MARKET INTERACTION BETWEEN TILAPIA IMPORTS AND US CATFISH PRODUCTION

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ABSTRACT

Tilapia exports to the US have been claimed to double in the last three years following the two bans on Vietnamese catfish imports in November 2001 and June 2003. The aim of these bans was to restrict imports from the major exporter of Catfish (Vietnam) reducing competition for US catfish producers in the market. Interestingly, the bans on Vietnamese catfish may have indirectly benefited tilapia imports and in particular, frozen fillets as catfish is mainly imported as frozen fillets into the US market. This could explain how frozen fillets of tilapia have astonishingly grown by 391% in the last three years.

In this study, we investigate relationships between the prices of frozen fillets from US produced and Vietnamese imported catfish as well as imports of tilapia frozen fillets to obtain information about their market structure. Prices were found to be non-stationary so the Johansen test was used as the empirical tool to investigate possible market integration between these three products. The results indicate frozen fillets of US produced and Vietnamese catfish imports are integrated, though not perfectly, in the same market. On the other hand, frozen fillets of tilapia imports have not been found to compete with either US produced or Vietnamese catfish imports. Tilapia must therefore be taking market share from a different product in the US market, such as red snapper. These results have important policy implications as a ban on tilapia imports would not benefit American catfish producers conversely it would severely affect an industry that is largely taking off in developing countries around Asia and South and Central America.

Keywords: tilapia, catfish, frozen fillets, market integration, cointegration

INTRODUCTION

Tilapia has become the sixth most consumed seafood species in the US after catfish and the third most imported after marine shrimp and Atlantic salmon. Imports have increased from almost nothing in 1991 to 56,287 tonnes in 2001 and further increasing to 112,939 tonnes in 2004. This means imports have grown by 101% in the last three years.

Tilapia imports into the US are divided into three products: frozen and fresh fillets and whole frozen. Of the three products imported, frozen fillet imports present the largest growth in the last three years. Frozen fillets have increased from 7,372 tonnes in 2001 to 36,160 tonnes in 2004. This means an astonishing growth in frozen fillet imports of 391% over this period. The sharp increase in frozen fillet imports in only three years suggests American consumers may be substituting the consumption of some other whitefish product for that of tilapia. Thus, tilapia must be winning market share in the US market from another product.

The fast increase in tilapia imports in the last three years has lead industry commentators to suggest tilapia may be competing with catfish in the American market [1,2]. Importers may have substituted Vietnamese catfish for tilapia following the two import bans on Vietnamese catfish in November 2001 and June 2003. These two bans occurred after increased frozen fillet imports of

Vietnamese catfish were identified as a cause for the decreasing price of American produced catfish [3].

The results of this study will be of interest as they may be able to offer some insights to the future development of tilapia in the US market. If tilapia frozen fillet imports are competing with frozen fillets of US produced catfish and Vietnamese imports of catfish, then it will be interesting to determine the extent of the competition between these two species. The policy implications of strong competition between tilapia and American produced catfish may result in the US aquaculture industry reacting against imports of tilapia as it did against imports of other seafood products such as Vietnamese catfish, salmon, crawfish and shrimp. On the other hand, if there is no competition between these two species, then the question remains of what seafood products tilapia frozen fillets is taking market share from. Furthermore, the policy implication of imposing a ban on tilapia imports if there is no competition between American produced catfish and tilapia would not help American catfish producers but it would severely affect an industry growing in developing countries.

To investigate whether frozen fillets of tilapia imports, Vietnamese catfish imports and US produced catfish compete in the same market, we have studied the relationship between their prices. The importance of prices in defining markets has been recognized early on by economists. Cournot defined a market as follows: "*It is evident that an article capable of transportation must flow from the market where its value is less to the market where its value is greater, until difference in value, from one market to the other, represents no more than the cost of transportation*" [4]. Similar definitions have been provided by a number of prominent economists such as [5, 6, 7].

