Marine Policy 93 (2018) 71–79

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Price transmission in the trans-atlantic northern shrimp value chain

Max Nielsen, Isaac Ankamah-Yeboah*, Lisa Staahl, Rasmus Nielsen

Department of Food and Resource Economics, Faculty of Science, Copenhagen University, Rolighedsvej 25, 1958 Frederiksberg C, Denmark

ARTICLE INFO

JEL Classification:
Codes: L11
Q21
Q22

Keywords:
Cointegration
Price transmission
Law of One Price
Weak exogeneity
Impulse-response function

ABSTRACT

Recent research has found that markets for farmed shrimp and wild-caught northern shrimp in Europe are integrated, indicating that northern shrimp prices are affected by total supply and demand of shrimp. Thus, the continued growth of global aquaculture production and associated price decline affect northern shrimp fisheries. In this paper, price transmission in the trans-Atlantic northern shrimp value chain is analysed using a Vector Auto Regressive model in Error Correction form. Cointegration, the Law of One Price (LOP) and weak exogeneity are tested. The results reveal linkages from Greenlandic and Canadian exports, via Denmark to the final consumers in Denmark and United Kingdom. The LOP was rejected in all cases. Hence, price transmission exists, but it is imperfect. Peeled shrimp is further found to be subject to downstream market leadership, while impulse-response functions identify mixed responses, with downstream market leadership being the dominant characteristic. Growth in shrimp aquaculture, ceteris paribus, presses northern shrimp fishermen, the Greenlandic economy and local economies at Newfoundland through price reductions. As such, fisheries and their management must continuously improve efficiency to stay competitive.

1. Introduction

The European shrimp and shrimp market is supplied by both wild-caught northern shrimp (*Pandalus borealis*) and farmed shrimp, mainly consisting of *Panaeus Vannenei* and *Panaeus Monodon*. While global shrimp farming has grown 9.7% annually over the last two decades (1994–2014), northern shrimp catches are largely the same [22,23]. With Ankamah-Yeboah et al. [3] documenting close market integration between farmed and wild-caught shrimp in Europe, and with global supplies of farmed shrimp and prawn being 15 times larger than northern shrimp [22,23], northern shrimp fisheries seem heavily affected by global supply and demand for farmed shrimp and prawn. However, that argument claims that price changes in consumer markets are transmitted through the value chain from final consumers back to fishermen. Otherwise, the intermediate actors in the nodes of the value chain at least partly absorb price changes. This paper examines price transmission between the different actors in the nodes of the trans-Atlantic northern shrimp value chain from Greenlandic fishermen and Canadian exports, via Denmark, to final consumers in Denmark and the United Kingdom (UK). Vector Auto Regressive models in Error Correction form are estimated, testing for cointegration, the LOP and weak exogeneity. Market integration between actors in the nodes reveals price transmission. Impulse-response functions inform the short-run adjustment process and the time horizon following external shocks.

Knowledge of price transmission of wild fish products that substitute for farmed fish is important, since it reveals whether fishermen are affected by price reductions downstream in the value chain, following aquaculture growth. That also accounts for the trans-Atlantic northern shrimp fishermen when markets for wild-caught northern shrimp and farmed shrimp and prawn are integrated. If price transmission is perfect, price changes downstream are transmitted perfectly back to fishermen, making the prices fishermen receive severely dependent on global supply and demand of farmed shrimp and prawn. If price transmission does not exist, northern shrimp fishermen are unaffected by aquaculture growth. If price transmission is imperfect, price changes are transmitted through the value chain, but a price change in one node is only partially felt in others. Other factors might affect upstream and downstream prices differently.

Knowledge of price transmission of northern shrimp is also of socio-economic importance in the fishing communities. For Greenland, shrimp constitutes the majority of the total export value in 2015 [44]. Copenhagen Economics [15] further assess that the fishery sector contributes 25% of GDP, either directly from harvesting, processing and trading, or indirectly by taking multiplier effects into account. Shrimp is by far the most important species. Shrimp is of equal socio-economic importance for some local fishing communities in East Canada, particularly in Newfoundland [21]. Hence, if moderate to high degree of price transmission exists, continued growth of shrimp and prawn farming can, ceteris paribus, lead to reduced prices on northern shrimp and severely affect these local economies. If price transmission does not

* Corresponding author.
E-mail address: iay@ifro.ku.dk (I. Ankamah-Yeboah).

https://doi.org/10.1016/j.marpol.2018.04.002
Received 17 January 2018; Received in revised form 14 March 2018; Accepted 3 April 2018

exist, the local economies are more protected against this competition. While shrimp fishermen and the local economies might be affected by price reductions following aquaculture growth, they might also benefit from increasing worldwide demand growth initiated by farmed shrimp and prawn. Again, that argument claims that moderate to high degree of price transmission exists.

Anderson [2] studies the interaction between wild and farmed fish markets theoretically and shows that in an open access fishery, the entrance of a competitive farmer increases the wild fish stock, reduces prices and increases long run supply, provided that the wild stock is below the Maximum Sustainable Yield (MSY) and that farmed fish dominate. In well-managed fisheries with stocks above MSY, a reduction of both prices and supply of wild fish will be the result. Empirically, the integration of wild and farmed markets is often found for the same species, while results across species are mixed ([11,36,6,37,39] and [12,41]). Asche et al. [6] present one of the earlier literatures of market integration for different species of salmon. Asche et al. [9] find perfect market integration between US wild-caught and imported shrimp. Ankamah-Yeboah et al. [3] find market integration between northern shrimp and farmed shrimp and prawn at five main European markets, with the LOP in force in most cases.

