Exploring the influence of fisheries management regimes and value chain on price formation at auction: the case of French scallop fisheries

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Abstract

In a context of the internationalisation of markets, a key issue to consider when analysing public policies is the interactions that exist between fishery management regimes and economic performance of fishery supply chains, from fishing fleets to consumers. The scallop fisheries are among the most important fisheries in France, and the French market is one of the principal scallop markets at international level. Most of these fisheries are regulated through licencing systems, with limitations on fishing effort limiting (rationing) fishermen's landings, and hence limiting supply in turn to auction markets. The management system has also brought some changes on the side of demand concerning first level purchasers (fishmongers, wholesalers, processors, …). The objective of the proposed paper is to study the influence of fisheries management on price formation at auction market, with application to the French small-scale scallop fisheries. An econometric model is constructed using an annual data set including all daily scallop auction transactions between fishermen and first purchasers in different auction locations. A large set of potential explanatory variables are tested, including the supply and characteristics of products deriving from the individual fisheries, but also the characteristics of the suppliers/purchasers. Specific relationships such as habits between operators are explored. The results are analysed and discussed regarding expected future changes in scallop fishery regulations.

Key words: market behaviour, price, fisheries management, scallop

JEL Codes: Q21, Q22, Q28, C01, L11

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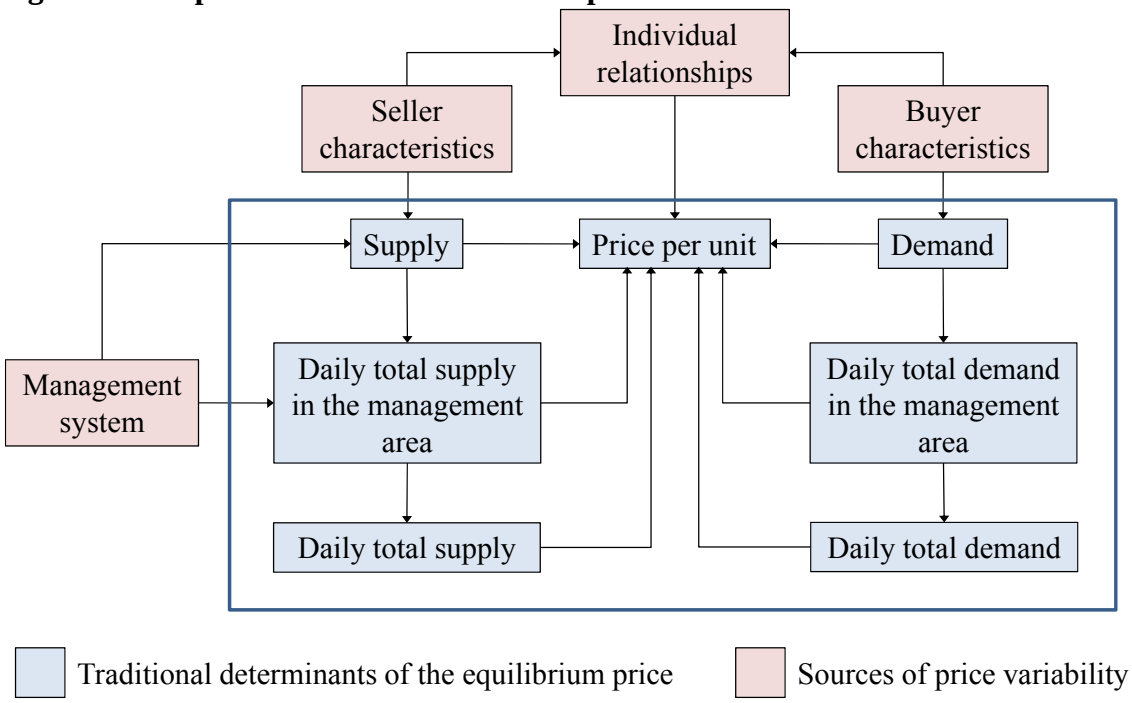
Introduction

The influence of a large set of attributes on fish prices is a growing concern (Alfnes et al., 2006; Asche and Guttormsen, 2001; Carroll et al., 2001; Guillotreau and Jiménez-Toribio, 2006; Kristofersson and Rickertsen, 2004; McConnell and Strand, 2000; Roheim et al., 2007; Wessells et al., 1999). Recently, some studies have underlined the importance of different ecolabels and fishing methods (Roheim et al., 2011; Sogn-Grundvag et al., 2013), gear types and geographical origins (Asche and Guillen, 2012) for the price determination process. However, no published studies exist concerning price formation for particular management regimes at the auction market level. Management regimes can impact the abundance of the daily supply of fish, and the weekly, monthly and annually repartitions of fish supply.

Consequently, it can influence the price determination process. Moreover, the influence of the value chain (through characteristics of the suppliers/purchasers and especially specific relationships between them) on price formation has received little attention. This paper proposes to explore these ways by studying the French scallop fisheries case. These fisheries are among the most important fisheries in France (FranceAgrimer, 2013) and the French market is one of the principal scallop markets at international level (Abso Conseil, 2011). Most of the scallop fisheries are regulated through licences systems, with limitations on fishing effort limiting (rationing) fishermen's landings, and hence limiting supply in turn to auctions markets (Dupouy, 1978; Dupouy et al. 1983, Fifas et al., 2003). The management system has also brought some changes on the side of demand concerning first level purchasers (fishmongers, wholesalers, processors).

The objective of the paper is to study the influence of fisheries management on price formation at auction market, with application to the French small-scale scallop fisheries. In tandem with the traditional price determinants of market equilibrium (the matching of supply with demand), the method we selected also considers the characteristics of purchasers and vendors, as well as their individual relationships that we think likely to influence the price at which the transaction is concluded, independently of the structure, or state of the market at the time of the transaction. Also, the constraint that has an impact on the offering (individual and total) according to the management system used, is integrated within the model (Figure 1).

Figure 1. Sale price determinants for scallops



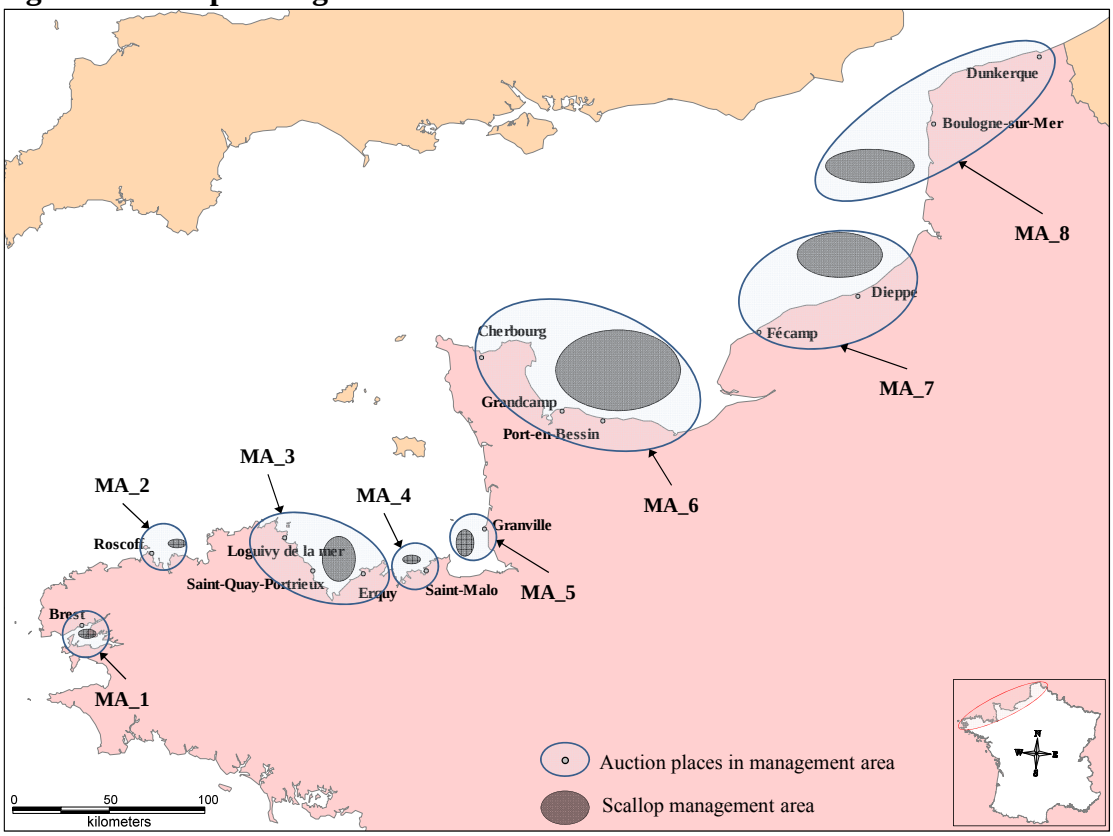
An econometric model is constructed using an annual data set including all daily scallop auction transactions between fishermen and first purchasers in different auction locations. A large set of potential explanatory variables are tested, including the supply and characteristics of products deriving from the individual fisheries, but also the characteristics of the suppliers/purchasers. Specific relationships such as habits between operators are explored.