The time period chosen for investigation was from October 1998 to August 2003. We chose this time period due to the non existent or small imports of either Vietnamese catfish or tilapia frozen fillets at other times.

The time series properties of the prices of frozen fillets of US and Vietnamese catfish and tilapia imports have been confirmed to be non-stationary, as it is the case in other seafood market studies[a]. Therefore cointegration analysis has been our preferred empirical tool. In particular, we have used the Johansen test to investigate the market integration between two price series at a time. This test was very useful as it allowed us to identify if the series were cointegrated or not, and if they were, we were able to further investigate if the series were perfect substitutes (Law of One Price) or not.

This paper will be organised as follows, in the background section we discuss the market for tilapia imports into the US as well as their possible relationship with American produced catfish and Vietnamese catfish imports in the US market. Following this, we present and study the time series properties of the data used in this analysis. Then we explain the methodology used in this paper. We further present our results in the section named empirical analysis and we provide our final comments in the concluding remarks.

BACKGROUND

The demand for tilapia has increased steadily since its introduction in the US market in 1954 [11]. Since then, tilapia has become the sixth most consumed seafood product after catfish and the third most imported after marine shrimp and Atlantic salmon. In the US, the increase in per capita consumption of farmed species has gone together with a decline in the consumption of cod, flatfish and scallops [12].

Tilapia total consumption has grown from 2,268 tonnes live-weight in 1991 to 229,200 tonnes live-weight in 2004. Tilapia is sold in the US market as live, fresh and frozen as whole, gutted, gutted and scaled and in fillets. The majority of US production is still marketed live to markets as American producers have got an advantage in the live market, which cannot be easily challenged by exporters. Tilapia is imported in three different forms: whole frozen, fresh and frozen fillets[b]. The main suppliers of whole frozen and frozen fillets to the US market are South East Asian exporters, in particular, China and Taiwan. On the other hand, South and Central American countries dominate the exports of fresh fillets benefiting from geographical proximity to the US market, in particular, Ecuador and Costa Rica.

Most of the supply to the US market comes from imports. Imports have increased from virtually nothing in 1991 to 220,000 tonnes live-weight in 2004. The increase in tilapia imports is especially interesting in recent years as they have skyrocketed from 56,287 tonnes (processed value) in the year 2001 to 112,025 tonnes (processed value) in the year 2004. If we look more specifically into imports, frozen fillets of tilapia have experienced the sharpest increase from 7,372 tonnes in 2001 to 36,160 tonnes in 2004. This represents a 391% growth over this period.

Industry commentators have suggested this extraordinary growth in the imports of frozen fillets of tilapia over the last three and a half years is a result of tilapia taking market share from catfish.

Unlike tilapia, catfish is mainly supplied in the US by local producers and it is the most important aquacultural species in the United States. Total consumption has grown from 179,693 tonnes (processed weight) in 1991 to 290,151 tonnes (processed weight) in 2004. Imports started to increase very fast in the year 2000 and they peaked to a total of 8,201 tonnes (processed weight) in 2001, due to exports from Vietnam (7,765 tonnes).

Despite the wide variety of product forms[c] supplied by local producers, the fast increase in imports of catfish frozen fillets[d] has left local producers feeling threatened**.** In 1998, frozen fillet imports only supplied 1% of the United States frozen catfish frozen fillet market. By 2001, catfish frozen fillet imports have represented 14% of the United States catfish frozen fillet market, 13% of which was supplied by Vietnam.

In response to the rapid increase in frozen fillets of catfish imports from Vietnam, the American catfish industry initiated advertising and legal actions against Vietnam as they considered Vietnamese imports as a significant threat to the domestic catfish industry.

In November 2001, a non-tariff trade ban was set against Vietnamese catfish. The US Food and Drug Administration started to prohibit the labelling of "catfish" unless it was a member of the North American *Ictaluridae* family. This affected Vietnamese producers whose catfish belonged to the *Pangasiidae* family. The labelling also included a Country of Origin Labelling (COOL), which applies to farm-raised fish, wild fish, and other commodities.

