The local effects of an innovation: Evidence from the French fish market

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ONLINE APPENDIX

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Appendix A. Additional results at the transaction level

In this appendix, we give a few additional descriptive statistics obtained with our transaction data that help to better comprehend changes in catches when some vessels are equipped with the new fishing gear.

Table Ap1 reports descriptive statistics on the proportion of fish and number of transactions by species before and after the introduction of the innovation. In particular, Panel A shows that there are very important changes in the composition of species fished by treated vessels after the innovation is introduced. By contrast, fish composition remains stable for matched control vessels. In particular, the difference in the proportion of red mullet between treated and matched control vessels increases by 17.1 percentage points, whereas the increase is 12.9 percentage points for mackerel and 12.3 percentage points for whiting.

[Insert Table Ap1]

Figure Ap1 represents the daily fish price per kilogram around the date at which the innovation is introduced separately for treated and matched control vessels by species. We consider the five species which have the largest contribution to total quantity fished by treated vessels over the period. By decreasing order of importance, those species are mackerel (340.3 tons), red mullet (268.1 tons), whiting (224.2 tons), squid (177.8 tons) and cuttlefish (140.8 tons). We exclude albacore (205.7 tons) because tuna catches are highly seasonal and require specific permits. Figures are commented in the main text.

[Insert Figure Ap1]

Appendix B. Results at the fish market level

In this Appendix, we give all the details on our study of the effects of the introduction of the innovation on the treated market. We present our aggregate data at the fish market level, our empirical strategy and comment the results that are presented in the main text as well as additional ones.

B1. Data

We evaluate the overall effect of the innovation in Les Sables d'Olonne using an aggregate dataset that spans from July 2009 to June 2011, in which the observation unit is a fish market in a given month. In 2010, there were 40 fish markets in France among which 34 were localized on the Atlantic coast. As there are sizable differences in prices and species between the Atlantic and Mediterranean coasts (Gobillon and Wolff, 2016), we limit the sample to fish markets on the Atlantic coast. Specifically, we consider the 31 fish markets for which there are transactions every month for the five main species during the period and this sample includes the treated market of Les Sables d'Olonne. Data contain information on the overall fish quantity involved in transactions on the fish market, its market value, composition by species, and the proportion of high-quality fish. Fish price per kilogram is computed as the ratio between value and quantity.

Figure Ap2.A represents the proportions of high-quality fish for Les Sables d'Olonne and the other fish markets on the Atlantic Coast. These proportions are rather similar before the innovation is introduced. The gap in quality is for instance at most 5 percentage points between November 2009 and March 2010. By contrast, quality in the treated market becomes much larger after the innovation is introduced. There is a sizable difference in the proportion of high-quality fish with other markets every month over the period after treatment. From July to November 2010, this difference increases from 5.7 to 25.3 percentage points and then decreases to around 10 percentage points. It then climbs again to reach 28 percentage points in March 2011 and decreases again. These variations in the quality difference could be related to seasonality effects such that the composition of caught species varies over time. In particular, seiners target specific species which may not be available to the same extent every month.

[Insert Figure Ap2]

Interestingly, Figure Ap2.B shows that the fish quantity sold at Les Sables d'Olonne is at the average level of other markets before the innovation is introduced. As expected, it decreases when some vessels are withdrawn from the fleet to be equipped with the new gear, but it then catches up with other fish markets at levels similar to those before the introduction of the innovation. This occurs whereas the fleet in Les Sables d'Olonne involves fewer vessels. As shown in Figure Ap3, this is mostly due to treated vessels catching more fish, but also to a lesser extent to an increase in quantity for matched control vessels. Finally, Figure Ap4 shows that neither Les Sables d'Olonne nor the other fish markets experience a change in the trend of average prices per kilogram after the innovation is introduced.

[Insert Figures Ap3 and Ap4]

B.2 Empirical strategy

We quantify the change in aggregate quality on the treated market in les Sable d'Olonne due to the Danish seine. For that purpose, we contrast the evolution of quality between the treated market and other markets after the innovation is introduced. We begin our analysis with a standard difference-in-differences approach that is valid under the assumption that the evolution for the treated market in the absence of the technological innovation would be the same as the evolution for the non-treated markets. As this assumption might be violated, we then turn to more general specifications that allow for heterogeneity in time trends across markets and estimate factor models involving a dummy for treatment. Nevertheless, estimates are based on extrapolation when the characteristics of the treated market are not in the support of control markets. We therefore confront our results with those obtained by interpolation when using the synthetic control method. We construct a synthetic market as a weighted average of control markets, and contrast the evolutions of quality after treatment between the treated and synthetic control markets.

Difference in differences

We first present the difference-in-differences approach that will be used to obtain first estimates of the treatment effect. Our data consist in a balanced panel of $N = 31$ markets (including Les Sables d'Olonne) and $T = 24$ months. The proportion of high-quality fish in market i at month t is denoted Y_{it} and the treated market is indexed by $i = 1$. The specification is given by:

$$Y_{it} = \delta \mathbb{1}_{\{i=1\}} \mathbb{1}_{\{t \geq \bar{t}\}} + Z_{it}\beta + \upsilon_t + u_i + \varepsilon_{it} \quad \text{(A1)}$$

where $\bar{t}$ is the month during which the new fishing technology is first introduced (ie. March 2011), $\mathbb{1}_{\{i=1\}}$ is a dummy for Les Sables d'Olonne (ie. the treated market), $\mathbb{1}_{\{t \geq \bar{t}\}}$ is a dummy for the date being post treatment, δ is the treatment effect, Z_{it} are some explanatory variables (in practice, the shares of every fish species in total quantity sold on the market), υ_t is a month fixed effect, u_i is a market fixed effect and ε_{it} is a residual. This specification allows for a correlation between market unobserved effects and treatment, and estimations are thus robust to the selection for treatment based on additive time-invariant local factors affecting quality. Nevertheless, selection may rather occur depending on local trends that can be heterogeneous across markets.

Factor models

We thus turn to a more general specification such that the effects of local factors depend on time in a very general way. Indeed, specification (A1) can be augmented with interactions between time fixed effects and market fixed effects such that:

$$Y_{it} = \delta \mathbb{1}_{\{i=1\}} \mathbb{1}_{\{t \geq \bar{t}\}} + Z_{it}\beta + \upsilon_t + u_i + F_t{}'\Lambda_i + \varepsilon_{it} \quad \text{(A2)}$$

where F_t is a $K \times 1$ vector of month fixed effects and Λ_i is a $K \times 1$ vector of market fixed effects. This specification contains not only market fixed effects u_i, but also K series of interactive terms involving market and month fixed effects which may be correlated with treatment. When rewriting the model in first difference, it can be seen that the specification allows for time-specific effects of several unspecified local factors on the evolution of fish quality. Specification (A2) can be estimated with least squares provided that some constraints are imposed on month and market fixed effects to ensure identification (Bai, 2009).

Synthetic controls

We also apply the synthetic controls method by computing the treatment effect as the difference in post-treatment quality between the treated market and a synthetic control market with similar characteristics and pre-treatment quality. This synthetic market is constructed as a weighted average of other markets that are used as control markets (Abadie and Gardeazabal, 2003; Abadie et al., 2010). Weights are comprised in the unit interval and the treatment effect is thus estimated using an interpolation of control markets. The synthetic control approach can be contrasted with factor models which allow for extrapolation. In case of support issues, results obtained with synthetic controls can differ from those obtained with factor models (see Gobillon and Magnac, 2016).

