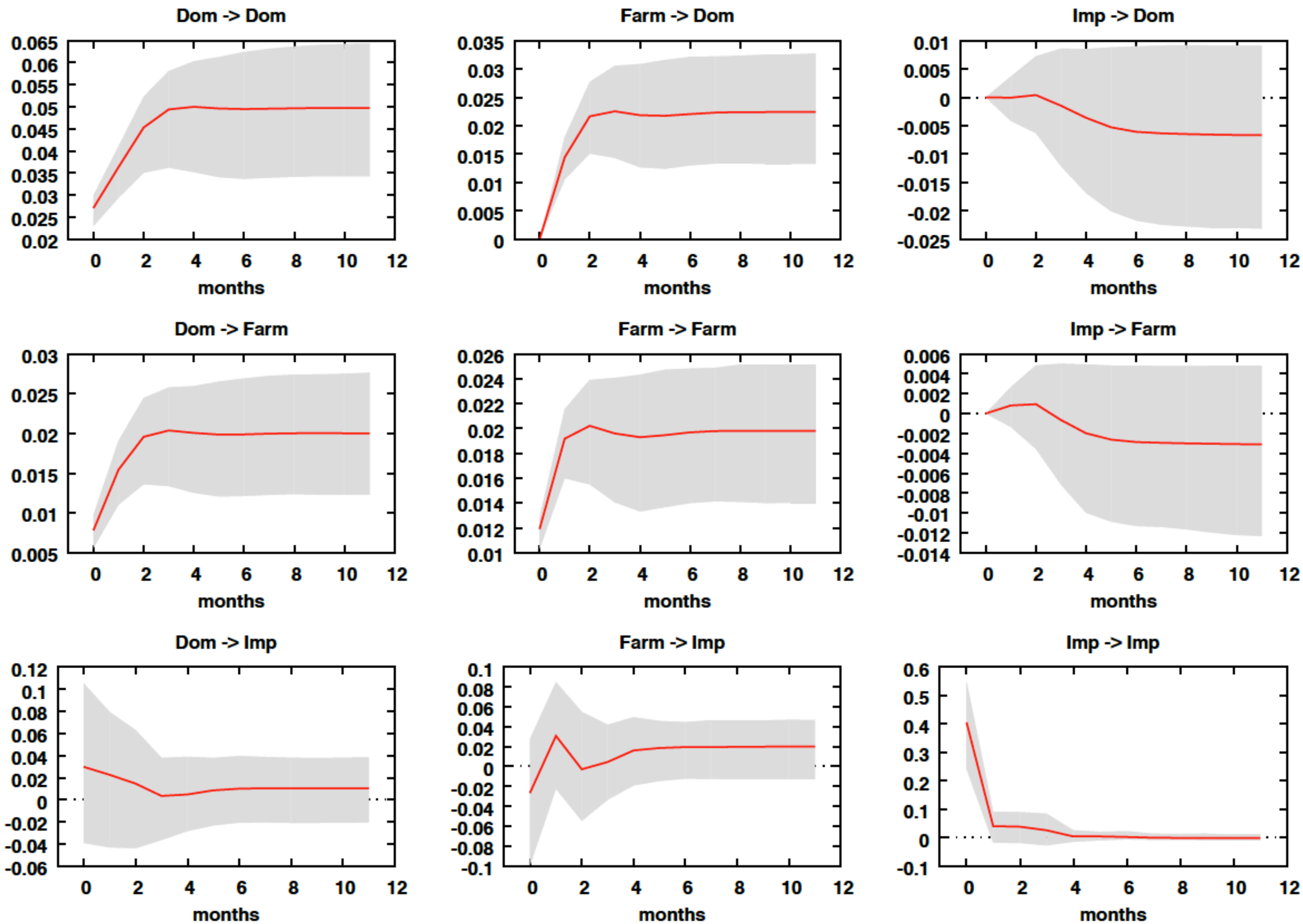

Figure 4. VECM impulse responses July 2003 – February 2013

