



Market driven management of climate change impacts in the Spanish mussel sector



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ABSTRACT

Mussel farming is the largest aquaculture activity in Spain both in volume and value, being a key pillar for the development of the coastal areas in Galicia (NW Spain), where this production is concentrated. The available scientific knowledge suggests that in the long term the primary productivity of the Galician estuaries will be reduced due to climate change. Consequently, adaptive management will be required to face this challenge. The impact of the likely production decrease will depend, among other factors, on the availability of substitutes, being their identification the main object of this research. So, it was analysed whether these markets are integrated or not through cointegration tests, finding that only the French and the Spanish markets are partially integrated. This implies that since very little substitutes are available for the Galician fresh mussels, decreases in production will not necessarily affect producer's income, as prices increases will compensate the (eventual) reduction in volume. In terms of policy, this study suggests that market intelligence may contribute to an adaptive, pragmatic and flexible framework to face climate change impacts, avoiding too anticipated or blind responses that may result in economic, environmental and social costs.

1. Introduction

Climate change is a major threat for human societies [1] and scientific evidence supports the conclusion that this process is already altering marine ecosystems [2], including changes in marine ecosystem productivity, fisheries, ocean CO₂ uptake, oceanic oxygen concentrations and terrestrial vegetation [1], as well as modifications in the intensity and timing of coastal upwelling with consequent impacts on fish migration patterns, recruitment, growth, distribution, abundance and predatory-prey relationships [3].

The implications of such a phenomenon for the fisheries and aquaculture sectors and coastal and riparian communities are difficult to ignore [4] but, at the same time, they are not deeply understood and, consequently, a risk of mismanagement exists. Particularly, how markets should react to changes in production is key to optimise producers and policy-makers efforts to achieve resilience [5].

In fact, climate change is considered an added factor of uncertainty that complicates the challenges to be addressed by fisheries and aquaculture to the extent that is expected to affect the volume and price of production, the operational costs [6] as well as revenues and profits of enterprises and households that depend on them [7,8].

Mussel farming in Galicia (Spain) is the figurehead of a system of industrial relations that contribute to the welfare of society both directly, by generating employment and income, and indirectly through ancillary and related activities. In 2011 the turnover was 157 million euros, and its technical coefficient was 0.23 [9], i.e., for every euro of production, 0.23 euros of intermediate inputs were demanded from upstream industries, contributing to sustain activity and employment in such activities. To those impacts should be added investment, with an additional demand of 37 euros for every 100 euros of turnover from sectors such as shipbuilding, construction of rafts, etc. [10]. It also generates 3436 full-time equivalent jobs plus 779 family workers.¹

This production system is linked to a very specific location: 98% of the Spanish mussel production comes from the Galician estuaries (NW Spain) [11], where a reduction in primary production is expected in the long term. Among the significant changes that are likely to occur in this area are the warming of the ocean surface [12], extreme events such as heat waves [13], the increasing of the renewal time of the estuaries and the weakening of upwelling [14].

The NW Iberian Peninsula is the northern limit of the Eastern boundary Large Marine Ecosystem that extends along the Atlantic coasts of Africa and Europe from 10°N to 44°N [15,16]. At these

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¹ Data obtained from the survey of the Input-output table of the Galician fishing sector 2011.

latitudes, coastal winds are favourable to the upwelling of the cold and nutrient-rich Eastern North Atlantic Central Water during the spring and summer and favourable to the downwelling of surface coastal waters during the autumn and winter [15,17] contributing to the high productivity of this kind of areas [18]. This unique combination of wind patterns and coastal morphology makes the Galician estuaries exceptional sites for the extensive culture of mussels (*Mytilus galloprovincialis*) on hanging ropes [14] and explains world's highest rates of growth [19].

Hence, even though the available evidence is not conclusive, most of the research suggests a weakening in the upwelling intensity in the NW Iberian coast [14,20–24]. Therefore, given the dependency of the high growth rates on the coastal upwelling and the circulation of the *Rías* [25], climate change represents a serious threat for mussel farming in Galicia. However, this may not necessarily imply a reduction in producer's income, since it depends not only on total production but also on prices. If substitutes are available fishers income will decrease; if, on the contrary, no substitutes are available, a reduction in volume will lead to higher prices, increasing unitary revenues. This means that market management may represent a suitable way to address the socio-economic impacts of climate change and reduce uncertainty for sea-resources dependent population. Understanding market dynamics is key to optimise mitigation strategies and to adopt a resilient behaviour of productive activities. This paper examines long-run relationships (substitution) between major European mussel markets (Spain, France and Italy) using cointegration analysis, to assess the degree of integration among these markets. The results can help in the design of adequate policies aimed at mitigating the effects of climate change on farmer's income.

2. Background

Spain, France and Italy are the three major producers [26] and consumers of mussels in Europe, being Spain the third world largest producer (after China and Chile) and accounting for almost a half of the European volume.