The paper is organized in three sections. The first section is devoted to a presentation of the scallop fisheries management and market structure. In the second section, hedonic price function approach and data are presented. In the third section, results are analysed and discussed regarding expected future changes in scallop fishery regulations.

Scallop fisheries : management and market structure[1]

The scallop (*Pecten maximus*) is the leading species landed in France (15.8 thousand tons) and ranks fourth in terms of value (€37.6 million) in 2012. The main fishing zones are the Saint Brieuc bay (MA_3) and the Bay of the Seine (MA_6) accounting for 37% and 28% respectively of the total production in the English Channel. The English Channel has 8 fishing grounds, most of which are located in French territorial waters (Figure 2)[2].

Figure 2. Scallop management areas and auctions locations



As regards fishery management, a minimum marketable size for fish set for each major fishing zone is the sole EU initiated measure in force for these zones[3]. For all fishing grounds, the fishing season is open from October to May in conformity with national (health authority) regulations[4]. Most fisheries are administered by licensing systems with a *numerus clausus* on the number of ships authorised to fish. The regimes in force regulating access are mainly managed by regional professional organisations, and implemented locally by departmental structures. Eligibility for the various licensing systems is defined by criteria of length and maximum vessel power. This has an impact on the structure of fleets exploiting these fisheries. As the table 1 shows, the vessel length and engine power are virtually growing from

[1] The data set used here derives, unless otherwise stated, from "Sales Data" (administrative data gathering details of sales (mainly in auction hall) professional fishermen from Directorate for Sea Fisheries and Aquaculture.
[2] The other French fishing grounds located in the Bay of Biscay represent less than 4% of the French production figure and are not considered in this study.
[3] Council Regulation (EC) No 850/98 of 30 March 1998 for the conservation of fisheries resources through technical measures for the protection of juveniles of marine organisms.
[4] "Arrêté du 29 septembre 2008 portant approbation d'une délibération du Comité national des pêches maritimes et des élevages marins définissant les conditions d'exercice de la pêche à la coquille Saint-Jacques", JORF n°0229 1st October 2008 page 15092.

West to East across the channel, with a minimum of 9.4m (87 kW) in zone MA_1 and a maximum of 16.7m (312 kW) in zone MA_8.

The number of ships authorised to fish varies depending on the zone. The number depends on the ships' fishing capacity, but also on the productivity of each fishing ground. The status of each fish stock is evaluated each year for the main zones. The objective is therefore to evaluate the sampling potential on the resource without endangering stock or future stock samplings. A fishing calendar setting dates and timeslots when fishing is authorised is therefore defined at the start of the fishing season in such a way as to limit the overall sampling applied to each fish stock (Dupouy, 1978; Dupouy and al., 1983; Fifas et al., 2003). As a result, the management systems for the West Channel MA_1, MA_2, MA_3 authorise on average two 45-minute trip per week, while management systems in the East Channel, and in particular fishing ground MA_6, allow four days' fishing per week, without any limitation on the fishing time[5]. From this can be calculated the heterogeneous average fishing productions per vessel, depending on the zone. This amounts respectively to 2, 10 and 29 tons on the first three fishing grounds, and a maximum of 39 tons in MA_6.

As Table (1) shows, the number of purchasers in the auction halls is quite homogeneous between fishing grounds, with the exception mainly of fishing grounds MA_3 that includes 186 producers, representing 76% of purchasers. This situation can be explained by the fact that all landed fish must be sold at auction – this is obligatory in the case of fishing ground MA_3. Producers wishing to sell directly to the consumer are therefore obliged to buy their fish back in the auction hall[6]. The percentage of production bought back by fishermen in the auction halls is, in this instance, 20%. This production figure is then sold locally (Monfort, 2011).

Frequencies of sales in fish auction halls are very heterogeneous between management areas and are linked to authorized number of days at sea.

Whatever the fishing ground, part of the production figure is bought by retail operators, mainly fishmongers, for resale to the end consumer. The consumption zone is in this case near to the fishing zone. The rate of purchase by these operators varies between 15% and 30%, depending on the fishing ground.

The majority of fishing grounds are characterised by a predominance of intermediary operators, and mainly fish merchants and wholesalers. Their activity represents 75%, 77% and 79% respectively of the quantities offered in fishing grounds MA_6, MA_2 and MA_7. It is lower than this - between 59% and 48% - in fishing grounds 1, 4, 5 and markedly lower in MA_3 (27%). The fish merchants and wholesalers are key operators to the extent that they supply purchasing departments for the major national retailers. These central purchasing services are responsible for centralising purchasing operations so they can be subsequently redistributed over the national territory. Some fish merchants or wholesalers can, in certain instances, be import or export operators and be at the hub of international markets.

[5] If weather conditions do not permit fishing vessels to operate, an option to 'catch up' exists, explaining that on average, the number of days of sale – corresponding to the number of fishing days – in fishing ground number 3, is more than 2.

[6] The data we have at our disposal does not allow us to distinguish, among the various purchases made by fishermen, between volumes that relate to their personal production and the purchases made from other fishermen. We therefore consider that a purchaser-fisherman is an operator that is distinct from a producer.

Table 1. Management areas characteristics

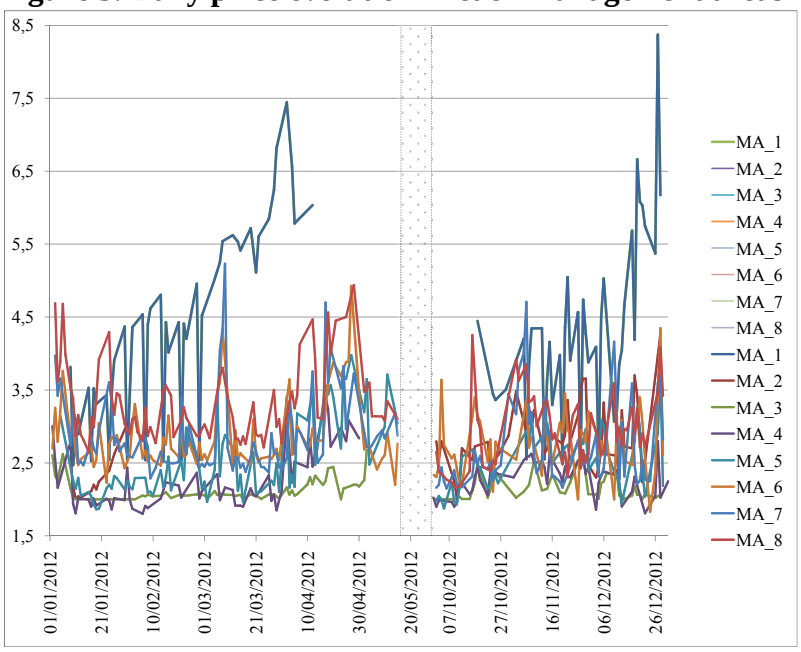
			MA_1	MA_2	MA_3	MA_4	MA_5	MA_6	MA_7	MA_8
Annual production (T)			156	172	5534	1191	847	4202	2175	691
Average price per kg (€)			4.3	2.7	2.1	2.3	2.4	2.8	2.7	3.0
Nunber of sellers (vessels)			63	18	192	37	25	107	62	24
Vessels length (Average)			9.4	11.7	10.8	12.1	13.9	13.7	15.6	16.7
Vessels engine powers (Average)			87	143	131	155	214	224	256	313
Number of transactions			2040	1174	10016	1332	4004	7635	4274	3591
Nb of days with transactions			87	60	123	110	130	151	160	146
Transactions average weight (kg)			77	147	553	894	212	550	509	192
Nb of buyers			43	53	186	17	55	67	59	68
Type of purchasers	Other	Freq.	2	2	1	6	2	3	5	3
		% vol. an	*11*	*0*	*0*	*29*	*1*	*0*	*4*	*4*
	Retailers	Freq.	23	11	11	24	38	33	39	47
		% vol. an	*5*	*15*	*3*	*20*	*27*	*12*	*7*	*25*
	Traders	Freq.	63	72	12	71	47	54	47	46
		% vol. an	*59*	*77*	*27*	*52*	*48*	*79*	*75*	*63*
	Producer	Freq.	9	4	76	-	4	6	-	-
		% vol. an	*25*	*3*	*20*	-	*0*	*1*	-	-
	Transformer	Freq.	2	11	1	-	9	4	8	4
		% vol. an	*0*	*5*	*50*	-	*24*	*8*	*14*	*9*

* type of usable fishing gear varies according to zone

Fishing ground MA_3 is the largest from the point of view of the quantities offered, and the most atypical in that purchasing for processing concerns 50% of the production total sold in auction halls. Production processing in this instance takes the form of producing frozen shelled whole scallops. The rate of purchase processor producers does not seem to be dependent on the quantities offered, since this rate rises to 24% in MA_5 for a quantity passed to auction of 850 tons, and 8% in MA_6 for a quantity of 4,200 tons. In these cases, the quantities bought seem more to depend in the short term on transformation capacity in factories sited near to the fishing grounds, with these capacities sometimes falling to zero in certain zones (MA_1 and MA_4).

Prices vary between management areas but also in a same area, from one sell to another (Figure 3).