Furthermore, in June 2003, the International Trade Commission imposed tariffs on Vietnamese fish exporters ranging from 37 to 64%, as it concluded Vietnamese producers had sold frozen catfish fillets at less than fair value. The two bans on Vietnamese catfish imports resulted in a strong decline in imports from 2002 to the beginning of 2004.

Nevertheless, the US did not impose anti-dumping tariffs on high-quality processed tra and basa (Vietnamese names for catfish) exports. Hence the Vietnam Association of Seafood Exporters and Processors (VASEP) has been able to increase sales of packaged fish by 30%.
Figure 1 shows the changes in quantities imported of tilapia and Vietnamese catfish frozen fillets as well as frozen fillets of catfish produced by the US from October 1998 till June 2004.

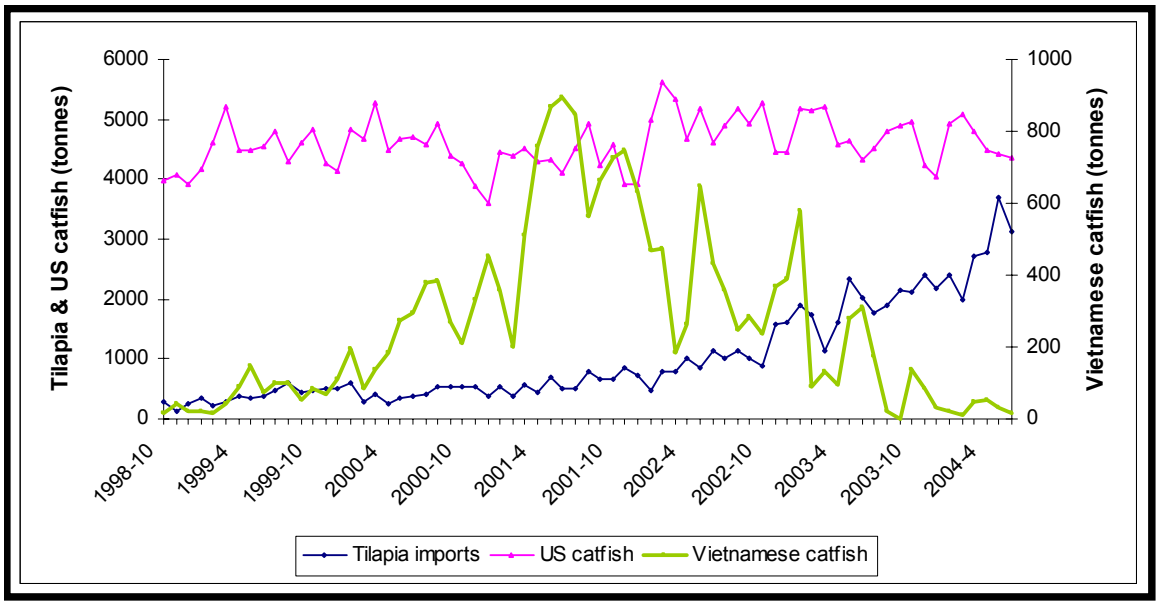

Figure 1. Quantity (tonnes) of frozen fillets of catfish produced in the US and Vietnamese imported as well as frozen fillet imports of tilapia

As we can observed from **figure 1**, tilapia imports of frozen fillets into the US market have increased continuously. In contrast, US produced catfish frozen fillets have remained more or less stable throughout the sample period at approximately 4,700 tonnes annually. Vietnamese imports of catfish frozen fillets increased from almost nothing in 1998 to 7,765 tonnes in 2001 and after declined again to very small values in 2004 following the two bans on Vietnamese catfish exports in November 2001 and June 2003.
Figure 2 presents the prices in US$/kg of frozen fillets of tilapia and Vietnamese catfish imports as well as American produced catfish from October 1998 to June 2004. Overall, it is possible to observe that prices of US produced frozen fillets of catfish declined over the first four months after the first ban on Vietnamese catfish imports in November 2001 due to a large increase of US catfish supply to the market. Since then, US farmers have reduced supply to the market resulting in an overall rise in prices.

