WORKING PAPER : Differences in selling mechanisms, differences in prices: the case of the Boulogne s/mer fish market

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Abstract

The Boulogne s/ mer fish market is organized through two different sub-markets: a negotiated one and an auction one. People can freely choose where to sell their merchandize. First empirical results show that the same species of fish are sold in more or less the same amount of quantities on both markets, and that the distribution of the prices transactions slightly differs from a sub-market to the other.

keywords: fish market, price dispersion, micro data analysis

J.E.L. codes: L1, L2, D8, G24

1 Introduction

Milgrom (2004) show how the differences in prices mechanisms can drive very different outcomes. Clearly, markets designs matter, and our paper seeks to understand the role and the influence of two different sale mechanisms, *i.e*

*Acknowledgments:

auctions and pairwise, on the markets results in terms of prices and quantities exchanged. The influence of different trade mechanisms on the market outcome has been largely emphasized in the economic literature and two important questions are considered, one comparing different auctions mechanisms, an other one comparing auction mechanisms and pairwise exchanges. As far as we know, when the literature concerning the comparison between different types of auctions is quite huge, very few studies concern the comparison between auctions and pairwise transactions.

Moreover, the results are not all going in the same way, suggesting that domination conditions depend on something more than simple price formation mechanisms. The interactions between the agents, the interactions between the agents and the organization, the consequences of the characteristics of the goods on the agents behavior influence the outcomes of the market. Milgrom (1986) and Milgrom (2004) show that auctions are more favorable to sellers than to buyers in the sense that they absorb the whole buyers surplus. This result has been reinforced by Bulow & Klemperer (1996) who demonstrates that the auction is always preferable when bidders' signals are independent. More recently, some results, mostly based on empirical or experimental evidence weaken the idea of auction dominance. Progrebna (2006) reports on a natural experiment in the British television show, Bargain Hunt, which offers a good opportunity to compare bilateral bargaining with auctions. It appears that auction prices are lower than negotiated prices. Kirman & Moulet (2009) compares two forms of market, a auction one and a negotiated one. They show, through simulation, that, if the auction is more interesting for "rich buyers", the one with the higher reservation prices, the negotiated market allows "poor buyers" to purchase. These evidences are more in line with the studies developed by the literature in financial markets. Viswanathan & Wang (2002) observe that on stock markets, small orders get executed via a limit-order book and large orders get executed via a dealership market. Considering the links between market architecture and behavioral ecology, Bottazzi et al. (2005) highlight the role of the institutional setting in the dynamic of prices determination but also suggest that this dynamic can result of a complicated interaction between the trading protocol and the ecology of traders behaviors.

The fish market has a long tradition in the economic literature. Thornton (1869) observed that the equilibrium price differs whether the fish is sold through English or Dutch auctions. Many authors refer to it when they want to investigate the organization of exchanges, no matter whether they are dealing with equilibrium or disequilibrium. This market constitutes a kind of economic paradox in the sense that, in a lot of cases, at first glance, one could conclude that these markets are pure competitive markets. They

are constituted by a a large enough number of sellers to avoid collusion, a huge number of buyers, it always exists a collective place of transaction and exchanges are carrying out in a very short time-period. There are no barriers to enter this market (traditionally, fish boats can sell their merchandise where ever they want, they only have to pay taxes on the fish sold). But the empirical analyzes always reveal strong price dispersion for homogeneous or very similar goods. There exist two main explanations to this surprising recurrent observation. A first way consists in exploring the individual learning process or adaptation strategies, as in Arthur (1989), Tedeschi et al. (2009) or Mignot et al. (2012). A second one takes into account the characteristics specific to the market, as the fact that it is a daily one and that people knows each other. Under these conditions the influence of social interactions and social network prevail.

The Boulogne s/mer fish market is organized in a very particular way. The transactions can be done both through an auction mechanism or through a negotiated one. When both buyers and sellers arrive on this market to transact, they have the choice to fully act through the auction mechanism, fully act through a negotiated mechanism or adopting something like a "mixed strategy" partly behaving on one market, partly on the other. Once chosen, they cannot revise their strategies until the following day. First empirical results reveal that this organization is a stable one and this looks like a paradox.

This article seeks to understand this stable co-existence through empirical analysis and agent-based models.

In a first step, it presents the main stylized facts of the empirical market, extracted from the database. it shows that the stable behavior found at the aggregate level is nowhere to be found at the individual level. Agents continuously switch from one market to the other, and each seller has a preference for one (or the other) selling mechanism. Furthermore, a price difference is shown. Some goods are sold at a higher price on the negotiated (respectively auction) market than on the auction (respectively negotiated) market.

After putting into evidence those facts, it proposes a very general agent-based model, where agents (buyers as well as sellers) can choose to trade through an auction mechanism or a negotiated one. This model is able to reproduce the main empirical stylized facts of the market. When the goods are homogeneous, the co-existence of the two markets is not stable and the negotiated segment quickly disappears. An hypothesis of heterogeneous goods is needed to replicate the stable coexistence of the two sub-markets despite the apparently erratic behavior of agents trading in them. Two kind of goods are introduced, one more common than the other. Each sellers

having mainly on of those kinds of goods to sell. With those settings the sub-markets coexistence is reproduced, as well as individual behaviors.

A second model is then introduced, keeping the two kind of goods and sellers, where agents can create commercial relationships between them. When the agents can create links on both markets, the bilateral segment soon disappears. When agents are only allowed to build these links on the negotiated market the co-existence is stable. Clearly, the possibility of establishing commercial relationships gives an advantage and this compensate the lack of efficiency for the pairwise mechanism compare to the auction ones. This advantage allows us to reproduce the coexistence of the two selling mechanism, each having a distinct advantage that benefits more to a different kind of good.

The rest of the paper is organized as follows: the section 2 of this paper presents the main statistical results, the section 3 presents an agent-based model when the agents adapt their strategies according to the types of goods they wish to sell. The section 4 presents the agent-based model with commercial relationships, The conclusion follows.

2 Empirical features

The Boulogne fish market is the most important one in France, in terms of quantities. It is situated in the North of France, near the Belgium frontier. Boats which lay down their fish come from France but also from other countries (mainly from Great Britain and Holland). 200 boats are registered in this market, that we will consider as sellers in what follows. 100 buyers purchase regularly, most of them present on both sub-markets. This market is opened 6 days a week: every day, sellers can decide of their strategies (going on one market or on both of them). Once they have decided, they can't change their strategy until the next market day. This section presents the main descriptive features. The database we use concerns two years (2006-2007) and represents 300000 daily transactions. For each transaction, the date, the type and characteristics (size, presentation, quality) of the fish exchanged, the buyers and sellers' identity, the type of trade mechanism (auction or negotiated), the quantity exchanged and the transaction price are known.