More precisely, denote by $Z_i = (Y_{i1}, \dots, Y_{i\bar{t}-1}, X_{i1}, \dots, X_{iT})'$ the set of pre-treatment qualities, measured by the proportions of high-quality fish at every date before treatment, and all the realizations of explanatory variables at all dates. The synthetic controls method consists in solving the following minimization program:

$$\min_{\omega_j | \omega_j \geq 0, \sum_{j=2}^{N} \omega_j = 1} \left(\sum_{j=2}^{N} \omega_j Z_j - Z_i \right)' W \left(\sum_{j=2}^{N} \omega_j Z_j - Z_i \right) \quad \text{(A3)}$$

where W is a symmetric positive matrix. This program leads to the choice of weights ω_j that should be attributed to control markets to obtain a synthetic control market which is similar to the treated market in terms of pre-treatment quality and realizations of explanatory variables at all dates. The matrix W is used to fix the respective influence of pre-treatment quality and realizations of explanatory variables at all dates in determining the weights.[1] Denoting the estimated weights by $\widehat{\omega}_j$, an estimator of the treatment effect is given by:

$$\hat{\theta} = \frac{1}{T - \bar{t} + 1} \sum_{t=\bar{t}}^{T} \left(\sum_{j=2}^{N} \widehat{\omega}_j Y_{jt} - Y_{1t} \right) \quad \text{(A4)}$$

[1] In our application, the vector Z_i contains 8 values for the pre-treatment quality and 144 values for the proportions of our five main species and the "others" category at all dates. Hence, matrix W is of dimension 152 x 152. It is fixed such that the contributions of pre-treatment quality and composition by species are respectively 80% and 20% when selecting weights. There proportions were chosen such that fish composition has a sizable influence but it is still possible to approximate fish quality before treatment with that of the synthetic control market. The chosen matrix W is diagonal with elements equal to .8/8=.1 for pre-treatment quality values and .2/144=.0014 for values of composition variables. We will also apply the synthetic control approach while omitting composition effects. In that case, matrix W is of dimensions 8 x 8 and it is fixed to be the identity matrix.

A test of nullity of the treatment effect at finite distance can be conducted with a Placebo experiment in which each market is alternatively considered to be fictitiously the treated market (although in reality no treatment is applied) and the treatment effect for that market is computed using the synthetic control approach (see Abadie et al., 2010). This experiment provides a distribution of the treatment effect and one can assess whether the estimate obtained for Les Sables d'Olonne is in the upper right tail of this distribution.

B.3. The effect of the innovation on quality, quantity and prices for the treated market

We now turn to the empirical evaluation of the overall effect of treatment on the market where the innovation was introduced. Our goal is to assess whether there are externalities of the innovation on the non-treated vessels as they may try to improve their fish quality to remain competitive.

We first estimate a standard panel specification of the proportion of high-quality fish in which additive market and month fixed effects are included together with a treatment dummy, which is defined as the interaction between a dummy for being the treated market (Les Sables d'Olonne) and a dummy for being in the March 2010-June 2011 period. Panel A of Table Ap2 shows that, when fish composition is not taken into account, the estimated effect of the innovation is significant and sizable with a value of 16.1 percentage points (column 1). This effect can be explained by the evolution of quality for treated vessels, their significant market share, incentives for other vessels to improve their quality, as well as adjustments of local demand. As expected, it remains nonetheless lower than the increase in the proportion of high-quality fish for treated vessels.

[Insert Table Ap2]

As the treated and control markets might be characterized by different trends in the evolution of quality, we conduct robustness checks by estimating specifications that also include interactive terms involving market and month fixed effects. The estimated treatment effect hardly changes since it takes values between 15.3 and 16.1 percentage points when varying the number of interactive effects that are introduced from 1 to 3 (columns 2-4).[2]

Heterogeneous time trends can also be taken into account with the synthetic control approach in which the treated market is compared to a synthetic control market, constructed as a weighted average of control markets such that pre-treatment quality is similar. As reported in Table Ap3, the synthetic market mostly involves six control markets, the two largest contributions being those of Loctudy (38.9%) and Ile d'Oleron (25.7%). These two fish markets are not located far from Les Sables

[2] Even if there are procedures to determine the right number of factors to be included in the specification (Bai and Ng, 2002; Moon and Weidner, 2015), they would be fragile (Onatski et al., 2013). As a consequence, we rather assessed the robustness of our results by varying the number of factors.

d'Olonne, but they are characterized by very different proportions of high-quality fish (respectively 13.2% and 74.6%).

[Insert Table Ap3]

Figure Ap5 represents the evolution of the difference in quality between the treated and synthetic control markets. It shows that the synthetic market reproduces very well the quality in the treated market every month before treatment. There are variations in the estimated treatment effect over time since it increases until December 2010 before fluctuating negatively or positively. However, we obtain an average estimated treatment effect very close to other estimates at 16.0 percentage points (column 5 of Table Ap2).

[Insert Figure Ap5]

We also conduct a Placebo experiment in which every control market is successively considered fictitiously as treated. We can then assess whether the estimated treatment effect obtained for the treated market is larger than those for the control markets. As the quality before treatment does not fit well for the synthetic control market obtained for some of the control markets, we only retain control markets for which the Root Mean Square Percentage Error (RMSPE) for quality before treatment is lower than five times that of the treated market.[3] The evolution of the difference in quality between each control market and its synthetic control market is represented in part A of Figure Ap6. Overall, the estimated treatment effect is larger for the treated market than for control markets, except during the transition period when treated vessels are successively reintroduced in the vessel fleet with their new equipment.

[Insert Figure Ap6]

We then take into account composition effects with the proportions of the five species most fished by treated vessels and the "others" category as additional controls. Panel B of Table Ap6 shows that the estimated treatment effect obtained with standard panel and factor model approaches is hardly affected. It is equal to 16.7 percentage points when estimating the difference-in-differences specification (column 1) and it oscillates between 15.2 and 18.2 percentage points when estimating factor models (columns 2-4). The synthetic control market now involves nine control markets which are rather different from those obtained when not taking into account the composition of species (see Table Ap3). The estimated treatment effect obtained with the synthetic control method is a bit smaller than other estimates, at 13.5 percentage points (column 5).[4] The reason for this discrepancy

[3] The RMSPE is given by the formula $\frac{1}{\bar{t}-1}\sqrt{\sum_{t=1}^{\bar{t}-1}(y_{it}-y_{it}^{s})^2}$ where y_{it} is the observed quality for treated market i at time t and y_{it}^{s} is the estimated quality for its synthetic control market (see Abadie et al., 2015, p. 502, footnote 16).

[4] Alternatively, we also experimented by considering, for composition variables, the proportions of the nine main species in the volume sold in the treated fish market (along with a residual category). The estimated

is that the quality slightly differs between the treated and synthetic control markets during several months before treatment as shown by Figure Ap5. This occurs because it is not possible to construct a synthetic control market that is similar to the treated market in the dimensions of both pre-treatment quality and composition of species.