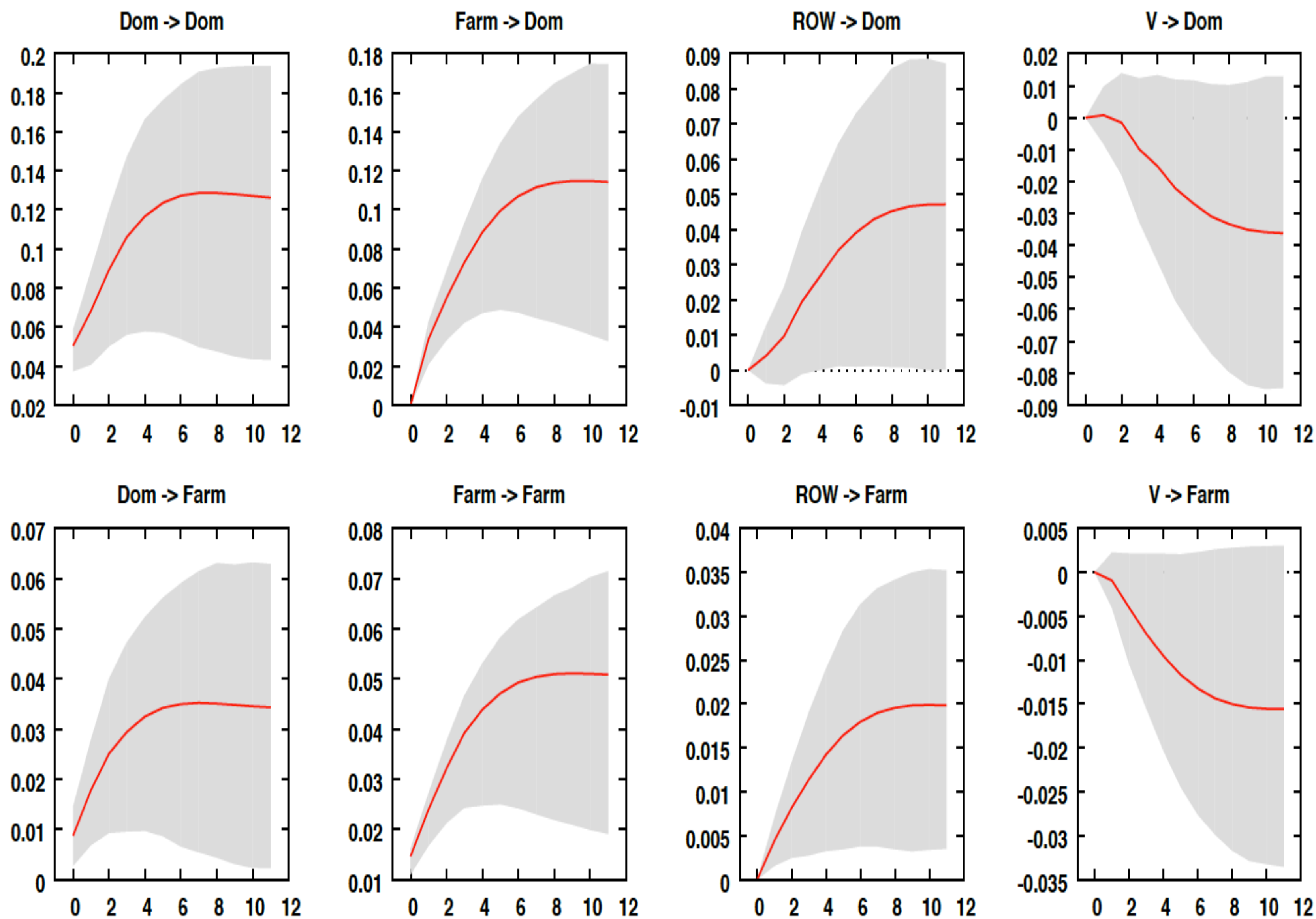

Figure 4. VECM impulse responses July 2003 – February 2013 (continued)