Figure 3. Daily price evolution in each management areas



Hedonic price function approach and data

Method

The Hedonic Pricing Method is particularly well-suited to analysing a market stucture through the study of transaction prices for differentiated goods[7] (Rosen, 1974)[8] and the more so when the natural environment imposes its own limitations on the production of the goods studied. The theoretical foundations of the hedonic approach to prices have been described by Lancaster (1966) who proposes three hypotheses: purchasers derive utility, not from goods in themselves, but from their characteristics; goods possess more than one characteristic and several characteristics are shared by several goods; and combinations of goods can have different characteristics from those of the goods taken separately. Following on from this, we are able to envisage that characteristics of goods exist, the value of which cannot be directly observed, and also to take into account heterogeneity of the products, associated, for example, with their quality[9] that may vary as a function of geographical source or origin.

This approach supposes that the products studied are sufficiently homogeneous to be comparable. However, in the case of the scallop, there is a very strong heterogeneity of products linked to fishing location, and this goes some way to explaining why the management system is not identical for all fishing grounds. Also, it is necessary to put forward the hypothesis that a global market for scallops really exists, but that this is made up of several sub-markets – as many as there are fishing grounds – each of which can be studied separately. The various sub-markets considered are the different management areas (see Figure 2). Each model is estimated using the same set of explanatory variables. In this way we keep the possibility to characterize the overall market of scallops from sub-markets treated independently.

An hedonic price function is estimated[10] for each of the eight fishing grounds under consideration. The functional form selected differs depending on the fishing ground, but the general form it takes is the following:

$$\ln Y = \alpha + \beta \ln X + \delta X' + \phi Z + \varepsilon \qquad (1)$$

where X and X' are continuous variables which, depending on the model, are in logarithmic or normal format[11].

Data

In order to study how prices are set at the first sale of the scallop in the various French fishing grounds, we study all transactions concluded in the various fish auction halls throughout the territory in 2012.

The transactions concluded in the various fish auctions relate to the batches of products considered to be homogeneous. Each transaction is concluded between a vendor-fisherman and an identifiable purchaser at the time of each transaction.

A certain number of explanatory variables are tested. These variables relate notably to the characteristics of local production with the objective of being able to identify the effect of management systems on the offering and its structure. Over and above the characteristics of

[7] A differentiated good is defined by all its constitutive characteristics (Le Goff, 1996).

[8] An alternative theoretical model has also been developed by Freeman in 1974 but if both are utilized, that of Rosen is the most often cited (Palmquist, 1989).

[9] It is the subjective quality linked with consumers' preferences.

[10] All estimates were computed with Stata.

[11] See appendices for variable coding, estimation results, variance inflation factors and endogeneity tests.

the demand, the attributes of purchasers and vendors on the market are taken into account as the conditions of competition at the various auction locations. The detail of variables tested is discussed below and their link with the management system is indicated.

Transaction characteristics (TC_var)

Temporal variables have been introduced, with the objective of identifying changes in demand for scallops. These are the months of the year and the days of the week at which the transactions took place. The months of the year are tested to the extent that certain works mention that there exists a certain seasonality in consumption habits for this product (Abso conseil, 2011). The scallop is, in effect, considered as an 'early' product by French consumers, the product only being available for part of the year. In other respects, the scallop has always been considered as a festive item, with consumption increasing during catholic feast periods (Christmas, Easter). The introduction of days-of-the-week effects is designed to isolate any effects associated to changes in demand on a weekly scale, given that scallops are in general consumed at the weekend when the product is sold fresh and whole. On the other hand, some operators (such as the processors, for example) may have operating constraints as regards processing or packaging of products purchased.

The quality and size class scallops is homogeneous for the same lot. The sales of product lots in the auction hall are organized according to these criteria. Even if the sign associated size class is not known *a priori*, even though larger-sized products are often preferred by the end consumer. There are, of course, counterexamples to this, like the eel, and the sardine, where a clear price advantage is demonstrable for smaller fish sizes. Products offered for sale are also classified as a function of their quality. It is likely that the prices observed depend on the classification applied in the fish auction halls.

It is also possible to differentiate between transaction types in auction halls as follows: transactions between vendors and purchases concluded by auction, by means of over-the-counter sales, or again via the medium of a contract negotiated between operators.

Market characterization (MC_var)

The first variable to characterize the market are those relating to the number of operators. They allow to take into account the degree of competition by type of operator and identify what type of operator probably most influences the market and can improve the way conditions of competition between operators in each of the auction halls. Even though a large proportion of sales is conducted via auction, it is nevertheless the case that the number of operators (vendor or purchaser) in each auction hall may be limited. In order to take this dimension into account, different variables have been constructed to measure the possible market power of vendors or of purchasers. These variables are, for example, the percentage of quantities or lots bought (sold) by operators in the course of a single day. If forms of market power exist, the expected signs associated to these variables will be negative and positive respectively.

The daily production figure for the fishing ground is an important variable since the quantities put on sale are determined by the management measures adopted in each of the fishing grounds, or in the identified management zone. As indicated earlier, the management measures can limit how much fish is available to be sold at each fish auction hall, and can explain its distribution over time. This is especially the case for fishing grounds classified for the scallop where licencing systems define which fishing vessels are authorized to fish, and the calendar for fishing open days (days and times for fishing). Even though the products sourced by the different fishing grounds are not totally homogeneous, one cannot rule out the possibility that the offering for scallop on a daily basis at national scale influences the pricing observed in each of the auction halls. This type of relationship is more plausible that on-line

purchasing are growing increasingly. A conventional analysis would lead one to expect negative signs for the coefficients associated to these variables. These coefficients enable us to identify price elasticity for local and national demand respectively.

As the market for *pectinidae* is international, the influence of monthly imports and exports of *pectinidae* in France must be considered. It is important to note that the available data do not allow us to isolate scallops (*Pecten maximus*). Different categories are differentiated in the external commerce data (fresh, frozen, transformed, sauce and waste) both in volume and in value. Potentially, imports can be used to offset a lack of supply, the price effect will be positive. The opposite effect can also be observed if the importers are indifferent to the origin of the products.
Similarly, exports may indicate a specialization of some buyers in international markets. The price effect will be positive if the supply is insufficient to satisfy the entire demand. Otherwise, we can expect no effect on the price level.

*Characteristics of operators (CS*_var*)*
Vendors. A fishing vessel is associated to each lot, along with its individual technical characteristics. The characteristics of these vessels (length & engine power) are tested. The vessel length is an interesting variable since it determines the radius of action for vessels. The smaller the vessel, the more limited the radius of action, and this in turn defines which of the fishing zones can be frequented, plus the duration of trips out to sea (Guyader et al., 2013). The fishing zones exploited can also be a source of differentiation of products sold, notably because of the associations between the nature of the habitats exploited and the morphology of the species. The smaller the vessels, the shorter will be the time between the moment the fish are caught and their sale at auction, and in general the fresher will be the product for any given conservation method.
Vessel owner ages have been incorporated into the analysis to test any possible effects linked to the experience of the fishermen. Here we may note that most ship owners are owner / skippers that sail with the vessel, but it is possible that a vessel owner disposes of several fishing vessels or licences for a single fishing ground. As a result, the variable that relates to this aspect can allow us to adjust the potential 'market power' associated to a fisherman, this potential power being possibly proportional to the number of ships belonging to the same ship owner present.
Other effects linked to vendors have also been incorporated within the analysis. A variable expressing economic dependence on the species is studied. This economic dependence is calculated as the ratio of turnover generated from the sale of scallops to the total turnover figure for the vessel. A reasonable assumption is that the more dependent the enterprise, the more the fishermen involved are inclined to valorize their production to best effect. The vendors (fishermen) are also identified by their membership (or not) of a producer organisation (PO). If the fisherman is a member of a PO, it is also possible to characterize the PO they belong to. POs have an important role notably in the framework of a Common Fisheries Policy (CFP) common market organisation (CMO). These organizations can intervene at the level of the auction hall to set a withdrawal price, below which all quantities proposed for sale are withdrawn from the market to be either destroyed, or stored so they can be sold on later. The effects of these price-fixing interventions are, *a priori*, negative, to the extent that withdrawal prices are floor prices. The Producer Organizations (PO's) also intervene in the management of quotas for EU species, but scallops are excluded from this mechanism (Larabi et al., 2012).

Purchasers. Different variables are used to characterise purchasers. Taking as starting point the codification of each enterprise (establishment), it is possible to identify the types of activities each enterprise engages in according to a national directory that classifies business activities[12]. Following minor corrections to enable us to validate the coherence of data, it was possible to differentiate fishmongers from fish traders, fish wholesalers, processors, GMS (Supermarkets), etc. These operators are intermediaries with roles that are highly differentiated within this sector. Fish merchants are, for example, intermediaries between fisherman and the end consumer. Their marketing zone is, in general, in the vicinity of the fishing grounds themselves, in the framework of short circuits. Fish traders are larger scale operators, notably with an intermediary role for central purchasing services and GMS distribution networks when last are not themselves buyers in auction hall. They can in some cases transform the products but it is not their core of business unlike transformers. Processors only transform the product, mainly into 'noix' for scallop. One can therefore anticipate different levels of 'willingness-to-pay' depending on the buyer, to the extent that their constraints are different depending on the intermediary.
The economic dependence of vendors on scallop was calculated for purchasers in the same way as for vendors. This dependence has the objective of measuring the sensitivity of operators to this species.
In order to complete the dataset relating to potential impacts of international exchanges[13] on the way these markets operate, certain variables allowing us to characterise the involvement of purchasers in the import or export of seafood produce have been introduced. Under condition of sufficient supply it is assumed that the effect of these variables is negative when the purchasers are importers, to the extent that they have the capacity to substitute imported scallops for locally fished ones. In the event that purchasers are exporters, the anticipated effect is less obvious: operators can research specific products for export, and therefore have a willingness to pay higher prices for the products on sale. A positive effect is in this case to be expected. Conversely, these operators, being linked in with international markets, can exert, like importers, downwards pressure on the prices of products sold.
Other attributes of purchasers and vendors are integrated in the analysis of price formation, that is, in the analysis of rates of each of the purchasers and vendors present in each auction hall. This rate expresses the ratio between the number of days where the purchaser (resp. vendor) has been active in the auction hall, and the total number of days of sale of scallops in this same auction hall. This variable can allow us to distinguish between the so-called 'regular' purchasers (resp. vendors) and those that one might consider as being more 'opportunistic'.