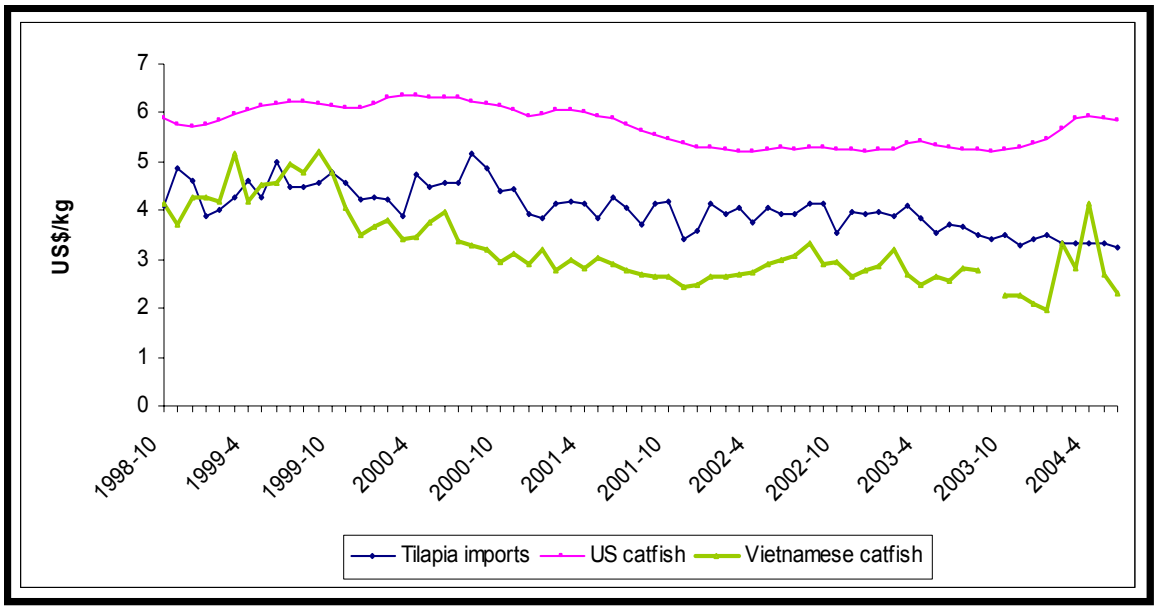

Figure 2. Prices (US$/kg) of frozen fillets of catfish produced in the US and Vietnamese imported as well as imports of frozen fillets of tilapia

Figure 2 also shows an overall decline in frozen fillet prices of tilapia imports and Vietnamese catfish imports. For tilapia frozen fillets the continuous decline in prices may have to do with the sharp increase in frozen fillet imports during this time period. The pattern between prices and quantities suggest that a reduction in price may have lead to an increase in demand rather than due to the substitutability with American produced catfish or Vietnamese catfish.

Vietnamese catfish frozen fillets prices increased slightly at the beginning of the sample period due to thin exports to the US. Later on, the increase in imports of Vietnamese catfish lead to a decline in prices, which instigated a non-tariff ban on Vietnamese catfish in November 2001 resulting in a reduction of Vietnamese exports and a rise in prices. Additionally, the International Trade Commission set antidumping tariffs against Vietnam in June 2003 leading to a further reduction of Vietnamese catfish exports and prices becoming very unstable.

DATA

Our aim is to test whether there is market integration between frozen fillets of tilapia and American catfish as well as Vietnamese catfish in the US market. Our study uses monthly prices from October 1998 to August 2003. This short data set is due to the non existent or low levels of tilapia and Vietnamese catfish frozen fillet imports before October 1998 and the small imports of frozen fillets of Vietnamese catfish after August 2003. As a result, we have been left with only 59 observations.

