



Market integration in the crustaceans market: Evidence from Germany



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ABSTRACT

In this paper the price dynamics and the degree of market integration in the German crustaceans market is examined using cointegration methods. The study focuses on wild caught cold water shrimp, farmed warm water shrimp as well as lobster and derives implications for the fisheries sector. In the analysis, both the import market and the retail market price reactions are distinguished. Therefore, it is evaluated how price changes affect competing commodities within and between the value chain of a given crustaceans commodity. Evidence of partial market integration is found for all species under study at the import level while at the retail level; there is weak evidence of perfect market integration. At the import-retail level linkages, shrimp markets are partially integrated, while the lobster market is fully integrated. Consequently, it can be concluded that the species under consideration are substitutes. Price determination processes for the shrimp markets vary with the level of the value chain. The results imply that the wild and farmed crustaceans markets are interacting through substitution effects. Hence, the markets have the capability to shield volatile and rising prices that would emanate from supply shocks. Overexploited wild caught species would have the potential to recover and the competing farmed species could expand to at least insure against rising prices due to supply shortage. Thus, alternative fisheries management and development strategies should consider competing species, at least from an economic perspective.

1. Introduction

Europeans eat large quantities of crustaceans in particular shrimp and lobster, as reflected by common trade statistics. Since 2013, crustaceans have been the most valued group of species imported to the European seafood market. In 2015, an increase in import prices of almost all imported crustaceans resulted in an all-time value peak of EUR 4.6 billion for 602,000 t [14]. For most crustaceans consumers have the choice between wild or farmed species. For instance, in the case of shrimp, there are cold water shrimp (*Pandalus* sp.) that are wild caught from the Atlantic Ocean, and warm water shrimp (*Panaeus* sp.) which are mainly farmed in aquaculture systems around the world. Lobster (*Humarus* sp.) on the other hand originates primarily from wild catches. Aquaculture systems for lobster are under development but production is still at very low levels. Particularly for the wild caught shrimp and lobster, stocks are classified to range between fully exploited to over-exploited [15], hence, aquaculture production presents an important alternative to meet consumers' demand for these species.

In spite of the potential, within the last decades shrimp aquaculture, especially Asian shrimp farming, has been the subject of controversial debates and a focus of negative publicity. The sector is criticized for its

negative impact on the environment due to chemical residuals, the use of antibiotics, disease outbreak and ecosystem destruction [34] which are perceived by consumers to affect fish quality. European consumers are therefore seeking for seafood production from sustainable and responsible sources. Currently, the organic and sustainable labels, which are built on a set of certification requirements, are market based incentivized regulatory instruments shaping the consumer demand for these products and are more important in the European retail market [21]. In the seafood sector, in particular the Aquaculture Stewardship Council (ASC) and the Marine Stewardship Council (MSC) labels give answers to the increasing attention for sustainability, food safety as well as responsible sourcing. Adoption of these standards are however, complicated by differences in production structure between the respective wild and farmed species, the economy of the production places (developing vs developed) and even consumer heterogeneity in preferences for the labels which translates to their willingness to pay and returns of investment on producers.

Moreover, for species presenting the choice of farmed and wild caught species, market interaction between the two sectors is relevant for continued supply and market growth. Market interaction could be assessed through market integration where market prices serve as the

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medium for information flow. Hence, a shock in a particular market (for example production shocks such as production costs, disease outbreak, environmental impacts) is reflected through the market prices and transmitted to competing markets if the markets are integrated or considered substitutes. This is important especially in an industry with an aquaculture sector and an overexploited fishery. In this regard, fish farming can reduce fishing pressure on wild capture fisheries but the extent depends on the degree of market integration ([1]; and [22]). Price hiking and volatilities can also be lessened if there is evidence of dependence.

Therefore, the focus of this study is to examine market interaction for the crustacean industry in Germany. Particularly, market integration and price dynamics between lobster, cold water and warm water shrimp species are tested. The issue is addressed from both the horizontal and vertical perspectives of the crustacean supply/value chain between the import and retail levels.

For this purpose, a Cointegrated Vector Autoregressive Model (C-VAR) for nonstationary price series is estimated to identify cointegration. The test of the Law of One Price (LOP) is conducted to identify the degree of market integration and weak exogeneity test of the price series are used to identify the market price determination process. The analysis of market integration in the crustaceans market is not new but still scarce. In particular, there is no study focusing on the German crustaceans market despite it being one of the most important consumption markets in Europe. Thus, this study intends to close the gap in literature. Whereas studies concerning crustaceans markets are rare, there is growing literature on the interaction between markets supplied by both wild caught and farmed fish. Numerous empirical studies on market integration between wild caught and farmed fish find mixed results [5,6,8,26,28,29,30,38]. Yet, most studies find that markets for the same species of seafood, whether appearing from fisheries or aquaculture, are integrated.¹ This implies that the fishing pressure on a species for which fish farming is increasing will likely decline and would in the short run have some time to recover. Moreover Asche et al. [4] point out, that the integration of wild and farmed species could imply the tendency of the farmed species being secured against severe price reductions that could emanate from their own increase in productivity. Also, that the prices and production of the largely traded farmed salmon are to a larger extent determined by the marginal cost of production. Hence, as the farmed salmon supply became large enough, the production cost of aquaculture determined the price also for wild salmon. Nevertheless, despite the benefits to producers in both the farmed and wild fish sectors, Gordon [19] show that producer welfare could be impacted by exogenous shocks for example from changes in exchange rates.