Relationships between vendors and purchasers. The influence of relationships between vendors and purchasers is tested through the notion of fidelity between purchasers and vendors. Fidelity rates are calculated on the basis of either the total number of transactions, or the volumes traded over the course of the year. This enables us to take into account the frequency of exchanges between a purchaser and a vendor, but also the volumes concerned by these exchanges.

[12] The majority of information on the types of buyers were found on the websites *infogreffe.fr* and *societe.com*.
[13] Source of data: Data base COMEXT – EUROSTAT, 2012.

Results and discussion

As mentioned previously, we have chosen for each model to test the same set of explanatory variables to allow comparison between Management areas. One consequences is the variability of the goodness-of-fit measured by the R^2. Thus, if the models for MA_1 and MA_8 have a relatively high goodness-of-fit given our constraints, management areas 2, 4 and 5 are relatively less fitted. Models of management areas 3 and 6 explain only a small part of the price variability. Also, significance at 0.1% level of the coefficients associated with the constants of all models confirms the existence of explanatory variables not included in the models.

In addition, some variables appear more frequently. Thus, all models include a reference to the transaction date (month and day). Also relatively to the international market of scallop concerning relationships with some international buyers or influence of international supply. The influence of local supply is also a determining factor in price formation except for the MA_1. The influence of national supply is an important explanatory variable in 5 management areas. MA_2, MA_6 and MA_7 are not concerned. In the case of MA_2, this can be explained by a lower frequency of the number of landings (days of sale) on the period compared to other management areas. For MA_6, the explanation probably lies in the fact that this area contributes the most to the national supply. The effect of the latter parameter is probably indirectly integrated into the variable related to local supply. Regarding the MA_7, this can be linked to a specificity of the product that induces no substitutability of the product with others locations.

The variables linked to the characteristics of stakeholders, to their relationships (nature of the transaction, interpersonal relations), to their dependence on scallop, to the frequency of their intervention on markets and to their importance and contribution to global supply or market share) are also important variables to explain the variability of prices in most management areas. Characteristics are less important in the case of sellers (this variable is present in only half of the areas) than buyers (null in MA_4). However, the membership to a PO is not significant in the fishing grounds located in the Western English-Channel, except for MA_5.

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Results also highlight the specificity of some management areas, mainly MA_6. The latter – for which the model goodness-of-fit is among the lowest - is distinguished by the lack of significance of the variables relating to the weight of the operators but also by its importance of the age of the owner in price formation (this variable is significant only in this location). It seems that in this area, the experience of the ownership allows him to better promote the production of its fishermen. In this area, the engine power of vessels is positively related to the selling price while the relationship is reversed with size. It is also the only fishing ground where the quality of the product is significant. It is one of the two areas (with MA_8) where the product category is critical for price formation. In this management area the type of transaction influence the most the price.

If a number of variables are common to fishing grounds, they do not have always the same effect on the price. The table 2 below summarizes the overall results.

Table 2. Summary of the results

	MA_1	MA_2	MA_3	MA_4	MA_5	MA_6	MA_7	MA_8
MC_L-totsupply	〃	-	-	-	-	-	-	-
MC_N-totsupply	+	〃	-	-	-	〃	〃	-
MC_impvol	〃	〃	-	〃	〃	〃	〃	〃
TC_mth1	〃	-	-	〃	-	-	+	-
TC_mth2	〃		+	-	-	-	+	-
TC_mth3	+		-		-	-	〃	-
TC_mth4*	+		〃	+	〃	〃	+	〃
TC_mth5			〃		〃	-	+	-
TC_mth10*	〃	〃	〃	〃	-	-	〃	-
TC_mth11	+	+	〃	+	〃	〃	+	-
TC_mth12	+	+↗	+		-		+	-
TC_d1	-	-	〃	〃	〃	-	+	〃
TC_d2	-	〃	〃	+	〃	〃	+	〃
TC_d3	-	-	〃	〃	〃	〃	+	+
TC_d4	〃	〃	〃	〃	〃	〃	+	〃
TC_d5	-	〃	〃	〃	〃	〃	〃	+
TC_d6*	〃		-	〃	〃	-	〃	〃
TC_qual2						-		
TC_cat1						-	〃	〃
TC_cat3						〃	〃	-
TC_typauct			+	-	-	+	+	+
MC_B-nb	〃	〃	+↗	〃	〃	-	〃	〃
MC_S-nb	-	+	〃	〃	+	+↗	-	〃
MC_B-dilrate	+↗	+	-	〃	〃	〃	〃	+↗
MC_S-dilrate*	+	〃	〃	+↗	〃	〃	+	〃
CS_S-veslthmet	〃	〃	〃	〃	〃	-↘	〃	〃
CS_S-vespow	〃	〃	〃	〃	〃	+	〃	〃
CS_S-veslth1	〃	-	〃	+	〃		〃	〃
CS_S-veslth2	〃	〃	〃	〃	+	〃	〃	〃
CS_S-nbvesown			+	-		〃	〃	
CS_S-ageowner2	〃		〃		〃	-		
CS_S-ageowner3	〃		〃	〃	〃	-	〃	〃
CS_S-ageowner4	〃	〃	〃	〃	〃	-	〃	〃
CS_S-ageowner5	〃	〃	〃	〃	〃	-	〃	〃
CS_S-ageowner8	〃	〃	〃	〃	〃	-	〃	〃
CS_S-ageowner10	〃	〃	〃	〃	〃	+	〃	〃
CS_S-ageowner11	〃	〃	〃	〃	〃	-	〃	
CS_S-pomber	〃	〃	〃	〃	〃	〃	〃	+
CS_S-pocme*				〃		-	-	〃
CS_S-pocob	〃	〃	〃	〃		-	〃	
CS_S-pofnord				〃	〃	〃	-	〃
CS_S-poopbn				〃	+	-	〃	
CS_S-dep4	〃		+	〃		〃		〃

Table 2. (Continued)

CS_S-dep6	//		//	//		-	//	//
CS_S-deprate	+	//	//	//	//	-	//	-
CS_S-dprod	-	- ↘	+ ↘	+	//	//	//	//
CS_S-dpartprod	//	//	//	//	-	//	//	+ ↘
CS_S-dprodsold					- ↗	//		
CS_B-typoth	-	//	//	//	//		//	//
CS_B-typwsaler	//				//	-		
CS_B-typfishmerch*	//	+	//	//	+	//	//	//
CS_B-typmong	//	+	+	//	//	+	-	//
CS_B-typtrans*	//	+	//		//	//	//	+
CS_B-deprate	-	//	-	+ ↘	//	//	- ↗	//
CS_B-dep1	//	//	//	//	//	-	//	//
CS_B-dpartpurch	//	//	//	//	- ↘	//	+ ↘	-
CS_B-dpurch	//	-	//	//	//	//	//	//
CS_B-impsfd	+	//	-	+	//	//	-	-
CS_B-expsfd*	//	+	//	//	+	+	//	//
CS_S-fidlot*	//	//	//	+	+	+	//	//
CS_S-fidvol*	- ↘	//	//	//	//	//	//	-
CS_B-fidvol	+	//	//	-	-	//	-	//

Note:
// indicates that the variable is not significant.
* indicates variables for which only one type of effects is found (positive or negative).
↘ indicates that it is the variable with less influential.
↗ indicates that it is the variable with most influential.

Some variables tested have similar effects on the price. Thus, the local daily supply negatively impact the selling price of scallop, effect that could be reasonably expected. Similarly, the exporters-buyers tend to pay more for scallop they buy, which probably allows them to purchase the volumes necessary for their activity on the international market. The positive relationship between types of buyer and scallops levels needed is also indicated by the variables that distinguish wholesalers and transformers from other buyers, provided that the market shares of transformers are low. If they were high, it is likely that the impact on prices would be the reverse. This may also be linked to the diligence rate which, according to the assumptions taken, will not have the same type of impact. Thus, the frequency of transactions between two stakeholders will positively impact the price, while the dependence of a seller to a particular buyer will provide the opposite effect. The results also show the existence of a bonus for the regularity of the presence of sellers. More a buyer will be present on the market and more he will be able to enhance its production.