The analysis of the database tells a story of heterogeneity. On this market, sellers are very different in terms of quantities offered and in terms of quality of the products

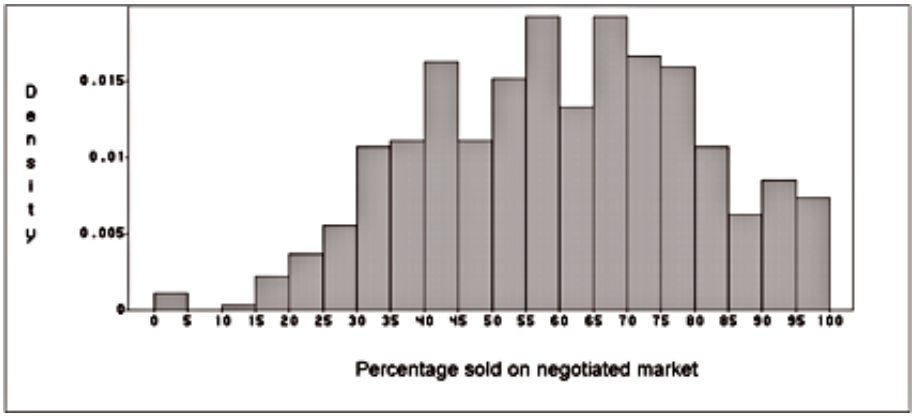

Figure 1: **The negotiated market**: This graph exhibits the distribution of the part of the production sold on the negotiated market. Significant percentages of the production are sold on both markets each day.

The two sub-markets (auctions and negotiated) have an equal importance: first analysis reveal that the same people are transacting on these two "sub-markets" and that the same types of fish are sold through both mechanisms. The trades concern 80 species of fish. Between 37% and 54% of each of the four main fish species are sold on the auction market which suggests an equivalent distribution of the production between the two market mechanisms. The figure 1 clearly shows that significant percentages of the production are traded on both markets each day. 19000 tons are sold through auctions while 24000 tons are exchanged through the negotiated market. Around 60% of the transactions are made per year, on the negotiated market and this proportion is stable through the period considered. This proportion stays more or less the same when one considers the quantities 63% or the value 66%. If the aggregate behavior exhibits a stable repartition over days through the two sub markets, our study shows further that most of the individuals switch over time from one market to the other.

Figure 2 displays the percentage of the average quantity played on the negotiated market.

The Augmented Dickey-Fuller test for unit root rejects the null hypothesis , meaning that the process is also stable. The lagged level of the series $t-1$, thus, provides some relevant information in predicting the change in t.

Moreover, to analyze the co-movement between the daily quantities sold in the negotiated and those sold in the auction, we have studied the correlation between these quantities. A significant positive correlation (+0.52) demonstrates the co-movement and the stability of this aggregate relation. In other words, when the whole quantity increases, the quantities played on

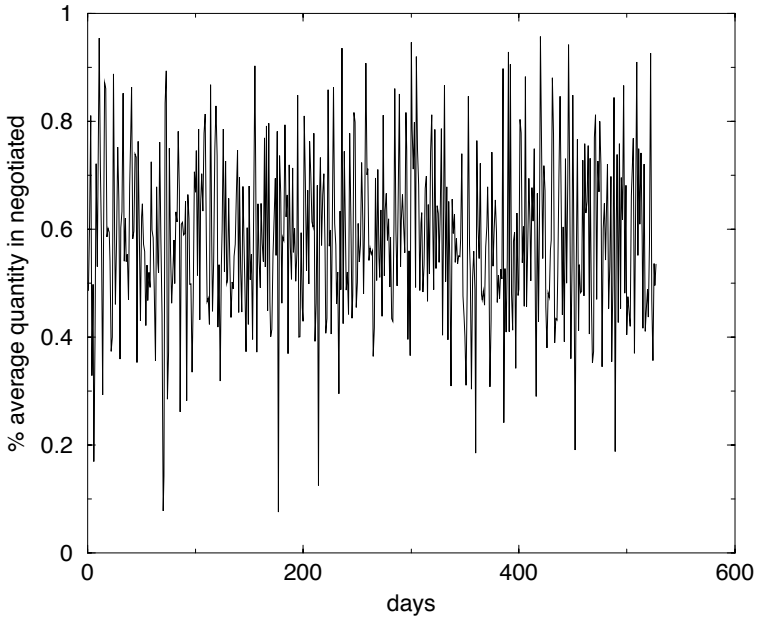

Figure 2: Percentage of the average quantity on the negotiated market.

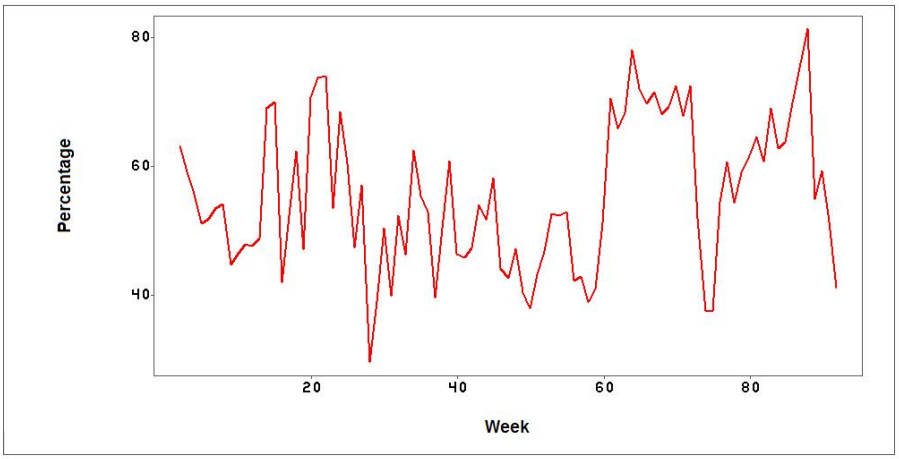

Figure 3: **The negotiated market**: This graph exhibits the percentage of the quantity sold on the negotiated market each week.

each market increase in absolute value. Instead, looking at the individual

level we find very different behaviors.

In Figure (3) we look at the percentage of the quantity sold on negotiated market each week, in order to remove weekly effects, and reduce the influence of 'extreme' days where very small quantities are sold.

2.1 The switching

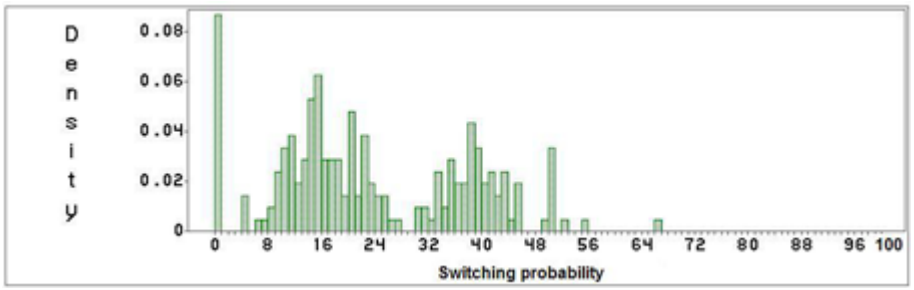

Figure 4: Distribution of switching probability of sellers

Figure 4 represents the distribution of the probability to switch from a market system to the other, that is to say the probability for a seller to put the majority of his product on one market one day, and on the other market the next time they come.
We can observe three peaks in the distribution, each representing one sellers' group. The ones that never switch are the sellers that only came a very small number of times on the market, and consequently did not have the opportunity to switch. Then we have two groups: the more 'switching' one is composed of the boats selling mainly on auctions, and the more stable one of the sellers going mainly on the negotiated market.