Prices on US imports of frozen fillets of tilapia and Vietnamese catfish have been obtained from the National Marine Fisheries Survey (NMFS). US catfish production frozen fillet prices have been obtained from the National Agriculture Statistics Service (NASS).

Before we perform the analysis, we need to study the time series properties of the three price series by testing for unit roots[e] using the most common approach available, the Augmented Dickey Fuller (ADF) test [13,14]. If a data series contains a unit root (I(1)), then, it is non-stationary, and unless it combines with another non-stationary series to form a stationary cointegration relationship, then regressions involving this variable will falsely identify the presence of a significant economic relationship.

We need to set the adequate lag length in the ADF test to achieve white noise in the error term. We have done this by using the Schwarz information criteria and an autocorrelation test (LM test). ADF tests for each series have been performed in levels and first differences with a constant and a trend. The null hypothesis in the ADF test is that each data series is non-stationary (I(1)).

Table 1 presents the ADF tests on nominal prices. The values in brackets represent the most reasonable number of lags chosen in each ADF test. We found all series in levels to be non-stationary and stationary in first differences I(1)).

Table 1. Unit root test (Augmented Dickey Fuller Test) Logged nominal frozen fillet prices

	Levels		**First Differences**	
Variable	**Constant**	**Trend**	**Constant**	**Trend**
Tilapia imports	-1.6884 (3)	-3.1061 (2)	-9.1128* (1)	-9.0377* (1)
US Catfish	-1.6945 (0)	-2.8331 (0)	-10.3979* (0)	-10.2979* (0)
Vietnamese Catfish	-0.7315 (1)	-3.0337 (1)	-3.9924* (0)	-4.1553* (0)

The values in brackets indicate the number of lags

* Indicate significance at 1% level; ** indicate significance at 5% level.

METHODOLOGY

We can use individual price series to study if products form a long run relationship between them. This is very useful because often prices are normally more available than quantities. The changes in prices over time will provide valuable information on the relationship among commodities within the same market. This idea follows closely Stigler's [15] market definition: "*the area within which the price of a commodity tends to uniformity allowance being made for transportation costs"*. Other definitions of a market will apply this concept not to geographical space but to product space, so quality differences will take the place of transportation costs [16].

Following these definitions, prices may deviate from each other in the short run but in the long run arbitrage and substitutability will insure prices form an equilibrium relationship. Therefore, if market theory holds, products will be in the same market when prices hold an equilibrium relationship (they are cointegrated). There have been a variety of seafood studies that have examined the market relationship between different goods by analyzing their prices through tests for cointegration[f].

There are two approaches to test for cointegration: The Engle and Granger test [26] and the Johansen test [27, 28]. We will use the Johansen test in the market integration analysis as it only requires price data and it allows testing for perfect substitution (the Law of One Price).

In our study, we will investigate possible market integration between three nominal non-stationary price series of frozen fillets of Vietnamese catfish imports and American produced catfish as well as imported tilapia. In particular, we will test for market integration between two price series at a time. Hence, our test is called the bivariate Johansen test. The Johansen test is based on a vector autoregressive (VAR) system. To start, we set a vector $\mathbf{z_t}$ containing two (*N*) of the price series we are investigating. Then, we model $\mathbf{z_t}$ as an unrestricted vector autoregression (VAR) model with "k lags" containing these variables in levels.

$$\mathbf{z_t = \Pi_1 z_{(t-1)} + \ldots + \Pi_k z_{(t-k)} + e_t} \qquad \mathbf{e_t} \sim \text{IN}(0, \Sigma) \qquad \text{(Eq. 1)}$$

Where, $\mathbf{z_t}$ is (n x 1) and each of the $\mathbf{\Pi_i}$ is a (n x n) matrix of parameters. The system is in reduced form with each variable in $\mathbf{z_t}$ regressed on only lagged values of both itself and all the other variables in the system. In order to use the Johansen test, the VAR representation in (1) needs to be turned into a vector error correction model (VECM) of the following form:

$$\mathbf{\Delta z_t = \Gamma_1 \Delta z_{(t-1)} + \ldots + \Gamma_{k-1} \Delta z_{(t-k+1)} + \Pi z_{(t-k)} + \mu_t} \qquad \text{(Eq. 2)}$$