The results also confirm our hypotheses about the importance of the period fromwhich the transaction was carried out. Thus, we found that early in the season (October) the prices are lower; at the end of the season (April), which corresponds to a favorable period to the consumption of scallops, there is relatively higher prices compared to other periods. This is particularly the case in the MA_1 for which the impact of this variable on price is 3 to 4 times higher than for others. This is also confirmed with the lowest price on Saturday. The effects of the other days are not the same between management areas. Thus, productions of the areas located in the East English Channel are better valued in the second part of the week, whereas in the Western English Channel. Similarly, some months do not have the same relationship with price depending on the location concerned. This is the case for MA_5 and MA_8 where

prices are lower during the Christmas holiday period. This may be due to a poor anticipation of the demand level from buyers of these areas. Price differences depending on whether the transaction took place in December or not are particularly important in MA_1. The impact of this variable is 2 to 7 times higher than in other areas concerned. Monthly variables stand out MA_1. This management area is the only one that does not have the same effects of the monthly variable on price. This probably explains the fact that we have not bring out a link between the level of national supply and the price, whereas this link exists in all other management areas.
An important result is also the impact of the number of operators on price. Indeed, prices in MA_3 and MA_6 are most sensitive to this feature. This indicates with higher levels of production in these areas and higher number of stakeholders, there is more competition in these markets than in others.

Conclusion

Making use of a hedonic model, specifying the price of scallops as a function of the attributes that characterize it, the paper has studied for the first time the influence of scallop fisheries management regimes on price formation at auction market, for eight management areas in France. Moreover, the influence of the value chain on price formation has been considered.
The results indicates that the supply (locally and nationaly) and number of vendors are important for the price determination process for scallop. These parameters are directly linked to management systems. Highlighting positive and negative impacts depending on the management areas in the case the variable "number of vendors" could indicate management systems not fully adapted. In the same way, the results for the variable "daily production" are also interesting since this parameter is significant only in the Western English Channel management areas. However, these remarks, based on models with very different goodness-of-fit, need further discussion to be validated.

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Appendices

Table A. Variable coding

Price	
Price	ppu: price per kg (€)
Transaction characteristics (TC_)	
Month of the transaction	TC_mth1to TC_mth12 with TC_mth1 = January
Day of the transaction	TC_d1 to TC_d7 with TC_d1 = Monday
Type of transaction	TC_typauct: auction TC_typcct: contract TC_typmuta: mutual agreement
Product quality	TC_qual1: alive TC_qual2: other quality
Product category	TC_cat1: european categorization of scallops UE10 TC_cat2: european categorization of scallops UE11 TC_cat3: european categorization of scallops UE12
Market characterization (MC_)	
Number of stakeholders	MC_S/B-nb
International trade	MC_impvol: volume of scallops and derivatives imported monthly MC_expvol: volume of scallops and derivatives imported monthly
Daily supply (volume)	MC_L-totsupply (locally) MC_N-totsupply (nationally)
Characteristics of stakeholders (CS_)	
Vessels length	CS_S-veslthmet (in meters) CS_S-veslth1: less than 10 meters CS_S-veslth2: 10 to less than 12 meters CS_S-veslth3: 12 to less than 18 meters CS_S-veslth4: 18 to less than 24 meters CS_S-veslth5: 24 meters or more
Vessels engine power	CS_S-vespow (in kW)
Age of shipowner	CS_S-ageowner1: [20-25[CS_S-ageowner2: [25-30[CS_S-ageowner3: [30-35[CS_S-ageowner4: [35-40[CS_S-ageowner5: [40-45[CS_S-ageowner6: [45-50[CS_S-ageowner7: [50-55[CS_S-ageowner8: [55-60[CS_S-ageowner9: [60-65[CS_S-ageowner10: 65 and over CS_S-ageowner11: unknow
Number of vessels by owner	CS_S-nbvesown
Producer organizations	CS_S-pomber: member of a producer organization CS_S-pocme: member of *CME* CS_S-pocob: member of *Cobrenord* CS_S-pofnord: member of *Fromnord* CS_S-poopbn: member of *OPBN* CS_S-poopob: member of *OPOB* CS_S-pooppan: member of *OPPAN* CS_S-popma: member of *PMA* CS_S-pono: not member of a PO

Table A. (Continued)

Dependence to scallop	CS_S/B-dep1: no dependence CS_S/B-dep2: low dependence CS_S/B-dep3: partial dependence CS_S/B-dep4: medium dependence CS_S/B-dep5: strong dependence CS_S/B-dep6: total dependence CS_S/B-deprate: rate of dependence
Daily individual production	CS_S-dprod: volume produce daily (locally) CS_S-dpartprod: proportion of the daily production (locally) CS_S-dprodsold: daily production sold (locally)
Type of purchasers	CS_B-typoth: other type of buyer CS_B-typretail: retailer CS_B-typwsaler: wholesaler CS_B-typsmkt: supermarket CS_B-typrest: restaurant CS_B-typfishmerch: wholesale fish merchant CS_B-typfishman: fisherman CS_B-typmong: fishmonger CS_B-typtrans: transformer CS_B-impsfd: seafood importer CS_B-expsfd: seafood exporter
Daily individual purchase	CS_B-dpurch: volume bought daily (locally) CS_B-dpartpurch: proportion of the daily production purchases (locally)
Relationships between operators	CS_S/B-fidlot: fidelity rate based on number of transactions CS_S/B-fidvol: fidelity rate based on volume exchange
Diligence rate of stakeholders	MC_S/B-dilrate

Note: The two first letters indicate variable category. 'S' or 'B' indicate variable concerning respectively vendors or purchasers.

Table B. Interpretation rules for estimated coefficients (Terra, 2005)

Type	Calculation	Interpretation
Log	$\hat{\beta}_k$	A 1% increase in the explanatory variable corresponds to an increase of $\hat{\beta}_k$% of the sale price per kilo
Norm	$\hat{\beta}_k \times 100$	A one-unit increase in the explanatory variable corresponds to a variation of 100. $\hat{\beta}_k$% of the sale price per kilo
Dum	$g = 100\left(e^{\hat{\beta}_k} - 1\right)$	The percentage impact of modality taking the value 1 of the explanatory variable on the sale price per kilo is equal to g

Tables C.

Note for all tables C:

ME: marginal effect. In the case of all continuous variables, the marginal effects are indicated for a 1% change in the level of the variable concerned for variables.

MP: marginal price

Significance levels: † p<0.1 * p<0.05 ** p<0.01 *** p<0.001

Table C1a. Descriptive statistics – MA_1 (2040 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	log	4.33	1.15	2	8.85
MC_N-totsupply	log	121.58	59.77	0.77	280.46
TC_mth2	dum	0.13	0.33	0	1
TC_mth3	dum	0.1	0.3	0	1
TC_mth4	dum	0.01	0.12	0	1
TC_mth11	dum	0.29	0.45	0	1
TC_mth12	dum	0.26	0.44	0	1
TC_d1	dum	0.27	0.45	0	1
TC_d2	dum	0.1	0.29	0	1
TC_d3	dum	0.24	0.43	0	1
TC_d5	dum	0.08	0.28	0	1
MC_S-nb	log	22.3	6.87	2	33
MC_S-dilrate	norm	41.56	15.52	1.15	64.37
MC_B-dilrate	norm	42.93	18.06	1.15	65.52
CS_S-deprate	log	69.52	33.23	0.29	100
CS_S-dprod	log	116.51	113.4	0.1	1217.8
CS_S-fidvol	log	9.16	12.58	0.05	100
CS_B-typoth	dum	0.03	0.18	0	1
CS_B-impsfd	dum	0.57	0.5	0	1
CS_B-deprate	log	17.57	21.86	0.07	96.96
CS_B-fidvol	log	2.98	3.7	0.01	91.82

Table C1b. Estimation results – MA_1 (2040 obs.)

Variable	VIF	β	t-stat	ME	MP
cons	-	1.4156 ***	23.4	-	-
MC_N-totsupply	2.03	0.0216 ***	4.71	0.022	0.0008
TC_mth2	1.65	0.1810 ***	17.72	0.198	0.8591
TC_mth3	1.53	0.3846 ***	35.94	0.469	2.0310
TC_mth4	1.29	0.4433 ***	15.63	0.558	2.4151
TC_mth11	1.90	0.1701 ***	17.32	0.185	0.8030
TC_mth12	2.00	0.3288 ***	22.27	0.389	1.6854
TC_d1	1.69	-0.0564 ***	-5.48	-0.055	-0.2373
TC_d2	2.36	-0.2901 ***	-10.98	-0.252	-1.0904
TC_d3	2.10	-0.0597 ***	-5.1	-0.058	-0.2509
TC_d5	1.43	-0.0642 ***	-3.87	-0.062	-0.2693
MC_S-nb	1.64	-0.0846 ***	-7.23	-0.085	-0.0164
MC_S-dilrate	1.23	0.0005 †	1.91	0.511	0.0024
MC_B-dilrate	2.20	0.0023 ***	7.05	0.944	0.0100
CS_S-deprate	1.46	0.0182 ***	3.72	0.018	0.0011
CS_S-dprod	1.65	-0.0590 ***	-10.84	-0.059	-0.0022
CS_S-fidvol	2.33	-0.0279 ***	-4.36	-0.028	-0.0132
CS_B-typoth	1.61	-0.1211 ***	-5.21	-0.114	-0.4937
CS_B-impsfd	1.42	0.0558 ***	6.25	0.057	0.2487
CS_B-deprate	1.74	-0.0202 ***	-5.16	-0.02	-0.0050
CS_B-fidvol	1.47	0.0167 ***	4.11	0.017	0.0243
R^2		0.6365			

Table C2a. Descriptive statistics – MA_2 (1174 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	-	2.7	0.53	2	5.16
TC_mth1	dum	0.18	0.39	0	1
TC_mth11	dum	0.26	0.44	0	1
TC_mth12	dum	0.34	0.47	0	1
TC_d1	dum	0.04	0.19	0	1
TC_d3	dum	0.2	0.4	0	1
MC_S-nb	log	8.83	3.7	1	14
MC_B-dilrate	log	40.6	15.37	1.64	63.93
CS_S-veslth1	dum	0.27	0.44	0	1
MC_L-totsupply	log	3880.56	1890.13	231	10242
CS_S-dprod	log	598.57	343.33	25	2066
CS_B-typfishmerch	dum	0.64	0.48	0	1
CS_B-typmong	dum	0.13	0.33	0	1
CS_B-typtrans	dum	0.05	0.23	0	1
CS_B-expsfd	dum	0.5	0.5	0	1
CS_B-dpurch	log	366.26	361.74	17.5	2096

Table C2b. Estimation results – MA_2 (1174 obs.)