For the shrimp market, evidence of market integration has been found for wild and farmed shrimp. The LOP holds in the US, Japanese and European import markets [37]. Nielsen et al. [27] investigated market integration for several seafood species in the EU and found no market integration for shrimp. Asche et al. [6] find market integration between US wild caught shrimp and US shrimp imports, along with evidence of the LOP. Tveterås [35] examined, inter alia, water shrimp imports from Honduras to Europe and the U.S. The results indicate that there is an interrelationship between the EU and U.S. import prices of Honduran warm water shrimp. For the Brazilian shrimp market Pincinato and Asche [31] test the degree of market integration between wild and farmed shrimp and conclude that the price of both production technologies forms a common market. In a recent study, Ankamah-Yeboah et al. [3] examine market integration between cold and warm water shrimp value chain in the UK, Denmark, Sweden and Norway.

¹ However, in particular the studies of Bjørndal and Guillen [7] and Regnier and Bayramoglu [33] show that wild and farmed seabeam do not form a common market. Moreover, Norman-Lopez and Asche (2008) show that the tilapia market is segmented from other farmed whitefish species.

The results show that in most cases the LOP holds and market integration can be confirmed. However, cold water shrimp prices are to a larger extent determined by the warm water shrimp market prices.

The rest of the paper is structured as follows: In the next section we give a brief overview of the Shrimp and Lobster market and present the data used for this study. In the third section, the methodology is presented. Thereafter, we present the estimation results and finally, the discussion and conclusion are presented while drawing on the implications.

2. Market overview and data

The crustaceans market comprises approximately 40,000 species and the global production of crustaceans reached around 2 billion tons in 2015. In this study we focus on the species cold water shrimp (*Pandalidae*), warm water shrimp (*Panaeus*) and lobster (*Homarus*). Shrimp is the most valuable seafood traded in the international market [16]. In 2015, global shrimp production was 8.3 million tons, from which 4.9 million tons were farmed and 3.4 million tons were wild caught shrimp. In contrast, global production of lobster was 310,571 t in 2015, from which around 99% was wild caught lobster. Lobster is one of the most expensive fishery products entering international trade. The average unit value is USD 20 per kg, while for shrimp it is around USD 10 per kg [16].

There are different varieties of shrimp available in the European market. Cold water shrimp are the smaller varieties caught in ocean waters in Canada and Greenland as the largest producers as well as in the northwest and northeast regions of the United States. They are known as *Pandalid* shrimp and provide just about 6% of the total world supply of all shrimp species. Warm water shrimp (*Panaeus*) are harvested and farmed in tropical and sub-tropical regions around the world with China, Indonesia, and Vietnam being the largest producers [16]. Wild shrimp refers to either cold water or warm water varieties that are harvested from coastal ocean waters with traditional vessels. The harvesting of wild shrimp is regulated by management programs that set annual production limits. Less than 10% of the shrimp eaten in Europe comes from wild catches. Farmed shrimp refers to warm water varieties that are grown in open and closed pond systems supplemented with formulated feeds. Over 90% of the shrimp eaten in Europe come from farmed sources grown in other countries around the world [16]. The main shrimp-consuming nations in the EU are Spain, France, and United Kingdom, followed by Italy, Germany, and Sweden [14].

Lobster are mostly available as wild caught species *Homarus americanus*, mainly caught in the North Atlantic Ocean from Labrador to North Carolina, as well as *Homarus gammarus*, which is found in the eastern Atlantic Ocean, the Mediterranean Sea and parts of the Black Sea. The EU is the second major lobster market after the USA. Annually, 33,400 t of lobster are imported into the EU, mainly from USA and Canada [17]. In general, the EU and Germany is a net importer of shrimp and lobster.

Table 1 shows the descriptive statistics on German imports of frozen unprocessed shrimp and lobster averaged for a four or three year period from 2006 to 2016.

As one can see, the table reveals that also on the German market, the most consumed species are warm water shrimp. The average prices for all three crustaceans' species increased during the past years. Lobster is the most expensive species but the warm water shrimp maintains some price premium over the cold species. The relative cold water shrimp prices tremendously increased in the last time period.

For all species the product form under study is frozen unprocessed measured in € per kg. Data used for this study are sourced from two sources and are monthly time series from January 2006 to July 2016. The import price series are taken from the German external trade database [9] and disaggregated at the 8 digits code. The prices are CIF (Cost, Insurance, Freight) and are calculated by dividing the imported value by the imported quantity. With no observations missing the

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