Going deeper into details, Spain represents the largest European market with an apparent consumption of 125,845 t in 2013, even though since 1998 shows a decreasing trend that leads to a convergence with the French (110,665 t) and the Italian (103,234 t) markets. At a significantly lower level, below 50,000 t, are countries like The Netherlands, Belgium, Germany or the UK. In this second group, the progressive reduction in the Dutch national consumption is striking, probably due to a drop in internal production. Specifically, the scarcity of seed and the fall in the growth rates led the Dutch production from 80,000 t in the 90 s to half of these figures in recent years [27] (Fig. 1).

Going further in the delineation of the national markets, the components of the apparent consumption in Spain, France and Italy are next

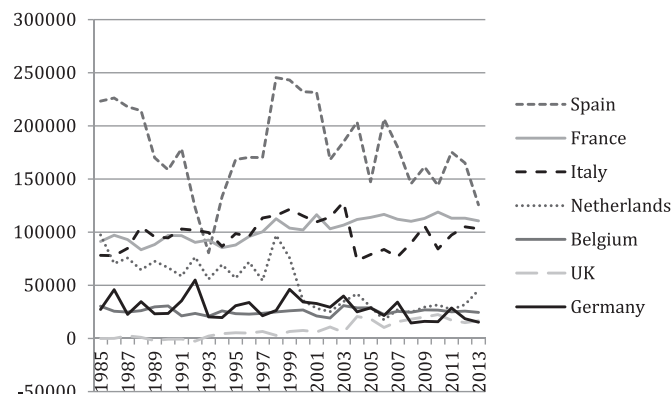


Fig. 1. Mussel apparent consumption in the major European markets (t.). Source: FAO, 2015.

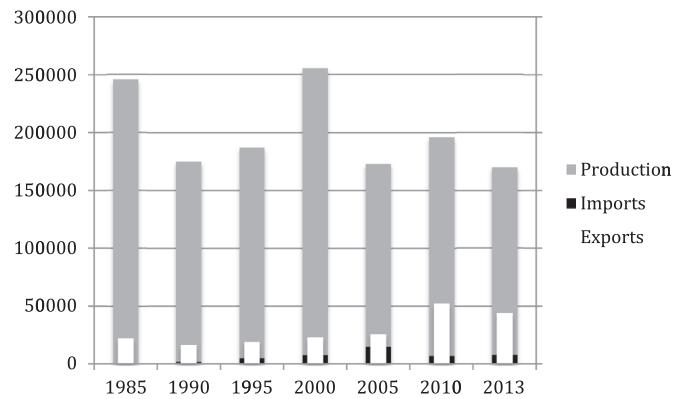


Fig. 2. Spanish apparent consumption of mussels (t). Source: FAO, 2015.

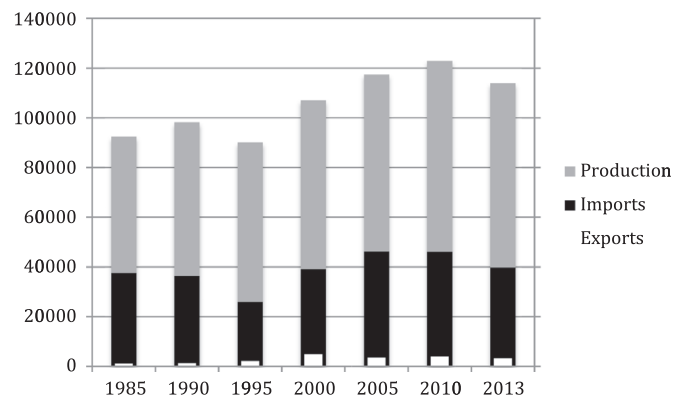


Fig. 3. French apparent consumption of mussels (t). Source: FAO, 2015.

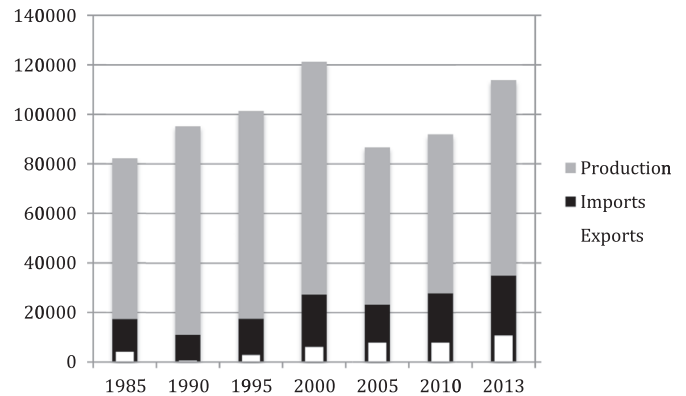


Fig. 4. Italian apparent consumption of mussels (t). Source: FAO, 2015.

analysed. Since, to obtain yearly consumption, exports are netted out from imports plus the internal production, the surface over the white bar (Fig. 2, 3 and 4) represents apparent consumption.

Spain constitutes a national-production dominated market, with a very low level of imports. As for France, during the last years, imports cover one third of total consumption, while exports are marginal. The insufficiency of the national supply is covered through imports from Spain during the whole year, Ireland and UK from January to April, the Netherlands in September and Italy from April to July [28]. Ultimately, Italy also shows a high identification between national production and consumption, with imports representing about one third of the internal demand.

3. Material and methods

The data used for the econometric analysis are weekly retail prices from EUMOFA (European Market Observatory for Fisheries and

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