Variable	VIF	β	t-stat	ME	MP
cons	-	1.7283 **	21.78	-	-
TC_mth1	1.71	-0.1193 ***	-13.4	-0.112	-0.3032
TC_mth11	1.82	0.1618 ***	17.29	0.176	0.4736
TC_mth12	2.09	0.1642 ***	13.96	0.178	0.4811
TC_d1	1.11	-0.164 ***	-8.55	-0.151	-0.408
TC_d3	1.14	-0.0336 **	-2.89	-0.033	-0.0892
MC_S-nb	6.02	0.0386 **	2.89	0.039	0.0118
MC_B-dilrate	1.18	0.029 ***	5.46	0.029	0.0019
CS_S-veslth1	1.60	-0.0322 **	-2.87	-0.032	-0.0854
MC_L-totsupply	5.98	-0.1002 ***	-7.46	-0.1	-0.0696
CS_S-dprod	2.01	-0.0169 *	-2.1	-0.017	-0.0001
CS_B-typfishmerch	2.04	0.0328 **	3.04	0.033	0.0899
CS_B-typmong	1.53	0.0445 **	3.37	0.046	0.1227
CS_B-typtrans	1.40	0.0381 *	2.14	0.039	0.1047
CS_B-expsfd	1.51	0.0192 *	2.01	0.019	0.0521
CS_B-dpurch	1.22	-0.0202 ***	-3.95	-0.02	-0.0001
R^2		0.4625			

Table C3a. Descriptive statistics – MA_3 (10016 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	-	2.09	0.14	1.7	2.88
MC_N-totsupply	log	154.7	51.23	2.45	246.96
TC_mth1	dum	0.11	0.31	0	1
TC_mth2	dum	0.12	0.32	0	1
TC_mth3	dum	0.2	0.4	0	1
TC_d6	dum	0	0.04	0	1
MC_B-nb	norm	62.27	25.28	1	103
MC_B-dilrate	log	54.19	24.67	0.77	76.15
TC_typauct	dum	0.91	0.29	0	1
MC_impvol	log	7.38	1.04	5.74	9.39
CS_S-nbvesown	norm	1.16	0.51	1	4
CS_S-dep4	dum	0.02	0.15	0	1
MC_L-totsupply	log	94311.42	35577.79	427	131208
CS_S-dprod	log	754.76	361.9	21	3077
CS_B-typmong	dum	0.04	0.2	0	1
CS_B-impsfd	dum	0.21	0.41	0	1
CS_B-deprate	log	70.93	35.46	0.74	100

Tableau C3b. Estimation results – MA_3 (10016 obs.)

Variable	VIF	β	t-stat	ME	MP
cons	-	2.169 ***	-	-	-
MC_N-totsupply	3.05	-0.0281 ***	-10.61	-0.028	-0.0004
TC_mth1	1.41	-0.0502 ***	-25.78	-0.049	-0.1023
TC_mth2	3.25	-0.0455 ***	-12.44	-0.044	-0.093
TC_mth3	1.64	-0.0414 ***	-23.35	-0.041	-0.0846
TC_d6	1.04	-0.0578 ***	-10.6	-0.056	-0.1174
MC_B-nb	3.99	0.0005 ***	10.55	2.485	0.001
MC_B-dilrate	1.31	-0.011 ***	-11.26	-0.011	-0.0004
TC_typauct	1.23	0.0148 ***	6.89	0.015	0.0312
MC_impvol	3.68	-0.062 ***	-5.87	-0.062	-0.0175
CS_S-nbvesown	1.01	0.0028 *	2.27	0.012	0.0059
CS_S-dep4	1.02	0.0087 †	1.83	0.009	0.0183
MC_L-totsupply	3.86	-0.0093 ***	-5.53	-0.009	-0.0000002
CS_S-dprod	1.06	0.0056 ***	4.35	0.006	0.00002
CS_B-typmong	1.36	0.0199 ***	4.05	0.02	0.042
CS_B-impsfd	2.91	-0.0068 *	-2.26	-0.007	-0.0141
CS_B-deprate	3.14	-0.01 ***	-6.88	-0.01	-0.0003
R^2		0.1856			

Table C4a. Descriptive statistics – MA_4 (1332 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	-	2.31	0.29	1.5	3.58
MC_N-totsupply	log	128.67	63.96	2.32	280.46
TC_mth4	dum	0.07	0.25	0	1
TC_mth11	dum	0.23	0.42	0	1
TC_mth12	dum	0.26	0.44	0	1
TC_d2	dum	0.18	0.39	0	1
MC_S-dilrate	norm	45.65	22.9	0.74	80
TC_typauct	dum	0.41	0.49	0	1
CS_S-veslth1	dum	0.07	0.25	0	1
CS_S-nbvesown	log	1.09	0.4	1	3
MC_L-totsupply	log	30157.36	38140.28	180	129945
CS_S-dprod	log	1963.51	2610.16	50	17073
CS_S-fidlot	log	24.9	25.1	0.23	100
CS_B-impsfd	dum	0.3	0.46	0	1
CS_B-deprate	log	61.04	39.14	2.6	99.28
CS_B-fidvol	log	12.38	17.39	0.03	63.63

Table C4b. Estimation results – MA_4 (1332 obs.)

Variable	VIF	β	t-stat	ME	MP
cons	-	1.131 ***	15.16	-	-
MC_N-totsupply	1.97	-0.0253 ***	-4.05	-0.025	-0.0005
TC_mth4	1.83	0.1716 ***	8.82	0.187	0.4322
TC_mth11	1.32	0.1133 ***	20.16	0.12	0.277
TC_mth12	1.52	0.0491 ***	6.63	0.05	0.1163
TC_d2	1.09	0.0183 *	2.21	0.018	0.0425
MC_S-dilrate	1.79	0.0006 ***	3.77	0.817	0.0013
TC_typauct	2.84	-0.0267 **	-3.24	-0.026	-0.0609
CS_S-veslth1	1.99	0.0379 *	2.54	0.039	0.0893
CS_S-nbvesown	1.12	-0.0964 ***	-7.63	-0.096	-0.205
MC_L-totsupply	5.39	-0.0182 ***	-3.53	-0.018	-0.0014
CS_S-dprod	2.60	0.0091 †	1.9	0.009	0.00001
CS_S-fidlot	2.76	0.0077 *	2.31	0.008	0.0007
CS_B-impsfd	1.43	0.012 †	1.88	0.012	0.028
CS_B-deprate	1.43	0.0084 **	3.07	0.008	0.0003
CS_B-fidvol	2.41	-0.0119 ***	-4.68	-0.012	-0.0022
R^2		0.4141			

Table C5a. Descriptive statistics – MA_5 (4004 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	-	2.43	0.55	1.78	4.49
MC_N-totsupply	log	103.92	62.96	3.52	280.46
TC_mth1	dum	0.13	0.34	0	1
TC_mth2	dum	0.15	0.35	0	1
TC_mth3	dum	0.17	0.37	0	1
TC_mth10	dum	0.14	0.35	0	1
TC_mth12	dum	0.16	0.37	0	1
MC_S-nb	log	8.28	3.04	1	14
TC_typauct	dum	0.95	0.22	0	1
CS_S-veslth2	dum	0.33	0.47	0	1
CS_S-poopbn	dum	0.76	0.43	0	1
MC_L-totsupply	log	9091.91	6259.5	78	27067
CS_S-dpartprod	norm	18.99	16.33	0.04	100
CS_S-dprodsold	norm	91.52	22.95	3.43	100
CS_S-fidlot	log	5.64	4.83	0.21	25.24
CS_B-typfishmerch	dum	0.5	0.5	0	1
CS_B-expsfd	dum	0.42	0.49	0	1
CS_B-dpartpurch	log	11.49	12.56	0.08	100
CS_B-fidvol	log	6.42	6.37	0.01	100

Table C5b. Estimation results – MA_5 (4004 obs.)