As before, we conduct a Placebo experiment and estimate the treatment effect for each control market by contrasting its post-treatment quality with that of a synthetic market as represented in part B of Figure Ap6. This time, we drop control markets for which the RMSPE for the quality before treatment is larger than two times that of the treated market. Indeed, the RMSPE for the treated market is now large due to the differences in quality before treatment between the treated and synthetic control markets.[5] Nevertheless, the results are similar to those obtained when not taking into account the composition of species, since the estimated treatment effect is larger for the treated market than for control markets after the transition period during which treated vessels are reintroduced in the fleet with their new equipment.

Overall, our results suggest that the treatment effect on the quality of the treated market would be comprised between 13.5 and 18.2 percentage points. This effect can be contrasted with the treatment effect obtained under the assumption that there is no spillover from the treated vessels to the non-treated ones. The treatment effect on treated vessels is 33.4 percentage points when considering the non-treated vessels in Les Sables d'Olonne as controls. Provided that 16.5% of transactions in the treated fish market involve treated vessels, this yields a treatment effect on the treated market if there was no spillover effect which is around 33.4*0.165=5.5 percentage points. This effect is smaller than the one we estimated from our market data, which suggests that spillover effects are significant.

Finally, we quantified the treatment effect on quantity and prices on the treated market. Interestingly, Table Ap4 shows that the innovation has no significant effect on quantity and the magnitude of the estimated treatment effect is rather small whether or not fish composition is taken into account.[6] As six trawlers were withdrawn from the fleet, it means that other vessels caught more fish consistently with the fleet adaptation plan of local authorities. Descriptive statistics suggest that it is was mostly control vessels that increased their quantity, but it is not possible to determine

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treatment effect is very similar. It is 16.8 percentage points when estimating the difference-in-differences specification, it ranges from 16.0 to 19.0 percentage points when estimating factors models, and it amounts to 12.6 percentage points when using the synthetic control method.

[5] When fish composition is not taken into account, the RMSPE is equal to 0.0047 for the treated market of Les Sables d'Olonne. The maximal RMSPE allowed for the placebo analysis is thus 5*0.0047=0.0235. When taking the fish composition into account, the RMSPE for les Sables d'Olonne is 0.0391 and we include in the placebo analysis only fish markets whose RMSPE is at most 2*0.0391=0.0782.

[6] An exception is the estimated coefficient obtained with the synthetic control approach when fish composition is not taken into account since the estimated coefficient is negative and not small (-0.118). But differences in the results between the synthetic control and panel approaches can be explained by support issues.

whether this occurred because they fished more intensively at their usual spots, they caught additional fish at spots where withdrawn trawlers used to fish, or they caught additional fish at new spots. Table Ap5 in Appendix shows that the estimated treatment effect on prices is always insignificant, whether or not fish composition and quality grades are taken into account.[7]

References

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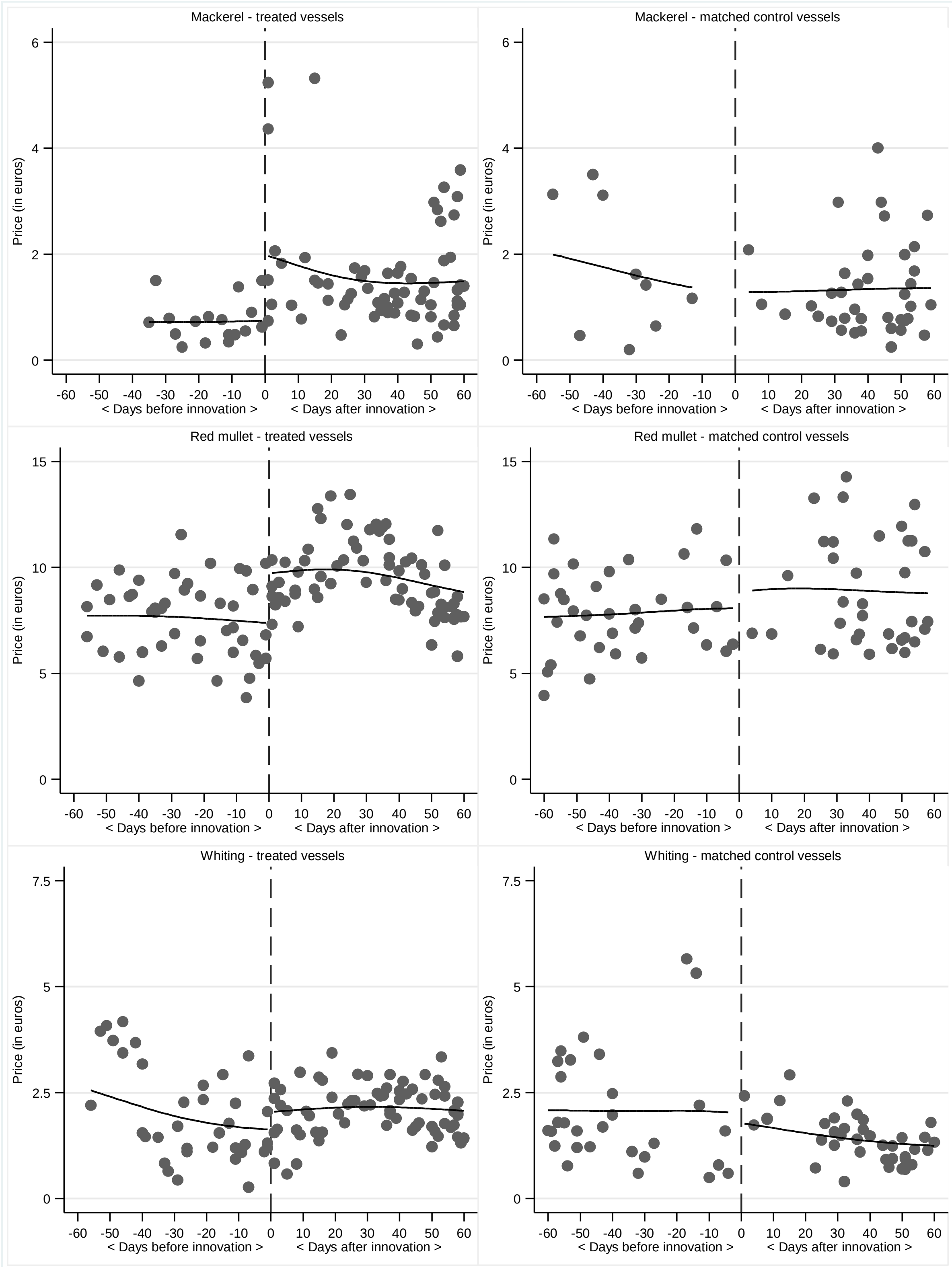
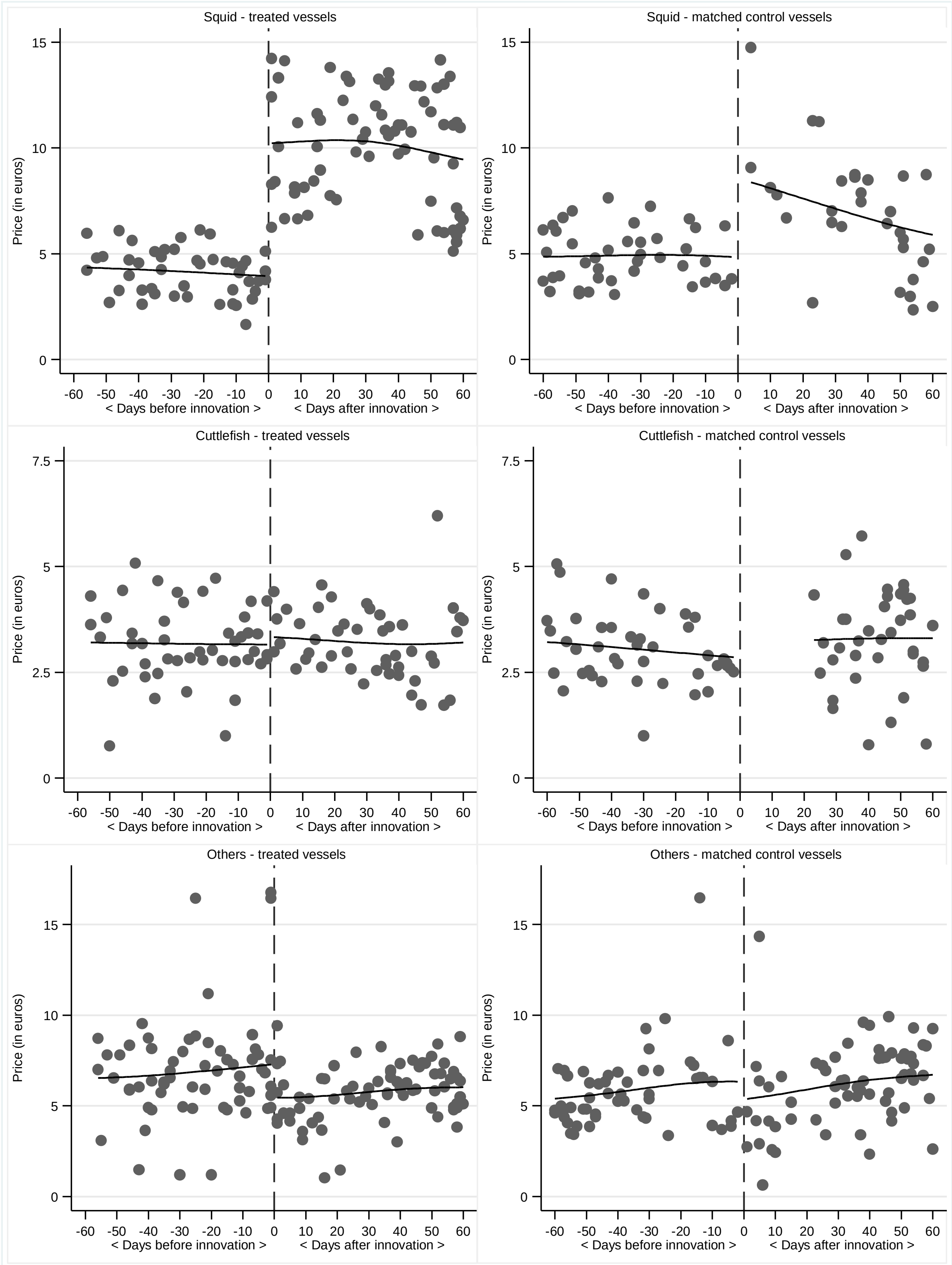
Onatski, Alexei, Marcelo Moreira and Marc Hallin (2013), "Asymptotic power of sphericity tests for high-dimensional data", *Annals of Statistics*, 41, pp. 1204-1231.