Where, $\mathbf{\Gamma_i = -(I - \Pi_1 - \ldots - \Pi_i), (i = 1, \ldots, k-1), \text{ and } \Pi = -(I - \Pi_1 - \ldots - \Pi_k)}$. The Johansen test centres on an examination of the $\mathbf{\Pi}$ matrix. $\mathbf{\Pi_k}$ is the long-run "level solution" to (2), since in equilibrium, all the first differences of the price series ($\Delta \mathbf{z_{t-i}}$) will be zero and setting the error terms, $\mathbf{u_t}$, to their expected value of zero will leave $\mathbf{\Pi z_{t-k} = 0}$. $\mathbf{\Pi = \alpha \beta'}$, where $\boldsymbol{\alpha}$ represents the speed of adjustment, while $\boldsymbol{\beta}$ is a matrix of long run coefficients. Both $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are (N x r) matrices.

There are two asymptotically equivalent tests for cointegration in the Johansen framework, a likelihood ratio test and a Trace test. The test for cointegration between the $\mathbf{z_s}$ is calculated by looking at the rank of the $\mathbf{\Pi}$ matrix via its eigenvalues. The rank of $\mathbf{\Pi_k}$, $\mathbf{r}$, determines how many linear combinations of $\mathbf{z_t}$ are stationary. If r = *N*, the variables in levels are stationary. If r = 0, none of the linear combinations are stationary ($\mathbf{\Pi_k} = 0$). When $0 < r < N$, there exist r linear stationary combinations of $\mathbf{z_t}$, or r cointegration vectors. In this instance, we need to determine how many $r \leq (n-1)$ cointegration vectors exist in $\boldsymbol{\beta}$.

If the series are cointegrated, we will further investigate whether the two price series are imperfect substitutes or whether they are perfect substitutes (LOP) so their relative price is constant. We will test for LOP by imposing the restriction $\boldsymbol{\beta}' = (1, -1)'$. This test follows from the composite commodity theorem of Hicks and Leontief [29, 30], which states that for a bundle of goods, if individual prices move proportionally over time; the bundle can be characterized using a single composite price index.

EMPIRICAL ANALYSIS

To investigate whether frozen fillets of tilapia imports, Vietnamese catfish imports and US produced catfish compete within the same market, we investigate the long-run relationship between the prices of these three products for the period October 1998 to August 2003. All the series have been confirmed to be non-stationary in levels and stationary in first differences (**table 1**).

We have studied the market integration between the series by performing bivariate Johansen tests[g] [27, 28] between the three price series of interest (**table 2**). All the pairwise tests with the exception of the bivariate test for US produced catfish and Vietnamese catfish imports fail to reject the null hypothesis of no cointegration vector Rank = 0 at the 5% level. On the other hand, the test for US produced catfish and Vietnamese catfish imports reject the null hypothesis of cointegration vector Rank = 0 at the 1% level but fail to reject the null hypothesis of cointegration vector Rank = 1 at the 5% level.

From the results in **table 2**, we can indicate two major findings. First, the prices of frozen fillets of US produced catfish and Vietnamese catfish imports form a long-run relationship over the period under study. Second, frozen fillets of tilapia imports are not competing in the same market with US produced catfish and Vietnamese catfish imports. Therefore, the two bans on Vietnamese imports in November 2001 and June 2003 have not impacted tilapia imports since they are not part of the same market. Tilapia frozen fillet imports are not taking market share from catfish as they are not within the same market.