Price transmission in the markets for salmon and cod is examined by Asche et al. [7,8,10]. The market for shrimp is examined by Ling et al. [33], who test for price transmission of *Panaeus monodon* from Indonesia and Thailand to the Tsukiji wholesale market in Tokyo. Changes in Japanese prices are found to have stronger backward effects than vice versa. Singh et al. [43] study the production of *Panaeus vannemei* in Thailand but do not find price transmission asymmetries. Ankamah-Yeboah and Bronnmann [5] identify asymmetries in import retail cost pass-through in the German seafood value chain with retailers determining the prices at the import level. Jaffry [29] similarly identify asymmetries in the French whole hake value chain where retailers adjust quickly to positive changes in auction prices but fail for falling prices. [34] find price transmission elasticities to be incomplete for Norwegian export prices and retail prices of France and the United Kingdom. Price transmission elasticities decrease with more processing and increase for packaged salmon products relative to fresh fish counter.

The article is organized as follows. In section two, the trans-Atlantic northern shrimp value chain is described. Section three presents the cointegration methodology of nonstationary data and fits it to price transmission. Section four reviews market data in the value chain. In section five, price transmission results are presented and discussed. The last section offers a conclusion.

2. The trans-Atlantic northern shrimp value chain

Northern shrimp is caught both in the North Atlantic and North Pacific Oceans but are available in largest densities on the East coast of Canada and around Greenland. The two countries accounted for 80% of global catches of shrimp of the *Pandalus* family [23] in 2015. In Greenland, exploitation of northern shrimp started inshore in the 1950's and reached 2000 t in the early 1960's. In the 1970's, Greenlandic fishing was extended off-shore, where European vessels also participated. Growth followed until 2008, after which a reduction followed until the catches on 73,000 t in 2015 [23].

Shrimp fishing in Canada started approximately 1980, with core activities in Newfoundland. After the collapse of the Grand Bank cod stock and the moratorium in 1992, shrimp fishing escalated in the following decade. This was partly because cod prey on shrimp, and this predator disappeared [38]; moreover fishermen were in need for alternative fishing opportunities. With the intensification of shrimp fishing in Canadian waters, European shrimp fishing in international waters at the Flamish Cap also took off and continued for 15 years. Canada overtook the supply lead from Greenland in 1998 and peaked in 2007, with catches being reduced afterwards.

Shrimp fishing in the two countries is performed by large factory trawlers, which cook, pack and freeze shell shrimp on-board, and by obligational landings of smaller shrimp for land-based processing. Moreover, coastal trawlers land directly at the factories that peel the shrimps. The large trawlers are capital-intensive, while the coastal trawlers are more labour-intensive.

Biologically, shrimp fisheries are managed using the precautionary principle [38]. The state of the West Greenlandic stock is relatively good, while the Canadian stocks are below limit values [38]. Individual transferable quota management is applied in Greenland. Total quotas combined with limited entry, and a last-in-first-out principle prevails in Canada. Despite the management schemes, stocks and catches have fallen substantially after 2007–2008 in both countries. The reason remains speculative; however, the gradual return of the cod preying on shrimps and increased sea temperatures might influence the stocks negatively, in addition to pressure from fisheries.

Reduced supply leads to price increases, ceteris paribus. However, if moderate to perfect price transmission prevails, a simultaneous growth in aquaculture induces downward pressure on northern shrimp prices. Hence, when price transmission exists, the northern shrimp fishermen cannot necessarily expect to be saved by increasing prices when catches are reduced.

Northern shrimp is consumed in several countries, mostly in Northern Europe. Greenland exports all shrimp via Denmark, due to historical ties and logistics. Greenland has free access to the EU market. Denmark also imports from Canada and re-exports shrimp to several countries, the UK and Sweden receiving most. Denmark forms a core intermediate node. Canada's largest export markets are the UK and Denmark [25]. While most peeled shrimp fall under the EU tariff suspension, Canada pays full tariffs for shell shrimp. Some vertical integration exists throughout the value chain, except in final sale.

Consumption of shrimp is approximately 1 kg live weight per capita in Denmark (AC [1]) and 600 g per capita in the UK [42]. While the overwhelming majority of consumption in Denmark is northern shrimp, northern shrimp and farmed shrimp and prawn fill UK consumption equally. The northern shrimp value chain is connected to value chains for farmed shrimp and prawn downstream and intermediately in the chain. Additionally, market integration exists across the two countries [3].

3. Methodology

The analyses of price relationships present important information about the functioning of commodity markets. Market integration or price transmission and marketing margin analyses are the two most common forms of analyses of price relationships [7]. This study examines the transmission of prices along the shrimp value chain from upstream to downstream, extending to the flow of shrimp across the geographic borders of Greenland, Denmark and the UK. In such analysis, the most common relationship expressed in the logarithm of prices in bivariate form is

$$p^{upstream} = a + \beta p^{downstream} + u \quad (1)$$

where p^i indicates log of upstream and downstream value chain prices. In the expression in Eq. (1), a relationship exists if β is different from zero. In the context of price transmission, $0 < \beta < 1$ indicates imperfect price transmission while $\beta = 1$ signals perfect price transmission. The parameter a captures the constant term, and u is the error term. Despite the simplicity of this relationship, estimation is constrained by the time series properties of the price series. This is because economic variables, such as prices, often exhibit non-stationary/unit processes (i.e., when the mean and variance change over time). Eq. (1) is only valid for stationary price data and might be augmented with lagged price changes. In the event of nonstationary price series as shown in this study, then Johansen [30] cointegration approach is used where Eq. (1) is embedded in a vector error correction model for determination of