[7] While the estimated treatment effect has a negative sign when estimating linear models, it has a positive sign when conducting a synthetic control approach. This difference comes from the inability to construct a synthetic market similar to the treated market with respect to prices before treatment.

Figure Ap1. Discontinuity analysis: daily fish price per kilogram, by fish species (window: four months)



[continued below]

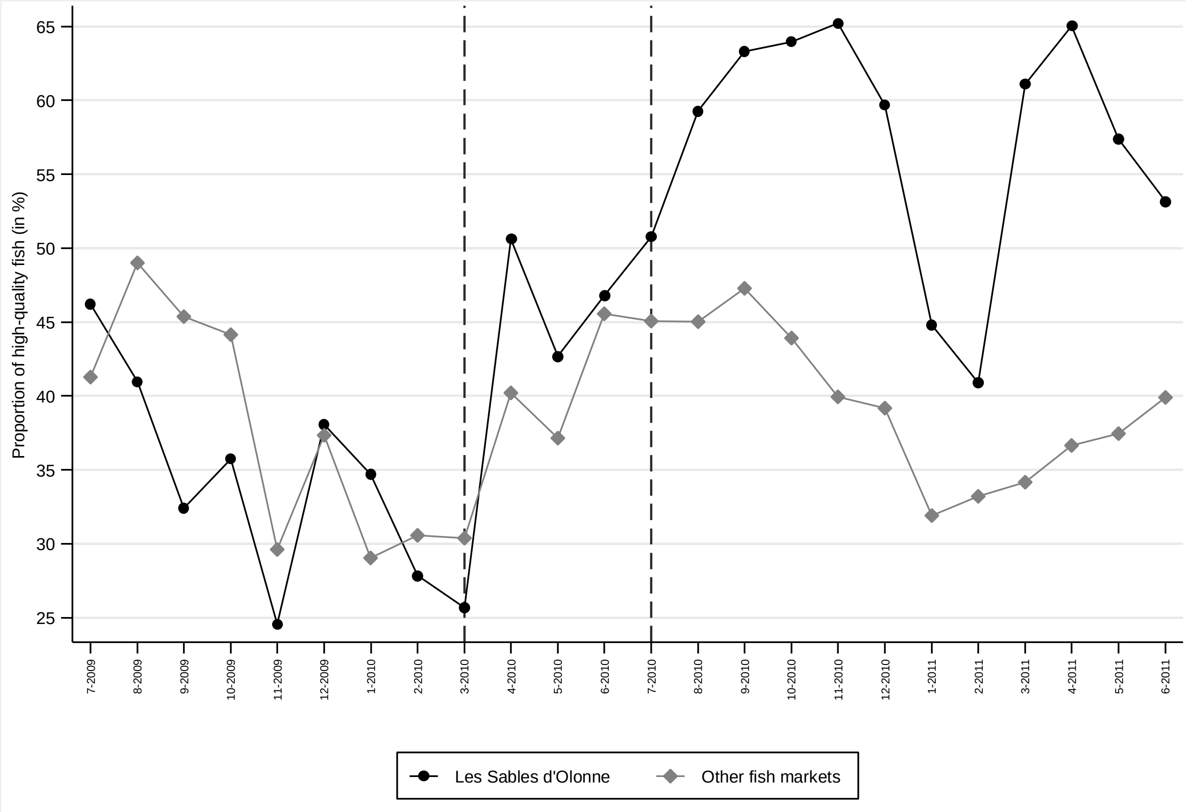


Source: authors' calculations, transaction data.