Variable	VIF	β	t-stat	ME	MP
cons	-	2.8007 ***	45.14	-	-
MC_N-totsupply	1.29	-0.0553 ***	-15.05	-0.055	-0.0013
TC_mth1	1.45	-0.2299 ***	-27.17	-0.205	-0.4995
TC_mth2	1.50	-0.1842 ***	-23.39	-0.168	-0.4091
TC_mth3	1.53	-0.1471 ***	-18.6	-0.137	-0.3326
TC_mth10	1.44	-0.2200 ***	-27.05	-0.197	-0.4802
TC_mth12	1.57	-0.0793 ***	-8.22	-0.076	-0.1853
MC_S-nb	4.33	0.0646 ***	5.2	0.065	0.019
TC_typauct	1.07	-0.0283 *	-2.08	-0.028	-0.0678
CS_S-veslth2	1.22	0.0151 **	2.6	0.015	0.0371
CS_S-poopbn	1.16	0.0138 *	2.3	0.014	0.0339
MC_L-totsupply	3.85	-0.1409 ***	-20.26	-0.141	-0.0377
CS_S-dpartprod	2.46	-0.0017 ***	-7.21	0.467	-0.0042
CS_S-dprodsold	1.28	-0.0004 **	-3.27	1.171	-0.0009
CS_S-fidlot	1.79	0.0269 ***	7.88	0.027	0.0116
CS_B-typfishmerch	1.32	0.0612 ***	11.11	0.063	0.1535
CS_B-expsfd	1.24	0.0328 ***	5.88	0.033	0.0811
CS_B-dpartpurch	1.66	-0.0060 *	-2.5	-0.006	-0.0023
CS_B-fidvol	1.49	-0.0060 *	-2.54	-0.006	-0.0023
R^2		0.482			

Table C6a. Descriptive statistics – MA_6 (7635 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	-	2.82	0.73	1.5	6.75
TC_mth1	dum	0.22	0.42	0	1
TC_mth2	dum	0.15	0.36	0	1
TC_mth3	dum	0.14	0.35	0	1
TC_mth5	dum	0.02	0.13	0	1
TC_mth10	dum	0.07	0.25	0	1
TC_d1	dum	0.06	0.24	0	1
TC_d6	dum	0.02	0.13	0	1
MC_S-nb	norm	30.73	15.11	1	58
MC_B-nb	norm	28.61	7.85	1	42
TC_typauct	dum	0.96	0.19	0	1
TC_qual2	dum	0.01	0.08	0	1
TC_cat1	dum	0.13	0.34	0	1
CS_S-veslthmet	dum	13.72	1.92	8.98	17.89
CS_S-vespow	log	224.19	62.89	78	346
CS_S-ageowner2	dum	0.07	0.26	0	1
CS_S-ageowner3	dum	0.05	0.22	0	1
CS_S-ageowner4	dum	0.16	0.37	0	1
CS_S-ageowner5	dum	0.22	0.42	0	1
CS_S-ageowner8	dum	0.1	0.3	0	1
CS_S-ageowner10	dum	0.01	0.11	0	1
CS_S-ageowner11	dum	0.06	0.23	0	1
CS_S-pocme	dum	0.02	0.14	0	1
CS_S-pocob	dum	0.02	0.14	0	1
CS_S-poopbn	dum	0.85	0.36	0	1
CS_S-dep6	dum	0.01	0.08	0	1
CS_S-deprate	log	87.31	16.45	1.88	100
MC_L-totsupply	log	38226.85	24587.4	392	166971
CS_S-fidlot	norm	7.8	9.73	0.14	100
CS_B-typwsaler	dum	0.05	0.22	0	1
CS_B-typmong	dum	0.21	0.4	0	1
CS_B-expsfd	dum	0.51	0.5	0	1
CS_B-dep1	dum	0.17	0.38	0	1

Table C6b. Estimation results – MA_6 (7635 obs.)

Variable	VIF	β	t-stat	ME	MP
cons	-	1.8052 ***	21.26	-	-
TC_mth1	1.37	-0.0530 ***	-7.83	-0.052	-0.1458
TC_mth2	1.33	-0.1360 ***	-21.5	-0.127	-0.3591
TC_mth3	1.37	-0.0972 ***	-13.43	-0.093	-0.2616
TC_mth5	1.27	-0.1651 ***	-12.81	-0.152	-0.4297
TC_mth10	1.26	-0.1188 ***	-13.2	-0.112	-0.3164
TC_d1	1.37	-0.1058 ***	-11.03	-0.1	-0.2835
TC_d6	1.18	-0.2040 ***	-12.45	-0.185	-0.5212
MC_S-nb	4.89	0.0013 **	3.42	1.503	0.0036
MC_B-nb	3.62	-0.0019 **	-3.18	1.036	-0.0055
TC_typauct	1.49	0.1068 ***	8.56	0.113	0.3182
TC_qual2	1.10	-0.1281 ***	-4.47	-0.12	-0.3396
TC_cat1	1.52	-0.1856 ***	-28.93	-0.169	-0.4785
CS_S-veslthmet	3.07	-0.0126 ***	-5.87	-0.013	-0.0357
CS_S-vespow	3.38	0.0755 ***	5.26	0.076	0.001
CS_S-ageowner2	1.56	-0.0609 ***	-5.44	-0.059	-0.1669
CS_S-ageowner3	1.26	-0.0342 **	-3.28	-0.034	-0.095
CS_S-ageowner4	1.44	-0.0178 *	-2.25	-0.018	-0.0499
CS_S-ageowner5	1.45	-0.0210 **	-3.07	-0.021	-0.0586
CS_S-ageowner8	1.34	-0.0184 *	-2.08	-0.018	-0.0514
CS_S-ageowner10	1.06	0.0428 *	2.16	0.044	0.1236
CS_S-ageowner11	1.18	-0.0389 ***	-3.5	-0.038	-0.1077
CS_S-pocme	1.35	-0.0539 **	-3.1	-0.052	-0.1482
CS_S-pocob	1.29	-0.083 ***	-5.32	-0.08	-0.225
CS_S-poopbn	1.81	-0.0463 ***	-4.69	-0.045	-0.1277
CS_S-dep6	1.09	-0.0776 ***	-5.12	-0.075	-0.211
CS_S-deprate	1.09	-0.0167 *	-2.48	-0.017	-0.0005
MC_L-totsupply	3.57	-0.0896 ***	-16.05	-0.09	-0.00001
CS_S-fidlot	1.34	0.0013 ***	5.32	0.105	0.0037
CS_B-typwsaler	1.11	-0.0474 ***	-4.61	-0.046	-0.1307
CS_B-typmong	1.09	0.0377 ***	6.09	0.038	0.1084
CS_B-expsfd	1.19	0.0501 ***	9.77	0.051	0.1451
CS_B-dep1	1.09	-0.0246 ***	-4.24	-0.024	-0.0687
R^2		0.2019			

Table C7a. Descriptive statistics – MA_7 (4274 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	-	2.65	0.55	1.66	5.94
TC_mth1	dum	0.14	0.35	0	1
TC_mth2	dum	0.09	0.28	0	1
TC_mth4	dum	0.08	0.28	0	1
TC_mth5	dum	0.04	0.19	0	1
TC_mth11	dum	0.18	0.38	0	1
TC_mth12	dum	0.17	0.37	0	1
TC_d1	dum	0.14	0.35	0	1
TC_d2	dum	0.16	0.37	0	1
TC_d3	dum	0.22	0.41	0	1
TC_d4	dum	0.18	0.39	0	1
MC_S-nb	log	13.32	6.16	1	26
MC_S-dilrate	log	33.56	14.75	0.61	54.27
TC_typauct	dum	0.87	0.34	0	1
CS_S-pocme	dum	0.01	0.12	0	1
CS_S-pofnord	dum	0.82	0.38	0	1
MC_L-totsupply	log	18686.44	10534.34	204	56235
CS_B-typmong	dum	0.22	0.42	0	1
CS_B-impsfd	dum	0.38	0.48	0	1
CS_B-deprate	norm	45.62	23.79	0.15	100
CS_B-dpartpurch	log	16.39	18.71	0.05	100
CS_B-fidvol	log	8.01	9.36	0.01	100

Table C7b. Estimation results – MA_7 (4274 obs.)

Variable	VIF	β	t-stat	ME	MP
cons	-	1.7296 ***	26.21	-	-
TC_mth1	1.33	0.1275 ***	19.27	0.136	0.3607
TC_mth2	1.27	0.0233 **	2.98	0.024	0.0624
TC_mth4	1.36	0.114 ***	12.23	0.121	0.3201
TC_mth5	1.15	0.0819 ***	9.56	0.085	0.2263
TC_mth11	1.37	0.0489 ***	6.73	0.05	0.1329
TC_mth12	1.44	0.0694 ***	8.31	0.072	0.1905
TC_d1	1.40	0.0286 ***	3.49	0.029	0.077
TC_d2	1.35	0.0275 ***	4.1	0.028	0.0738
TC_d3	1.44	0.0347 ***	5.54	0.035	0.0937
TC_d4	1.38	0.0246 **	3.38	0.025	0.066
MC_S-nb	5.53	-0.0261 **	-2.77	-0.026	-0.0052
MC_S-dilrate	1.68	0.0189 ***	4.2	0.019	0.0015
TC_typauct	1.20	0.0407 ***	6.77	0.042	0.1102
CS_S-pocme	1.19	-0.0667 ***	-3.74	-0.065	-0.1711
CS_S-pofnord	1.23	-0.0294 ***	-3.95	-0.029	-0.0769
MC_L-totsupply	5.24	-0.0817 ***	-9.7	-0.082	-0.0116
CS_B-typmong	1.80	-0.0462 ***	-6.31	-0.045	-0.1198
CS_B-impsfd	1.75	-0.0813 ***	-11.82	-0.078	-0.2069
CS_B-deprate	1.71	-0.0004 **	-3.26	0.78	-0.0011
CS_B-dpartpurch	2.48	0.004 †	1.69	0.004	0.0006
CS_B-fidvol	1.72	-0.0116 ***	-5.28	-0.012	-0.0038
R^2		0.3487			

Table C8a. Descriptive statistics – MA_8 (3591 obs.)