Table 2. Bivariate Johansen Test for Cointegration

	Null Hypotheses[a]				Law of One Price
	Rank (ρ) = 0		Rank (ρ) ≤ 1		
Nominal Prices	Max[b]	Trace[c]	Max[b]	Trace[c]	
Tilapia /US catfish	12.2242	13.4798	1.2555	1.2555	-----
Tilapia/ Vietnamese catfish	11.6884	12.3774	0.6890	0.6890	-----
US catfish / Vietnamese catfish	32.7102*	41.5905*	8.8803	8.8803	19.1189*

Results from Schwarz IC

a The null hypothesis is that the number of cointegrating vectors is equal to ρ

b Maximum eigenvalue test

c Trace test

* Indicates significance at the 1% level; ** indicates significance at the 5% level

We have further investigated the substitutability between frozen fillets of US produced catfish and Vietnamese catfish imports. If these two products are perfect substitutes then we can say the Law of One Price (LOP) holds. The LOP was rejected within the pair-wise relationship, with a test statistic of 19.119 (**table 2**). So we can conclude the market for catfish fillets is not fully integrated.

CONCLUDING REMARKS

The purpose of this paper has been to investigate whether frozen fillets of tilapia imports, US raised catfish and Vietnamese catfish imports are competing within the same market. The results are interesting as they offer some insights to the future development of tilapia frozen fillets in the US market after imports of this product have grown by 391% in only three years. The rapid increase in imports suggests tilapia may be taking market share from another, currently unidentified, whitefish species. Industry commentators have proposed catfish as a product competing with tilapia in the American market following the first non-tariff ban on Vietnamese catfish imports in November 2001 [1, 2]. If this is the case, tilapia imports could face a similar trade complaint as the ones made against a number of seafood products including Vietnamese catfish, salmon, crawfish and shrimp.

The results have indicated that frozen fillets of US catfish and Vietnamese catfish imports are within the same market. This does not come as a surprise, as the competition of these two products in the US market led to two bans on Vietnamese catfish imports in the US market. On the other hand, frozen fillets of tilapia imports do not appear to compete in the same market with either frozen fillets of US produced catfish or Vietnamese catfish imports. Therefore, the rapid increase in frozen fillets of tilapia imports in the last three and a half years does not seem to be as a result of tilapia taking market share from catfish in the US market. We therefore, suggest tilapia frozen fillets may be taking market share from another species in the US market, such as for example red snapper. Nevertheless, attempting to reveal the identity of this product is beyond the scope of this paper and demands further investigation.

The absence of competition between frozen fillets of tilapia imports and US raised catfish has important policy implications. If a ban on tilapia imports was imposed, American catfish producers would not benefit from the trade barrier as consumers do not regard catfish and tilapia as substitutes. However, the ban would severely affect tilapia imports, an industry primarily based in and generating revenue for developing countries around Asia and South America.

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ENDNOTES

[a] E.g., [8, 9, 10]
[b] Of all product forms of tilapia imported into the US, whole frozen tilapia still remains an important product form imported into the US market. Nevertheless, whole frozen import quantities have remained stable in the last few years while fresh and frozen tilapia fillets have accounted for almost all import growth.
[c] A continuation we provide a detailed explanation of the differences between catfish products : Whole dressed fish (the catfish has been deheaded, eviscerated, and skinned), fillets (with belly flap), shank fillets (boneless fillet with the belly flap or nugget removed), fillet strips (boneless finger-size pieces cut from shank fillets), nuggets (belly flap section removed from fillet), steaks, breaded filets and nuggets, marinated fillets, smoked (fillets and dressed fish). All of these forms are marketed fresh and/or frozen. Processors also sell round-eviscerated catfish with the head still attached.
[d] 99% of total catfish imports are frozen fillets. Other product forms are whole frozen and fresh fillets of catfish
[e] All the unit root tests were performed with the econometric software package Eviews 5
[f] Applications to seafood data includes: [8, 9, 10, 17, 18, 19, 20, 21, 22, 23, 24, 25].
[g] The Johansen cointegration framework was performed with the econometric software package Eviews5. The software allows performing the cointegration test with five different trend assumptions. We chose to have no deterministic trend and a restricted constant following the Schwarz information criteria