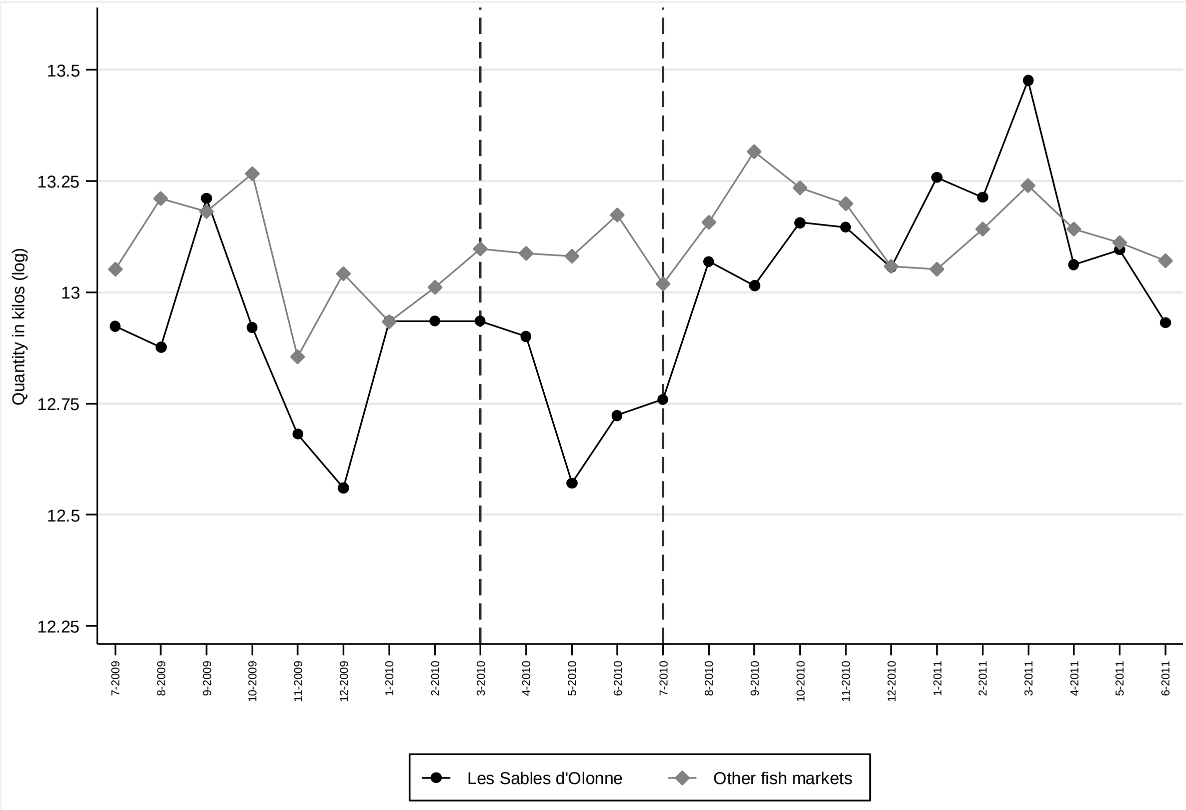
Note: each dot corresponds to the average price per kilogram for the set of transactions of one vessel on a specific day. Data are smoothed using a kernel-weighted local polynomial regression with a Gaussian kernel.

Figure Ap2. Proportion of high-quality fish and quantity: Les Sables d'Olonne versus other fish markets

A. Proportion of high-quality fish



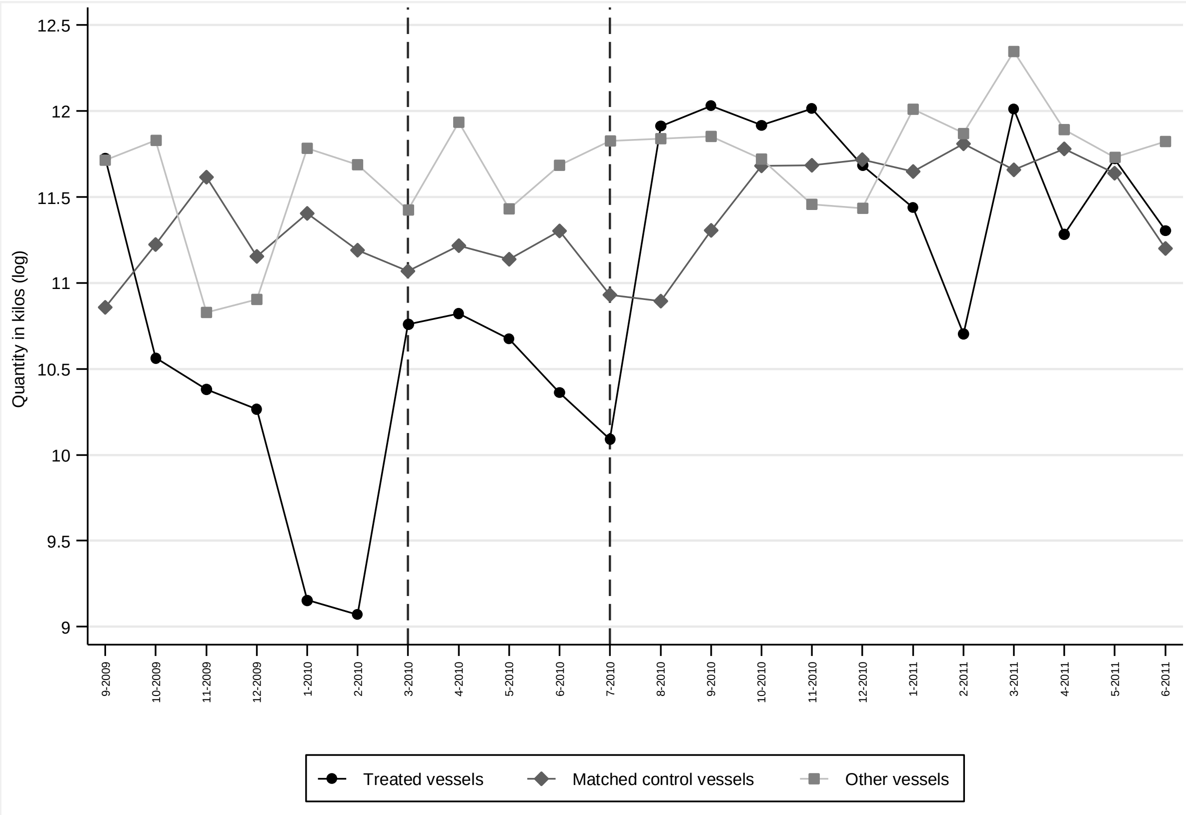
B. Quantity



Source: authors' calculations, RIC data.