Figure 5 shows the percentage of the average quantity sold on the negotiated market by two generic fishermen[1]. What is clear is the heterogeneity of the individual strategies. While the fisherman j (right side) plays mainly on the negotiated market, the agent i (left side) is more switching between the two sub-markets.

Choosing the sales mechanism (auction or negotiated) seems to be a strategic tool for sellers. Figure 6 reveals that among the biggest sellers,

[1]We show the percentage of the average quantity for sellers 644073 (left side) and 87 (right side). *However we have investigated this behavior for 20 agents selected randomly, finding heterogeneous characteristics.*

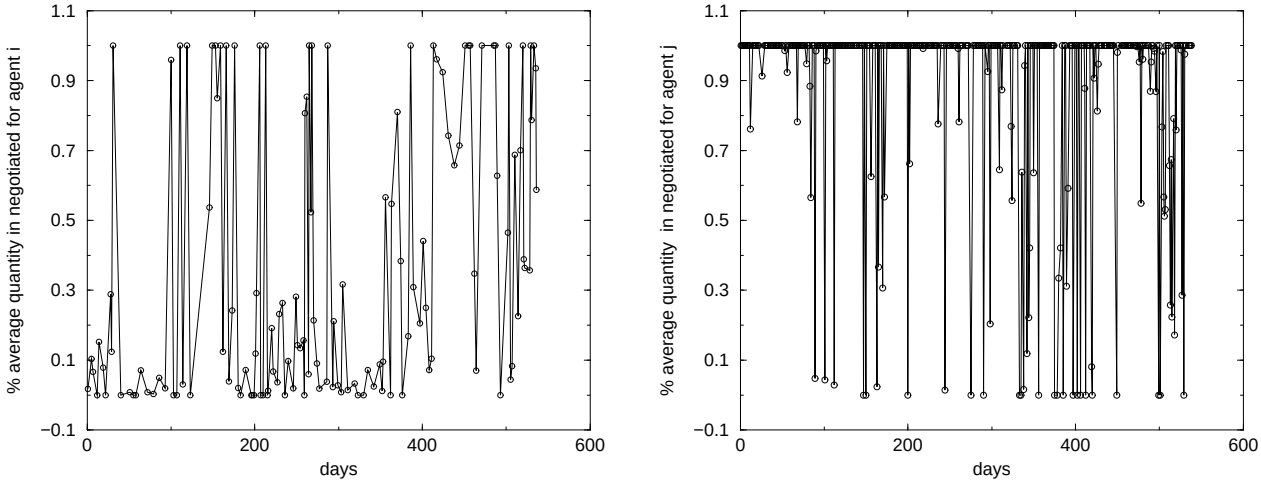

Figure 5: Percentage of the quantity on the negotiated market for two different sellers.

two main strategies dominate, one which consists to sell mostly on the negotiated market, another one which consists to sell less than 45% on this market.

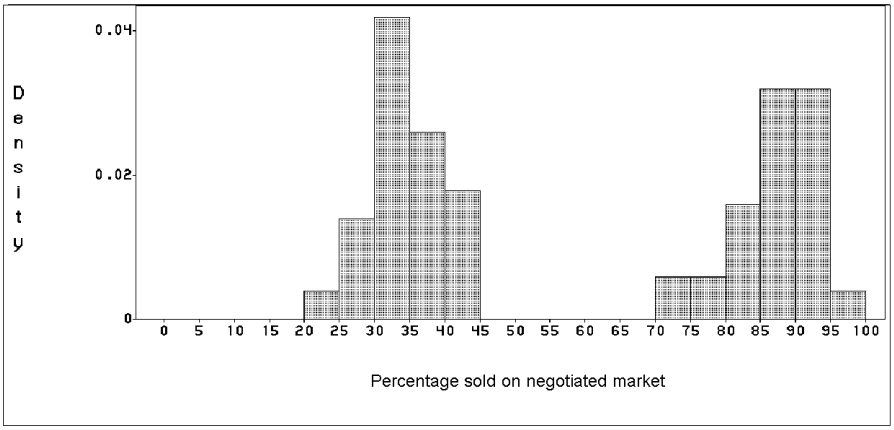

Figure 6: **The negotiated market**: distribution of quantities purchased by the 100 biggest sellers on each market. Two mains strategies dominate, selling mostly on the negotiated market, or selling less than 45% on this market.

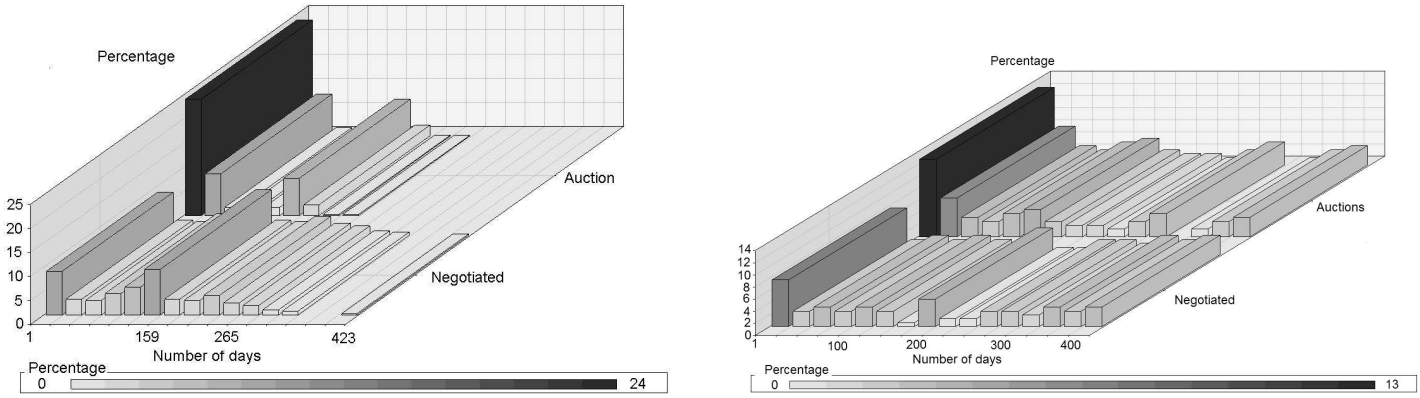

Figure 7: Frequency of sellers (left side) and buyers (right side)presence on each market.

When we look at the presence of both sellers and buyers on the two sub markets (cf. Figure 7), what can be observed is that there are more people playing rarely on the auction market than on the negotiated one (especially on the sellers side). This could indicate a need to come often on the negotiated market to be efficient on it, a need that does not exist on the other market. This evidence seems in line with what some papers in financial literature claim, the auction organization being more efficient for less informed agents (cf. Viswanathan & Wang (2002))

We have now observed that the sellers adopt different strategies, some mainly selling on the auction market, some mainly selling on the negotiated market and most of them switching from one market to the other. Two important questions are, first to understand what determines the choice of the main market, then to explain the switching process.

2.2 Characteristics of prices distributions

This section explores the particularities of the two prices distributions (the one on the auction market, the other one on the negotiated market) in the aim to better understand what drives the fishermen strategies.