Variable	Type	Mean	Std. Dev.	Min	Max
ppu	-	3.02	0.53	1.8	5.11
MC_N-totsupply	log	101.74	70.38	2.5	280.46
TC_mth1	dum	0.13	0.33	0	1
TC_mth2	dum	0.12	0.33	0	1
TC_mth3	dum	0.14	0.35	0	1
TC_mth5	dum	0.04	0.19	0	1
TC_mth10	dum	0.15	0.35	0	1
TC_mth11	dum	0.18	0.38	0	1
TC_mth12	dum	0.19	0.39	0	1
TC_d3	dum	0.27	0.44	0	1
TC_d5	dum	0.18	0.38	0	1
MC_B-dilrate	norm	48.18	21.95	0.67	79.19
TC_typauct	dum	0.56	0.5	0	1
TC_cat3	dum	0.64	0.48	0	1
CS_S-pomber	dum	0.99	0.09	0	1
CS_S-deprate	log	90.28	11.49	10.56	100
MC_L-totsupply	log	6323.03	3328.24	180	16198
CS_S-dpartprod	log	26.03	21.76	0.48	100
CS_S-fidvol	norm	5.03	4.73	0.03	26.97
CS_B-typtrans	dum	0.09	0.29	0	1
CS_B-impsfd	dum	0.44	0.5	0	1
CS_B-dpartpurch	log	8.02	8.73	0.2	100

Table C8b. Estimation results – MA_8 (3591 obs.)

Variable	VIF	β		t-stat	ME	MP
cons	-	2.3074	***	31.5	-	-
MC_N-totsupply	1.89	-0.0374	***	-12.48	-0.037	-0.0011
TC_mth1	3.03	-0.0735	***	-7.7	-0.071	-0.2139
TC_mth2	2.95	-0.1461	***	-16.17	-0.136	-0.4103
TC_mth3	3.28	-0.1536	***	-17.02	-0.142	-0.4297
TC_mth5	1.78	-0.1475	***	-12.94	-0.137	-0.4139
TC_mth10	3.83	-0.2891	***	-26.21	-0.251	-0.7577
TC_mth11	4.29	-0.1314	***	-12.22	-0.123	-0.3715
TC_mth12	4.70	-0.1004	***	-9.12	-0.096	-0.2882
TC_d3	1.66	0.0631	***	11.25	0.065	0.1967
TC_d5	1.21	0.0528	***	9.01	0.054	0.1636
MC_B-dilrate	1.47	0.0006	***	5.37	0.708	0.0018
TC_typauct	1.13	0.0208	***	4.96	0.021	0.0634
TC_cat3	1.06	-0.0274	***	-6.32	-0.027	-0.0815
CS_S-pomber	1.03	0.126	***	6.71	0.134	0.4054
CS_S-deprate	1.32	-0.0337	**	-3.14	-0.034	-0.0011
MC_L-totsupply	2.26	-0.0775	***	-14.55	-0.078	-0.037
CS_S-dpartprod	1.70	0.012	***	3.87	0.012	0.0014
CS_S-fidvol	1.70	-0.0022	***	-4.26	0.086	-0.0067
CS_B-typtrans	1.07	0.0157	*	2.16	0.016	0.0477
CS_B-impsfd	1.20	-0.0236	***	-5.28	-0.023	-0.0703
CS_B-dpartpurch	1.73	-0.0213	***	-8.76	-0.021	-0.008
R^2		0.5319				

Table D. Endogeneity tests of endogenous regressors and overidentification tests of all instruments.

MA_1			MA_2			MA_3			MA_4		
	Tests			Tests			Tests			Tests	
Variables	Hausman	Hansen	Variables	Hausman	Hansen	Variables	Hausman	Hansen	Variables	Hausman	Hansen
MC_N-totsupply	0.484	0.058	MC_S-nb	0.025	1.587	MC_N-totsupply	0.528	0.754	MC_N-totsupply	0.442	0.120
	0.4864	*0.8099*		*0.8734*	*0.2077*		*0.4673*	*0.3851*		*0.5061*	*0.7290*
MC_S-nb	0.280	0.133	MC_B-dilrate	0.011	1.141	MC_B-nb	1.163	0.099	MC_S-dilrate	0.390	0.168
	0.5967	*0.7151*		*0.9181*	*0.2855*		*0.2809*	*0.7527*		*0.5325*	*0.6822*
MC_S-dilrate	0.074	0.473	MC_L-totsupply	0.007	1.603	MC_B-dilrate	0.936	0.366	CS_S-nbvesown	0.338	0.220
	0.7850	*0.4914*		*0.9349*	*0.2054*		*0.3333*	*0.5450*		*0.5612*	*0.6387*
MC_B-dilrate	0.167	0.359	CS_S-dprod	0.081	1.641	MC_impvol	0.934	0.367	MC_L-totsupply	0.546	0.007
	0.6826	*0.5489*		*0.7762*	*0.2002*		*0.3339*	*0.5444*		*0.4598*	*0.9348*
CS_S-deprate	0.104	0.444	CS_B-dpurch	0.786	0.497	CS_S-nbvesown	0.450	0.769	CS_S-dprod	0.556	0.001
	0.7468	*0.5050*		*0.3752*	*0.4810*		*0.5022*	*0.3804*		*0.4559*	*0.9745*
CS_S-dprod	0.122	0.426				MC_L-totsupply	1.255	0.035	CS_S-fidlot	0.408	0.148
	0.7272	*0.5141*					*0.2626*	*0.8523*		*0.5230*	*0.7009*
CS_S-fidvol	0.229	0.313				CS_S-dprod	0.228	1.056	CS_B-deprate	0.084	0.437
	0.6325	*0.5759*					*0.6327*	*0.3041*		*0.7717*	*0.5087*
CS_B-deprate	0.186	0.293				CS_B-deprate	0.973	0.322	CS_B-fidvol	0.557	0.000
	0.6663	*0.5881*					*0.3239*	*0.5706*		*0.4556*	*0.9848*
CS_B-fidvol	0.548	0.000									
	0.4590	*0.9849*									

Table D. (Continued)

MA_5		
	Tests	
Variables	Hausman	Hansen
MC_N-totsupply	1.113 *0.2914*	0.109 *0.7408*
MC_S-nb	1.567 *0.2107*	0.095 *0.7581*
MC_L-totsupply	1.633 *0.2012*	0.039 *0.8436*
CS_S-dpartprod	0.060 *0.8065*	1.610 *0.2045*
CS_S-dprodsold	0.347 *0.5556*	0.870 *0.3509*
CS_S-fidlot	0.601 *0.4384*	1.058 *0.3037*
CS_B-dpartpurch	0.725 *0.3946*	0.936 *0.3333*
CS_B-fidvol	0.729 *0.3931*	0.921 *0.3372*

MA_6		
	Tests	
Variables	Hausman	Hansen
MC_S-nb	0.064 *0.7996*	0.848 *0.3572*
MC_B-nb	0.821 *0.3650*	0.080 *0.7779*
CS_S-veslthmet	0.002 *0.9618*	0.912 *0.3397*
CS_S-vespow	0.648 *0.4210*	0.266 *0.6060*
CS_S-deprate	0.219 *0.6400*	0.695 *0.4043*
MC_L-totsupply	0.540 *0.4623*	0.367 *0.5447*
CS_S-fidlot	0.492 *0.4830*	0.414 *0.5200*

MA_7		
	Tests	
Variables	Hausman	Hansen
MC_S-nb	0.080 *0.7769*	1.120 *0.2899*
MC_S-dilrate	0.606 *0.4362*	0.698 *0.4034*
MC_L-totsupply	0.018 *0.8923*	1.239 *0.2656*
CS_B-dpartpurch	0.913 *0.3394*	0.138 *0.7101*
CS_B-fidvol	1.062 *0.3028*	0.219 *0.6395*

MA_8		
	Tests	
Variables	Hausman	Hansen
MC_N-totsupply	2.093 *0.1480*	0.392 *0.5314*
MC_B-dilrate	0.094 *0.7588*	2.175 *0.1403*
CS_S-deprate	0.921 *0.3371*	1.942 *0.1635*
MC_L-totsupply	0.038 *0.8454*	2.516 *0.1127*
CS_S-dpartprod	0.085 *0.7709*	2.301 *0.1293*
CS_S-fidvol	2.141 *0.1435*	0.530 *0.4667*
CS_B-dpartpurch	0.416 *0.5191*	2.437 *0.1185*