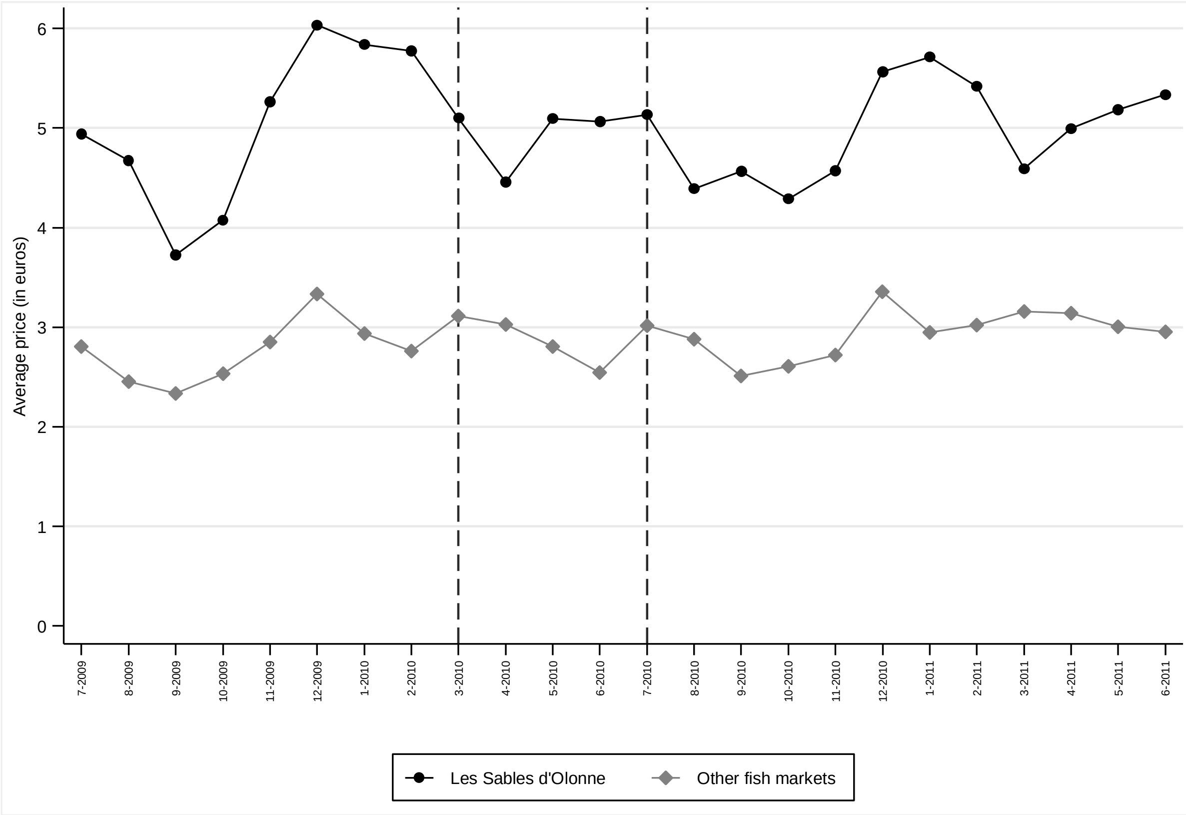
Note: fish markets located on the Mediterranean Sea are excluded. Quantity is the average per market for the other fish markets.

Figure Ap3. Monthly quantity in Les Sables d'Olonne, by group of vessels



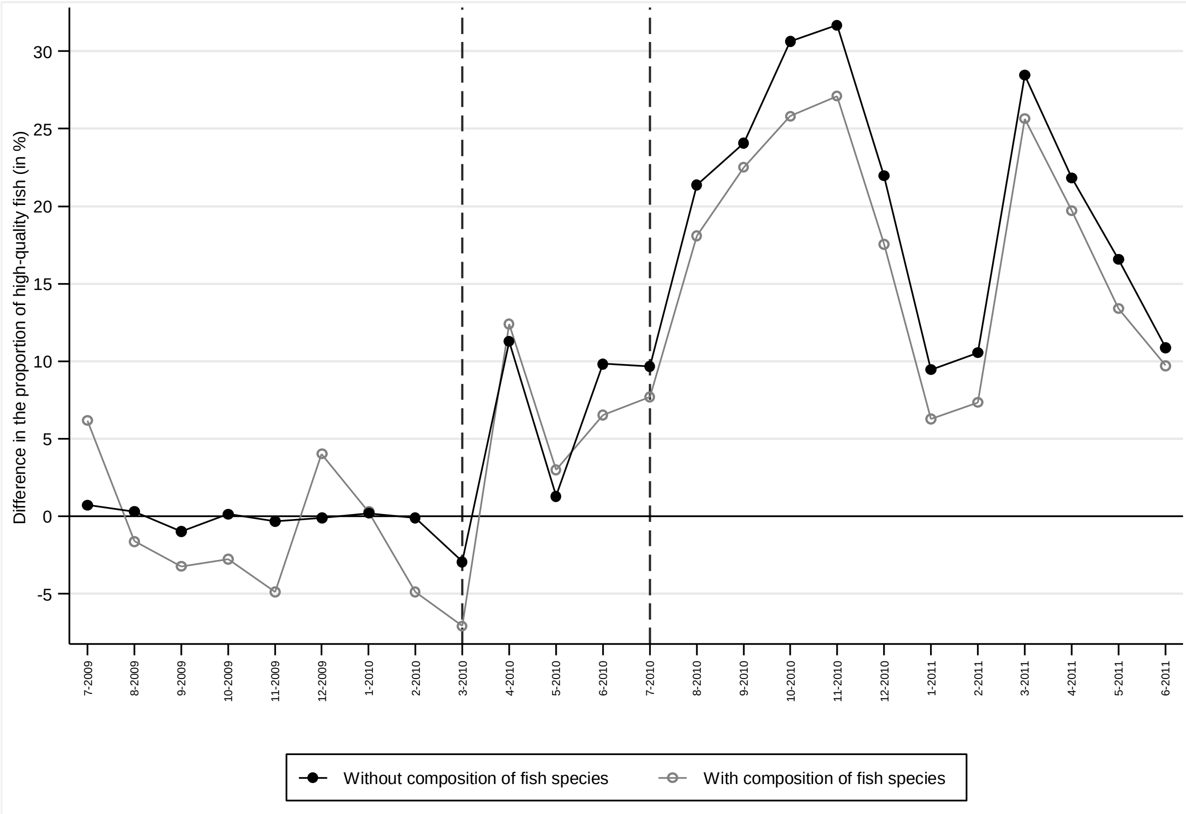
Source: authors' calculations, transaction data.

Figure Ap4. Average prices per kilogram: Les Sables d'Olonne versus other fish markets



Source: authors' calculations, RIC data.
Note: fish markets located on the Mediterranean Sea are excluded.

Figure Ap5. Proportion of high-quality fish: Les Sables d'Olonne versus synthetic markets, without and with fish composition

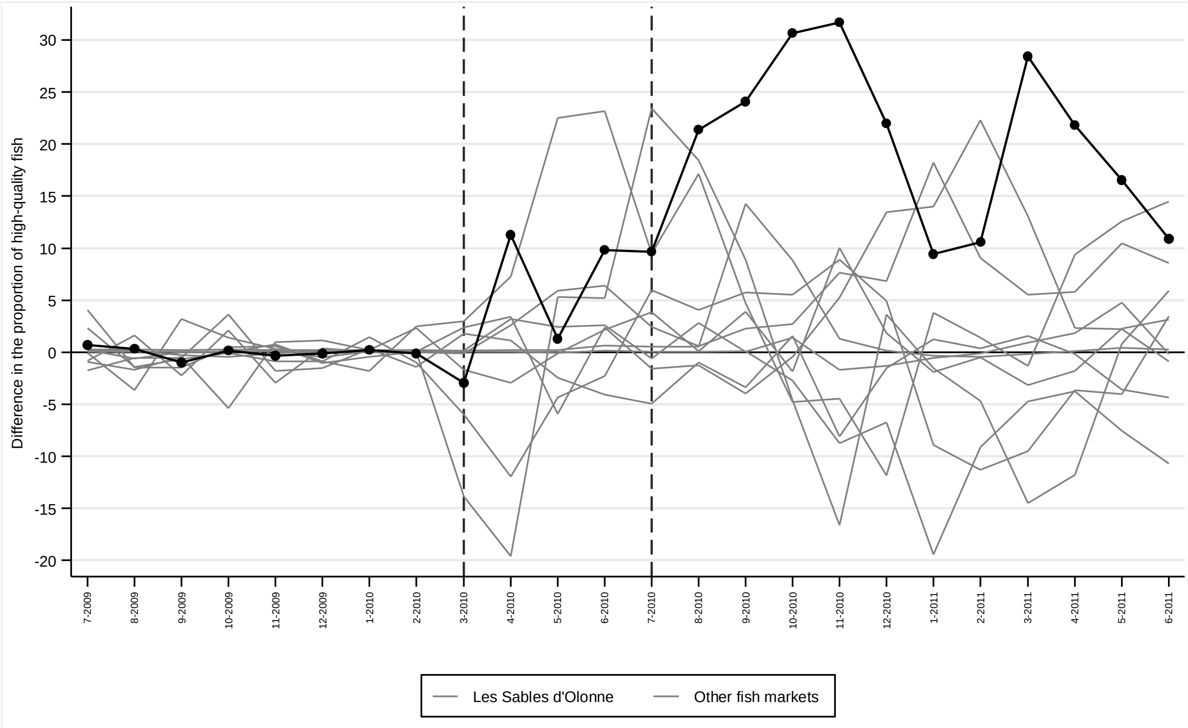


Source: authors' calculations, RIC data.