The price index used in this paper corresponds to a classic Paasche index.

	Auction Market	Negotiated Market
kurtosis	9.7	11.9
skewness	2.33	2.67
Median	2.43	2.46
St.Dev	1.06	1.39

Table 1: Daily prices descriptive statistics for sellers going mainly on auctions

For each day t it is calculated :

$$\hat{P}_t = \sum_{i=1}^{i=N} (p_i(\frac{q_i}{\sum_{i=1}^{i=N}(q_i)})) \tag{1}$$

p_i being the unit price of one transaction, q_i the quantity sold in this transaction, and N the number of transaction made on this day.

The prices distributions are analyzed on the two markets, separately for each group of sellers. The ones selling mainly on auctions and the ones mainly on negotiated as seen on figure (6). The analysis is driven for all the transactions daily prices, which means that the goods are heterogeneous. Figures (8) and (9) show the distribution for the two markets and for each group.

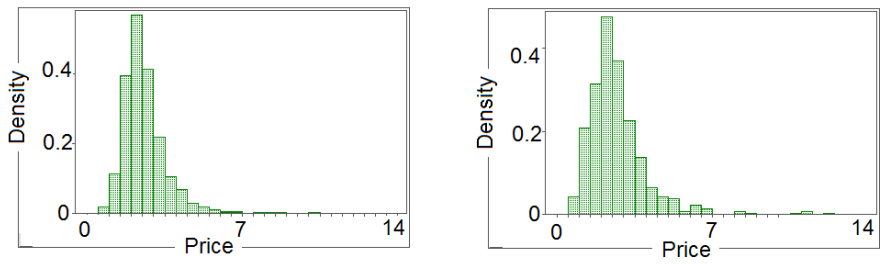

Figure 8: Price distributions on auction (left) and negotiated (right) markets for sellers going mainly on auctions

When it comes to sellers that put the majority of their products on the auction market it can be observed (table 1) that the median price is slightly higher for them on the negotiated market, but with a higher standard deviation and skewness indicating higher volatility and rarer large gain events,

	Auction Market	Negotiated Market
kurtosis	2.02	4.0
skewness	1.45	1.39
Median	3.23	3.32
St.Dev	2.76	1.46

Table 2: Daily prices descriptive statistics for sellers going mainly on negotiated

making the decision to go to this market riskier. It is then clear that at least for risk-adverse agents, going on the auction market can be a better strategy.

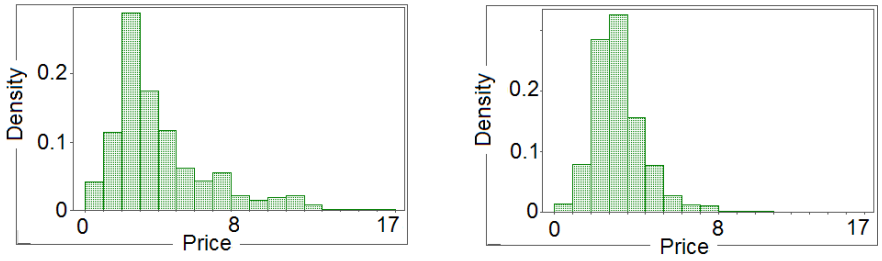

Figure 9: Price distributions on auction (left) and negotiated (right) markets for sellers going mainly on negotiated

Otherwise, for sellers going mainly on negotiated, it can be observed in table 2 that the median price is slightly higher on the negotiated market, when the skewness and the standard deviation are higher on the auction market. Less risky and insuring slightly higher expected prices, the negotiated market is here more interesting.

2.3 The goods

Defining the three families of goods. We can divide the different species of fishes into three families. In the first one are represented all species without a significant difference between the two sub-markets in term of daily prices. This family represents 20000 Tons of fishes, with 56% of them sold on the negotiated market.

In the second one the species sold at a higher price one the auction market. the quantities are pretty similar, 19000 Tons, with 52% sold on negotiated.

And in the last one, are all species sold, on average, at a higher price on the negotiated market. The quantities are smaller, 4200 Tons, mainly sold one the negotiated market : 74%

–	"auction type" family	"negotiated type" family	"neutral type" family
Average	3,71	7,51	2,96
Median	2,3	3,5	1,99
Std dev	3,65	6,94	3,04
Quantities	19000	4200	20000
Repartition	52%	74%	56%

Table 3: three "families" of species. the quantities are in Tons, and the repartition is the percentage sold on the negotiated market.

The empirical study has now suggest that, concerning the sellers, going on one market or the other clearly results from a strategic choice. For some of them, going on the auction market is more interesting than going on the negotiated while the inverse is true for some others. Despite of this evidence, we also have pointed out that most of the fishermen switch from a market to the other. The section 3 proposes an artificial agent based model to show how this switching, which can seem erratic at a micro point of view allow a stable macro behaviour.

3 Agent based model

3.1 The design

3.1.1 The sellers

We have $j = 1, .., n$ sellers playing at each time step.
they are defined by :

- A supply of rare goods : $Q_{r,j}$;
- A supply of common goods : $Q_{c,j}$;
- An expected price for rare goods on the negotiated market : $\hat{P^n_{r,j,t}}$;
- An expected price for common goods on the negotiated market : $\hat{P^n_{c,j,t}}$;
- An expected price for rare goods on the auction market : $\hat{P^a_{r,j,t}}$;

- An expected price for common goods on the auction market : $\hat{P^a_{c,j,t}}$.

At each time step, sellers estimate their profit on each market using the information available to them. Their choice s made in function of the difference, in term of profits, between the two submarkets, they will tend to go where the expected profit is higher.

This expected profit is defined as : the quantity of good available (of each kind of good) times by the expected price for each of them 3.1.1.

$$Pr_j^{neg} = (Q_{r,j} * \hat{P^n_{r,j,t}}) + (Q_{c,j} * \hat{P^n_{c,j,t}}) \text{ Expected profit on the negotiated market.} \quad (2)$$

$$Pr_j^{auc} = (Q_{r,j} * \hat{P^a_{r,j,t}}) + (Q_{c,j} * \hat{P^a_{c,j,t}}) \text{ Expected profit on the auction market.} \quad (3)$$

If a seller goes on the negotiated market, his expected price is the one he will ask buyers in exhange of his goods.

We divide our sellers into two groups in order to fit the empirical facts. On selling mainly rare goods, and the other common goods.

3.1.2 The buyers

We have $j = 1, .., n$ buyer playing at each time-step.

They have a reservation price for each kind of good, defined as follow: 4, 5

$$r_{j,r} = 2 * x_{i,r} + 2 \quad with\ 0 < x_{i,r} < 1 \quad (4)$$

ith $x_{i,c}$ an idiosyncratic variable.

$$r_{j,c} = x_{i,c} + 1 \quad with\ 0 < x_{i,c} < 1 \quad (5)$$

with $x_{i,c}$ an idiosyncratic variable.

Buyers are also defined by :

- A demand for rare goods : $D_{r,i}$
- A demand for common goods : $D_{c,i}$
- An expected price on the negotiated market for rare goods : $\hat{P^n_{r,i,t}}$
- An expected price on the negotiated market for common goods : $\hat{P^n_{c,i,t}}$

- An expected price on the auction market for rare goods: $\hat{P^a_{r,i,t}}$
- An expected price on the auction market for common goods : $\hat{P^a_{c,i,t}}$

Buyer are acting in the opposite way of the sellers, going where the expected prices are the lower for the goods they are looking for. Their goal is to minimize their costs.

$$C_j^{neg} = (D_{r,j} * \hat{P^n_{r,i,t}}) + (D_{c,j} * \hat{P^n_{c,i,t}}) \text{ expected cost on the negotiated market.} \quad (6)$$

$$C_j^{auc} = (D_{r,j} * \hat{P^a_{r,i,t}}) + (D_{c,j} * \hat{P^a_{c,i,t}}) \text{ expected cost on the auction market.} \quad (7)$$

Any transaction done by a buyer has to be done at a price below his reservation price.

3.1.3 The market

The market is working in a way described in the figure Fig:10 :

At each time-step, each seller decide which market he is going to use. To do this, he begins by calculating a ratio between the two sub-markets to decide which one is more interesting for him.

$$R_{j,t} = \frac{P_j^{auc} - P_j^{neg}}{(P_j^{auc} + P_j^{neg})} \quad (8)$$

We obtain an index comprised between -1 and 1, -1 corresponding to a price infinitely superior on the negotiated market, and 1 a price infinitely superior on the auction market (and 0 if price is the same on both sub-markets).

Then sellers choose the market they will use in a probabilistic way. If $R_{j,t} = 0$ (same profit on each market), the choice will be made at random, with a probability of 50% to go on one market or the other. $R_{j,t} = 1$ (respectively -1) meaning a probability of 100% to go to the auctions (respectively the negotiated market).

Once the market chosen by the sellers, the buyers take their decisions. They do so in a similar way as the sellers, except they want to minimize the prices.

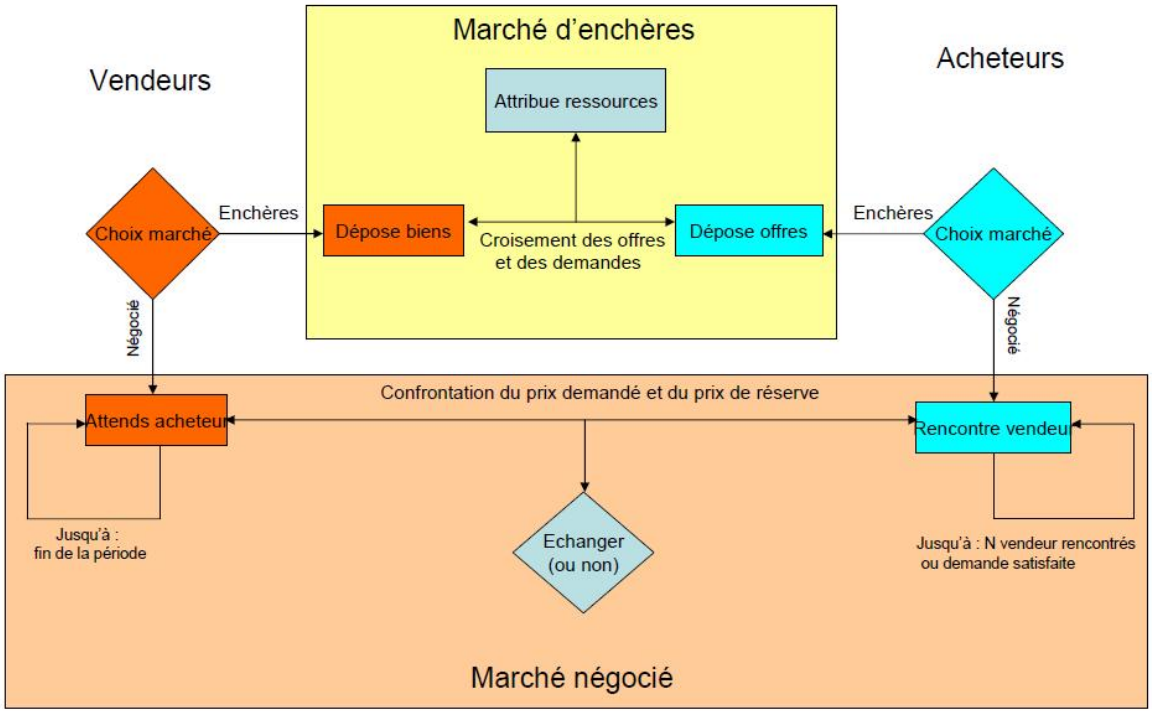

Figure 10: The model

$$R_{i,t} = \frac{P_i^{neg} - P_i^{auc}}{(P_i^{neg} + P_i^{auc})} \tag{9}$$

Now the market choice has been made for all the agents. From now on their behavior will differ following the market they transact on. We present this behaviors separately, but they take place at the same time.

3.1.4 Auction market

This market is modeled in a very simple way. The reserve prices and demands of the buyers are known, as well as the quantities offered by the sellers. We

just compute the prices for which the offer is equal to the demand for each kind of good.

We obtain a price for scarce good $P^{auc}_{r,t}$ and one for common goods $P^{auc}_{c,t}$.

3.1.5 Negotiated market

The simulated negotiated market is completely different. At each time-step, the following procedure is repeated k times. Each buyer meet a seller and try to transact with him. For each kind of good, if the price asked by the seller is lower or equal to the reserve price of the buyer, the transaction occurs. If the demand of the buyer is not satisfied after meeting k sellers, then he is rationed.

As said before, we suppose that buyers are ready to pay a higher price for scarce goods on the negotiated market . We model this by adding a parameter α_i to the reserve price (for this kind of good) of each buyer i.

3.2 Price dynamic

At the end of each time-step t, agents update their beliefs concerning the prices on both sub-markets (using prices observed in t). This mechanism is different depending on the sub-market chosen by agents. They have not been exposed to the same information.

3.2.1 On the auction market

For agents on the auction market, the updating mechanism is quite simple.

The prices on the auction market are public, so the expected prices of auctions in $t+1$ will simply be the prices observed in t.
The information they have concerning the negotiated market is incomplete. We suppose they only know the average price of each kind of good ($P^n_{r,i,t}$ and $P^n_{c,i,t}$.

$$\hat{P^n_{r,i,t+1}} = P^n_{r,i,t} \tag{10}$$

$$\hat{P^n_{c,i,t+1}} = P^n_{c,i,t} \tag{11}$$

$$\hat{P^a_{r,i,t+1}} = P^a_{r,i,t} \tag{12}$$

$$\hat{P^a_{c,i,t}} + 1 = P^a_{c,i,t} \tag{13}$$

3.2.2 On the negotiated market

Here the situation is quite different. The agents present on the negotiated market have as much information on the auction market (the information is public), but also have more accurate informations about the negotiated market.