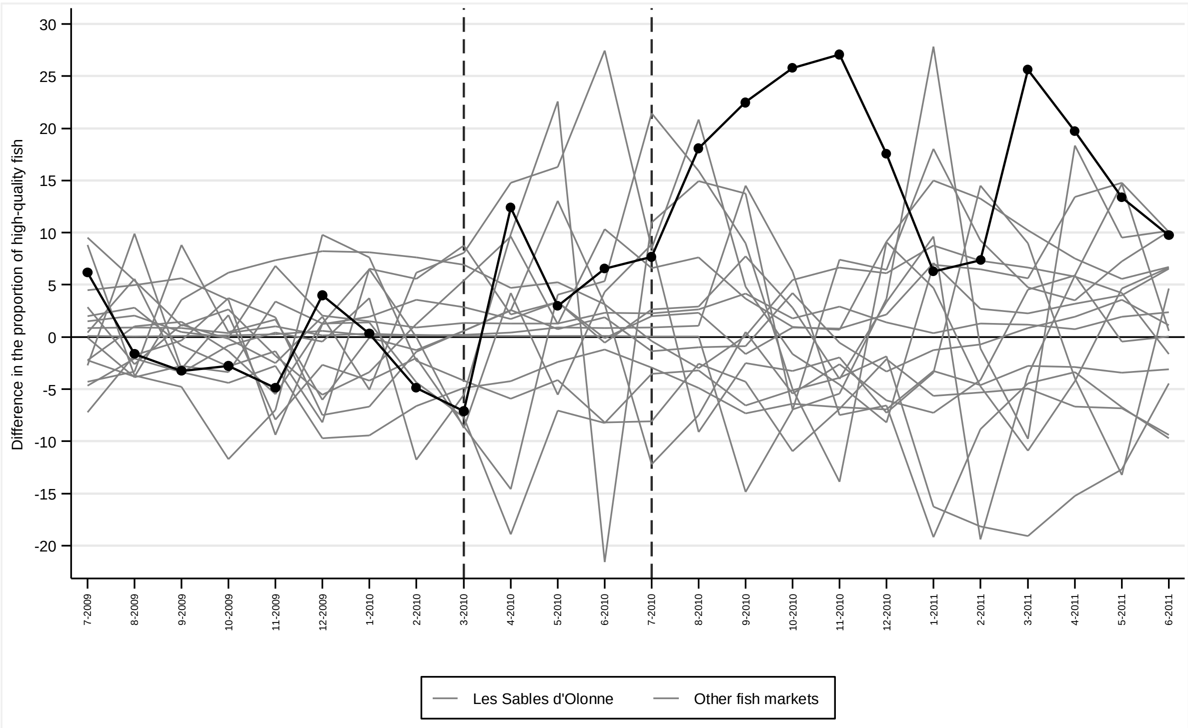
Note: monthly proportion of high-quality fish from July 2009 to February 2010 are used as predictor variables for the synthetic control estimator without fish composition. With fish composition, the predictor variables used for the synthetic control estimator also include the proportions of the 5 most important species – mackerel, red mullet, whiting, squid, cuttlefish – and the "others" category. Fish markets located on the Mediterranean Sea are excluded.

Figure Ap6. Proportion of high-quality fish: Les Sables d'Olonne versus synthetic hall market, placebo analysis

A. Without composition of fish species



B. With composition of fish species



Source: authors' calculations, RIC data.

Note: when not taking into account fish composition, monthly proportions of high-quality fish from July 2009 to February 2010 are used to determine the synthetic market. When taking into account fish composition, variables used to determine the synthetic market also include the monthly proportions of the 5 most important species – cuttlefish, squid, red mullet, mackerel, whiting – and the "others" category for all months. Markets whose Root Mean Square Percentage Error is more than five times (respectively two times) higher than that of Les Sables d'Olonne are excluded when not taking (resp. when taking) fish composition into account.

Table Ap1. Descriptive statistics for treated and matched control vessels

Variables	Treated vessels			Matched control vessels			Difference in differences
	Before	After	Difference	Before	After	Difference	
Panel A. Proportion of fish species							
Mackerel	0.008	0.225	0.217	0.011	0.099	0.088	0.129
Red mullet	0.016	0.176	0.160	0.022	0.011	-0.011	0.171
Whiting	0.013	0.147	0.134	0.023	0.034	0.011	0.123
Squid	0.075	0.105	0.030	0.100	0.062	-0.038	0.068
Cuttlefish	0.147	0.067	-0.080	0.172	0.103	-0.069	-0.011
Other species	0.741	0.281	-0.460	0.672	0.690	0.018	-0.478
All species	1.000	1.000		1.000	1.000		
Panel B. Number of transactions							
Mackerel	67	4260	4193	138	2089	1951	2242
Red mullet	304	10819	10515	519	1091	572	9943
Whiting	196	8274	8078	478	2120	1642	6436
Squid	652	4003	3351	1293	2542	1249	2102
Cuttlefish	937	2515	1578	1410	3018	1608	-30
Other species	5635	19583	13948	10604	37734	27130	-13182
All species	7791	49454	41663	14442	48594	34152	7511

Source: authors' calculations, transaction data for Les Sables d'Olonne.

Note: the sample includes all transactions of treated and control vessels observed between September 2009 and June 2011.

Table Ap2. Estimates for the proportion of high-quality fish (aggregate market data)

Variables	(1) DID FE	(2) Additive and interactive FE			(3) Synthetic control
		1 factor	2 factors	3 factors	
Panel A. Without fish composition					
Les Sables d'Olonne x (March 2010-June 2011)	0.161**	0.157***	0.161***	0.153***	0.160
	(0.065)	(0.034)	(0.030)	(0.026)	
Proportions of fish species	NO	NO	NO	NO	
Month fixed effects	YES	YES	YES	YES	
Fish market fixed effects	YES	YES	YES	YES	
Number of observations	744	744	744	744	744
R^2	0.826				
Panel B. With fish composition					
Les Sables d'Olonne x (March 2010-June 2011)	0.167***	0.152***	0.182***	0.168***	0.135
	(0.057)	(0.034)	(0.029)	(0.027)	
Proportions of fish species	YES	YES	YES	YES	
Month fixed effects	YES	YES	YES	YES	
Fish market fixed effects	YES	YES	YES	YES	
Number of observations	744	744	744	744	744
R^2	0.871				

Source: authors' calculations, RIC data.