Each sellers has been able to observe directly the demand corresponding to his own reserve price, and can update his beliefs increasing his price of his individual demand was superior to his supply, decreasing it otherwise.

$$\hat{P^n_{r,i,t+1}} = \hat{P^n_{r,i,t}} * (1 + \lambda * \tanh \frac{\sum_{i=1}^{n}(D_{r,i}) - Q_{r,i}}{Q_{r,i}}) \tag{14}$$

$$\hat{P^n_{c,i,t+1}} = \hat{P^n_{c,i,t}} * (1 + \lambda * \tanh \frac{\sum_{i=1}^{n}(D_{c,i}) - Q_{c,i}}{Q_{c,i}}) \tag{15}$$

$$\hat{P^a_{r,i,t+1}} = P^a_{r,i,t} \tag{16}$$

$$\hat{P^a_{c,i,t}} + 1 = P^a_{c,i,t} \tag{17}$$

Concerning buyers, they have no interest in using their observed prices instead of the average price. So their update is the same as the one used on the auction market.

3.3 The general model

If we suppose that all the sellers have only one kind of goods (common goods, the quantities of rare goods beeing fixed at zero), then the simulations results shows a fast convergence of the quantities on the auction market. There is only a residual quantity left (average 6%) due to the probabilistic nature of the decision making.

As we can see, this does not reproduce at all the studied empirical market

3.4 The importance of the goods characteristics

So now we introduce a second kind of good. A good that will be sold at a higher price one the negotiated market.

The parameters used in the simulation fits the ones observed on the real market. We use 200 sellers and 100 buyers.

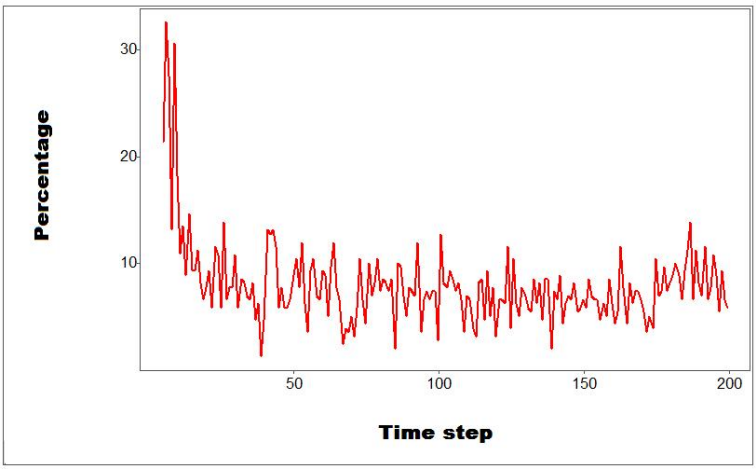

Figure 11: Percentage of the quantities on the simulated negotiated market.

We divide our sellers into two groups of 100 agents. Like on the real market, the first group has mainly rare goods to sell, and the second common goods.

The individual supply of the sellers of the first group are randomly uniformly generated in the interval $S_{i,r} \in [100, 200]$ for the rare goods and $S_{i,c} \in [50, 100]$ for common goods.

Concerning the second group, the goods are distributed in the intervals $S_{i,r} \in [50, 100]$ for rare goods and $S_{i,c} \in [200, 400]$ for common goods.

Individual demands of the sellers are distributed in the interval $D_j \in [150, 300]$ for both kind of good. It means that the global demand is the same for both kind of goods, but with very different supplies.

The number of sellers a buyer can meet every day is $k = 3$. γ is equal to 0.1.
We show the results of the simulation for a period of 200 time-steps.

The results are coherent with the empirical analysis. We reproduce the four stylized facts :

- A bimodal distribution of agents, specializing in one market or the other;
- A constant switching between each sub-market, more or less frequent following agents' and markets' characteristics;
- A stable coexistence of the two sub-markets;

- Prices differences for a same good on each sub-market.

3.4.1 Coexistence

We can observe that this coexistence exist in this model (12). Each sub-market attracting mainly on kind of population. The proportion sold on the negotiated market at the equilibrium is of no importance and can be modified through the parameters. What is important is the stability of the coexistence of both markets.

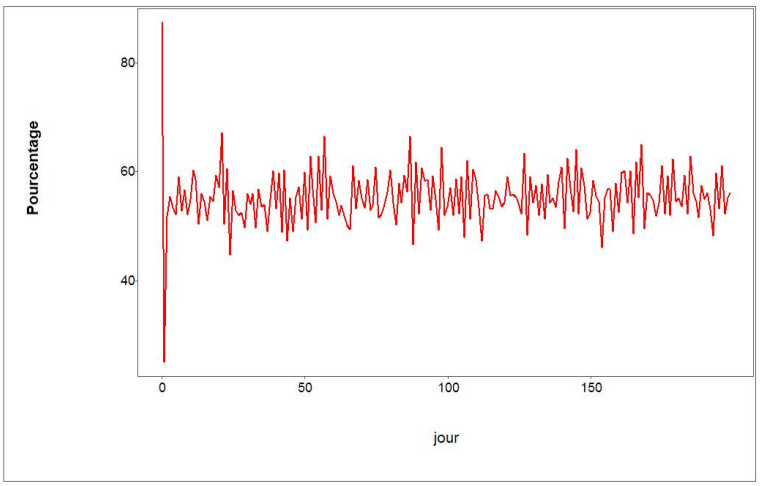

Figure 12: Percentage sold on the negotiated simulated market.

3.4.2 Bimodal distribution

If we look at the distribution of the proportion sold through the negotiated mechanism (13), we observe a bimodal distribution. Sellers having mainly rare goods going more to the negotiated market, and sellers having mainly common goods going more to the auction market.

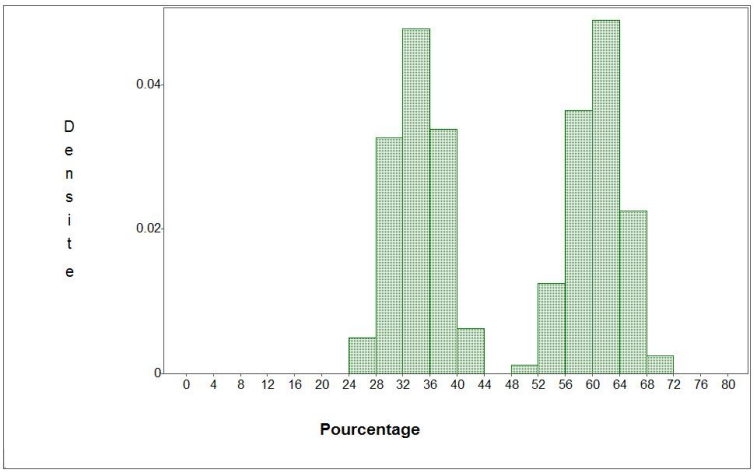

Figure 13: Distribution of the proportion put on the negotiated market by each seller.

3.4.3 switching

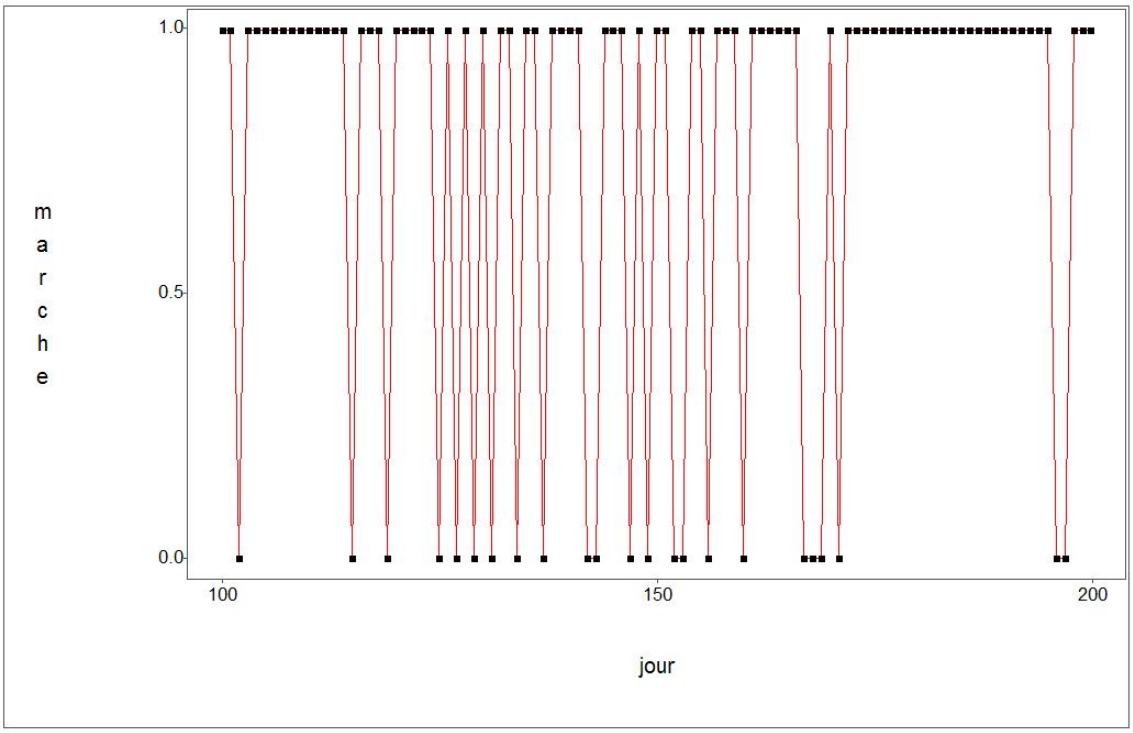

Figure 14: Switching from one market to the other for a seller chosen at random.

We also check is the sellers switch from one market tot the other. Even if they have a preference toward a market, they all use both of them (14).

3.4.4 Prices differences for homogenous goods.

Here we check that we obtain significant price differences between each selling mechanism for the same type of good. The common goods are sold at a higher price one the auction market, and the rare goods at a higher price one the negotiated market.

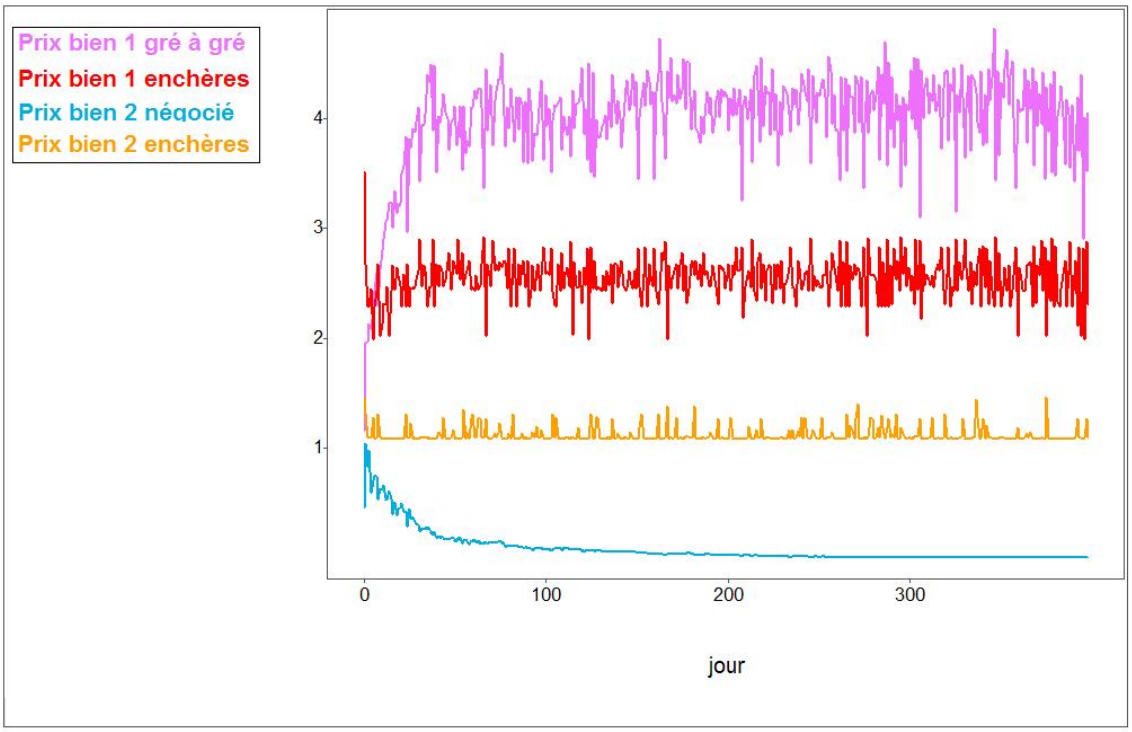

Figure 15: Prices for the two kinds of goods on each submarket.

The model presented above is able to reproduce the stylized facts observed at the empirical level. But to do so we had to include a strong hypothesis, saying that buyers are ready to pay more for rare goods on the negotiated market. We extend the model to remove the need for this hypothesis, adding social networks.

4 Social networks

We add a system allowing agents to create links between them. They will allow sellers to exchange first with buyers they are linked with, at predetermined prices.

The reasoning is :
Paying the competitive price on the auction market comes with the risk of not obtaining enough rare goods. Agents don't know the distribution of the reserve prices, nor the quantities that will be sold on each market. One solution for buyers needing this kind of goods (and being rich enough) is to create a contract with a seller, buying all his rare goods everyday, at a price superior to the average auction price. If the seller is specialized in this kind of good, the increased earnings might decide him to choose the negotiated market in spite of the probable low price he will get for his common goods, in respect of the one he could have obtained on the auction market. If it is attractive for both a buyer and a seller, a link is created between them.

4.1 The design

The model is the same as the one described before, be we ad the possibility for buyers and sellers to create links between them, and remove the hypothesis that, for some kind of goods, buyers are ready to pay more one the negotiated market.

4.1.1 The agents

The agents are defined in the same way as before. The difference is that, if a buyer and a seller decide to create a link between them, both of them will then have to go on the negotiated market so that they can transact together.

4.1.2 Link creation mechanism

A link is created between a buyer and a seller if the two following conditions are met.