Note: DID stands for difference-in-differences, FE for fixed effects. Significance levels are respectively 1% (***), 5% (**) and 10% (*). In panel A, monthly proportions of high-quality fish from July 2009 to February 2010 are used to determine the synthetic market. In panel B, variables used to determine the synthetic market also include the monthly proportion of the 5 most important species – cuttlefish, squid, red mullet, mackerel, whiting – and the "others" category for all months. Fish markets located on the Mediterranean Sea are excluded.

Table Ap3. Characterization of the synthetic fish market of Les Sables d'Olonne

Code	Fish markets	Proportion of fish of extra quality	Total quantity (log)	Distance from Les Sables d'Olonne (in kms)	Weight in the synthetic control	
					Without composition of fish species	With composition of fish species
AC	Arcachon	0.047	15.160	209.9	0.000	0.000
AD	Audierne	0.918	14.413	268.9	0.000	0.000
BL	Boulogne	0.041	17.994	532.7	0.000	0.127
BT	Brest	0.434	14.971	293.0	0.000	0.000
CC	Concarneau	0.554	16.464	222.9	0.000	0.000
CH	Cherbourg	0.284	16.214	349.7	0.000	0.043
CR	Le Croisic	0.965	14.976	104.8	0.000	0.031
DK	Dunkerque	0.969	14.400	590.4	0.000	0.000
DP	Dieppe	0.396	15.623	436.1	0.000	0.000
DZ	Douarnenez	0.989	16.355	262.1	0.000	0.000
EQ	Erquy	0.361	16.854	242.7	0.000	0.000
GD	Grandcamp	0.670	15.036	326.3	0.001	0.000
GL	Saint-Gilles Croix-de-Vie	0.308	15.879	24.7	0.051	0.117
GR	Granville	0.778	16.921	261.0	0.000	0.000
GV	Le Guilvinec	0.065	17.297	238.5	0.000	0.000
IO	Ile d'Oléron	0.746	16.164	71.4	0.257	0.246
LC	Loctudy	0.132	15.651	233.9	0.389	0.000
LO	Lorient	0.148	17.390	183.6	0.000	0.000
LR	La Rochelle	0.154	15.230	61.3	0.000	0.247
NO	Noirmoutier	0.966	15.061	66.9	0.000	0.000
PO	Port en Bessin	1.000	14.444	326.2	0.000	0.000
QB	Quiberon	0.996	14.622	149.2	0.000	0.000
RO	Roscoff	0.241	16.379	297.9	0.111	0.000
RY	Royan	0.518	14.273	112.8	0.075	0.000
SG	Saint-Guénolé	0.545	17.085	242.5	0.000	0.000
SJ	Saint-Jean de Luz	0.330	15.762	345.5	0.108	0.068
SM	Saint-Malo	0.582	14.864	238.4	0.000	0.000
SQ	Saint-Quay Portrieux	0.623	16.841	252.4	0.000	0.000
TB	La Turballe	0.651	16.231	109.8	0.000	0.028
YE	Ile d'Yeu	0.415	14.632	48.0	0.009	0.093
LS	Les Sables d'Olonne	0.471	16.177			

Source: authors' calculations, RIC data.

Note: when fish composition is ignored, monthly proportions of high-quality fish and monthly fish quantity from July 2009 to February 2010 are used to determine the synthetic control estimator. When fish composition is taken into account, the variables used to determine the synthetic control estimator also include the monthly proportions of the 5 most important species – cuttlefish, squid, red mullet, mackerel, whiting – and the "others" category for all months.

Table Ap4. Estimates for the logarithm of monthly quantity (aggregate market data)

Variables	(1) DID FE	(2) Additive and interactive FE			(3) Synthetic control
		1 factor	2 factors	3 factors	
Panel A. Without fish composition					
Les Sables d'Olonne x (March 2010-June 2011)	-0.002	0.002	0.011	-0.014	-0.118
	(0.197)	(0.130)	(0.107)	(0.094)	
Proportions of fish species	NO	NO	NO	NO	
Month fixed effects	YES	YES	YES	YES	
Fish market fixed effects	YES	YES	YES	YES	
Number of observations	744	744	744	744	744
R^2	0.851				
Panel B. With fish composition					
Les Sables d'Olonne x (March 2010-June 2011)	0.104	0.036	0.046	0.022	0.097
	(0.191)	(0.129)	(0.107)	(0.097)	
Proportions of fish species	YES	YES	YES	YES	
Month fixed effects	YES	YES	YES	YES	
Fish market fixed effects	YES	YES	YES	YES	
Number of observations	744	744	744	744	744
R^2	0.855				

Source: authors' calculations, RIC data.

Note: DID stands for difference-in-differences, FE for fixed effects. Significance levels are respectively 1% (***), 5% (**) and 10% (*). In panel A, monthly logarithms of total quantities from July 2009 to February 2010 are used to determine the synthetic market. In panel B, variables used to determine the synthetic market also include the monthly proportions of the 5 most important species – cuttlefish, squid, red mullet, mackerel, whiting – and the "others" category for all months. Fish markets located on the Mediterranean Sea are excluded.

Table Ap5. Estimates for the logarithm of price (aggregate market data)

Variables	(1) DID FE	(2) Additive and interactive FE			(3) Synthetic control
		1 factor	2 factors	3 factors	
Panel A. Without fish composition and quality					
Les Sables d'Olonne x (March 2010-June 2011)	-0.016	-0.124	-0.076	-0.106	0.008
	(0.095)	(0.091)	(0.100)	(0.110)	
Log of quantity	YES	YES	YES	YES	
Proportions of fish species	NO	NO	NO	NO	
Proportion of high-quality fish	NO	NO	NO	NO	
Month fixed effects	YES	YES	YES	YES	
Fish market fixed effects	YES	YES	YES	YES	
Number of observations	744	744	744	744	744
R^2	0.826				
Panel B. With fish composition, without quality					
Les Sables d'Olonne x (March 2010-June 2011)	-0.011	-0.037	-0.032	-0.093	0.084
	(0.094)	(0.085)	(0.083)	(0.104)	
Proportions of fish species	YES	YES	YES	YES	
Proportion of high-quality fish	NO	NO	NO	NO	
Month fixed effects	YES	YES	YES	YES	
Fish market fixed effects	YES	YES	YES	YES	
Number of observations	744	744	744	744	744
R^2	0.881				
Panel C. With fish composition and quality					
Les Sables d'Olonne x (March 2010-June 2011)	-0.006	0.003	-0.037	-0.088	0.058
	(0.094)	(0.086)	(0.084)	(0.104)	
Proportions of fish species	YES	YES	YES	YES	
Proportion of high-quality fish	YES	YES	YES	YES	
Month fixed effects	YES	YES	YES	YES	
Fish market fixed effects	YES	YES	YES	YES	
Number of observations	744	744	744	744	744
R^2	0.881				

Source: authors' calculations, RIC data.

Note: DID stands for difference-in-differences, FE for fixed effects. Significance levels are respectively 1% (***), 5% (**) and 10% (*). In panel A, prices from July 2009 to February 2010 and quantities over all the period are used to determine the synthetic market. In panel B, variables used to determine the synthetic market also include the proportions of the 5 most important species – mackerel, red mullet, whiting, squid, cuttlefish – and the "others" category for all months. In panel C, they also include the proportion of high-quality fish for all months. Fish markets located on the Mediterranean Sea are excluded.