On the seller side : The expected profit one the negotiated market if the link is created must be superior to then expected profit on the negotiated market.

$$\text{if } ((Q_{r,j} * P^{\hat{a}}_{r,j,t}) + (Q_{c,j} * P^{\hat{a}}_{c,j,t})) <$$
$$(((Q_{r,j} - Q_{r,j,i}) * P^{\hat{a}}_{r,j,t}) + ((Q_{c,j} - Q_{c,j,i}) * P^{\hat{a}}_{c,j,t}) + (Q_{r,j,i} * P_{r,i}) + (Q_{c,j,i} * P_{c,i}))$$

Then the seller j will want to create a link with the buyer i.

With $Q_{r,j,i}$ the quantity of rare goods asked by the buyer i to the seller j, at the price $P_{r,i}$ and $Q_{c,j,i}$ the quantity of common goods asked by the buyer i to the seller j, at the price $P_{c,i}$

on the buyer side : The supply of the seller must at least be equal to half the demand of rare goods of the buyer.

4.2 The influence of selling mechanisms on the creation of links

Once we introduce this link creation mechanism, The results obtained fits well with empirical facts observed :

4.2.1 Coexistence

This model is able to reproduce the coexistence of the two selling mechanism, with proportions of sold quantities equivalent to the ones observed on the real market (16).

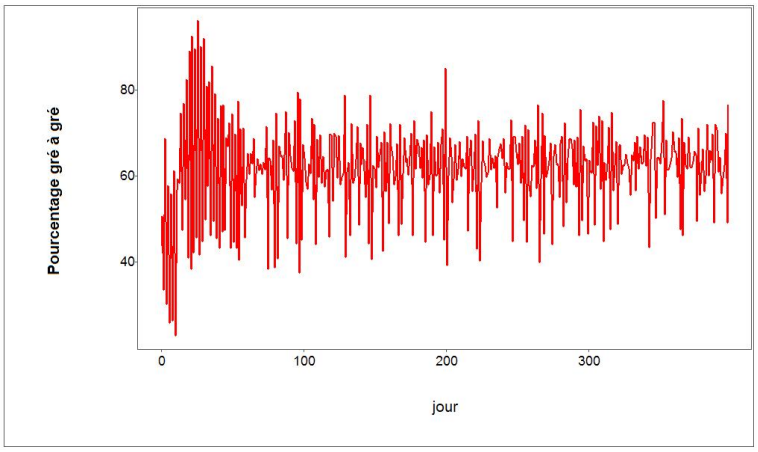

Figure 16: Percentage of the quantities on the negotiated simulated market.
0

After a learning period where the proportion fluctuate greatly, we obtain a stable equilibrium.

4.2.2 Bimodal distribution

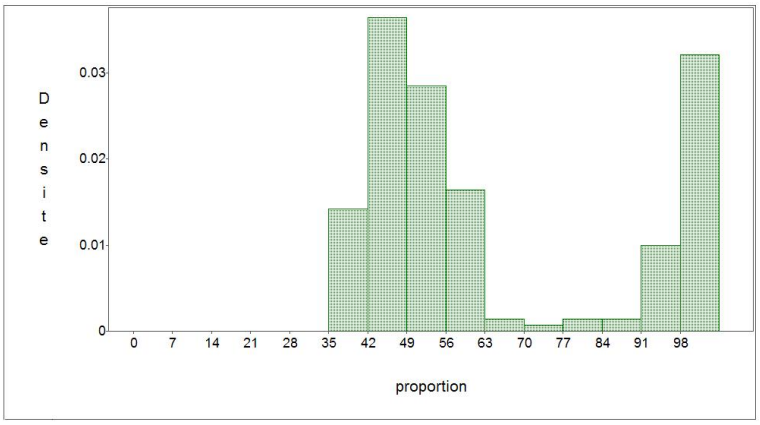

Figure 17: Distribution of proportion sold on the negotiated market per seller.

We show here the existence of two different behaviors for the sellers. With one group going mainly on the auction market, and the other on the negotiated market (17).

4.2.3 switching

In this model the switching disappear for the sellers that created contracts with buyers. This happens because,to simplify the model, we don't allow the contracts to be renegotiated. As a consequence sellers creating a contract will stay on the negotiated market until the end of the period.

4.2.4 Price differences for homogenous goods

The results show a significant price difference for the same kind of goods between the two sub-markets. The rare goods being sold at a higher price on the negotiated market and the common goods at a higher price on the auction market [2].

[2]The significance of the price differences is confirmed by a t-test.

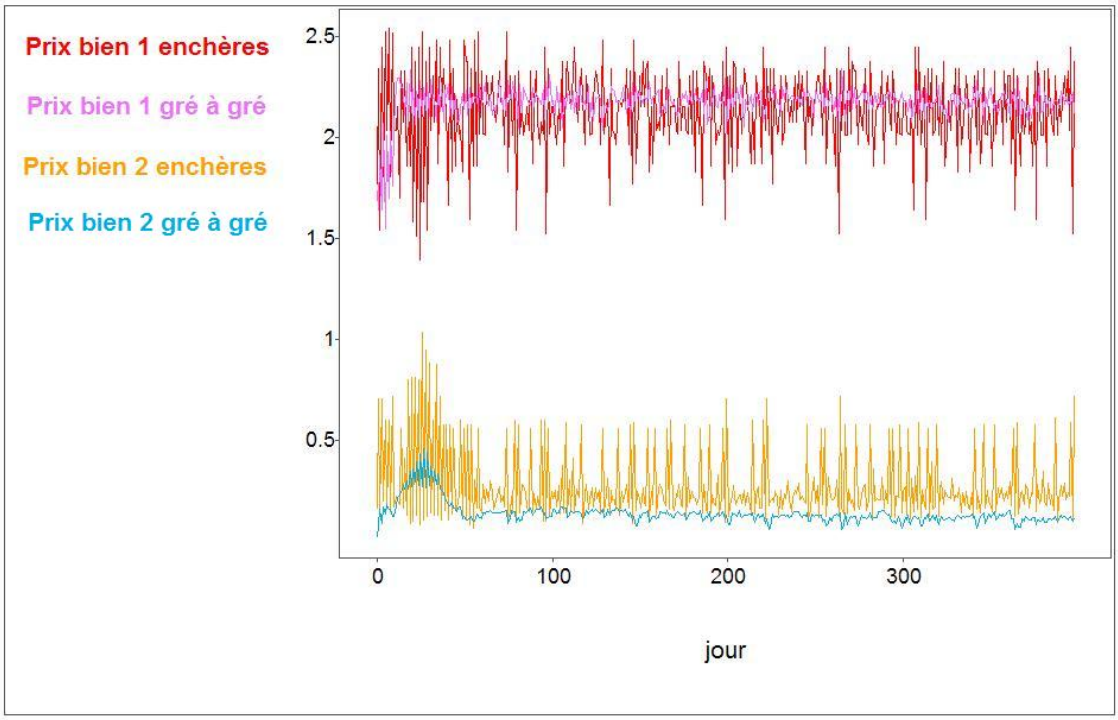

Figure 18: Evolution of prices for each kind of goods on each sub-market.

5 Conclusion

We have presented a model able to reproduce the main stylized facts of the Boulogne-sur-Mer fish market. Taking into account risk aversion, heterogeneity of goods and of agents allows us to explain those prices differences between the two sub-markets, and the coexistence of the two selling mechanism.

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