Working Papers SMART - LERECO

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Corinne BAGOULLA, Emmanuelle CHEVASSUS-LOZZA,
Karine DANIEL, Carl GAIGNÉ

Working Paper SMART – LERECO N°10-01

January 2010

UMR INRA-Agrocampus Ouest **SMART** (Structures et Marchés Agricoles, Ressources et Territoires)
UR INRA **LERECO** (Laboratoires d'Etudes et de Recherches Economiques)

Regional production adjustment to import competition: evidence from the French agro-industry

Corinne BAGOULLA

LEMNA, Université de Nantes, France

Emmanuelle CHEVASSUS-LOZZA

INRA, UR1134 LERECO, F-44000 Nantes, France

Karine DANIEL

ESA LARESS, Angers, France

INRA, UR1134 LERECO, F-44000 Nantes, France

Carl GAIGNÉ

INRA, UMR1302 SMART, F-35000 Rennes, France

Agrocampus Ouest, UMR1302 SMART, F-35000 Rennes, France

Acknowledgements

This research is part of a research program supported by the French PSDR Program on Competitiveness, Location and Public Intervention.

Auteur pour la correspondance / Corresponding author

Emmanuelle CHEVASSUS-LOZZA
INRA, UR1134 LERECO
Rue de Géraudière, BP71627
44376 Nantes Cedex 03, France
Email : chevassu@nantes.inra.fr
Téléphone / Phone: +33 (0)2 40 67 51 77
Fax: +33 (0)2 40 67 50 74

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Abstract

This paper aims at evaluating the impact of increasing imports on the reallocation of agri-food production across regions within countries. From French data for the period 1995-2002, we show that regional agri-food production adjusts differently to increasing imports according to the region where the agri-food firms are located. More precisely, even though proximity to consumers significantly shapes the spatial distribution of agri-food production, an increase in agri-food imports does not make regions with a high demand more attractive but makes low-wage regions more attractive. In addition, an increase in imports of agricultural products processed by agri-food firms leads to the reallocation of agri-food production from regions with good access to agricultural products towards those with limited access.

Keywords: trade openness, location, agri-food

JEL classifications: R12, F12

Libéralisation des échanges et localisation régionale des industries agro-alimentaires françaises

Résumé

Ce papier vise à évaluer l'impact d'un accroissement des importations sur la ré-allocation de la production agro-alimentaire entre les régions au sein d'un pays. A partir de données françaises sur la période 1995-2002, nous montrons que la production régionale s'ajuste différemment selon la région où sont implantées les firmes agro-alimentaires. Plus précisément, quand bien même la proximité aux bassins de consommations influence la distribution spatiale de la production agro-alimentaire, un accroissement des importations de biens agro-alimentaires ne rend pas les grandes régions plus attractives mais renforce les régions offrant des salaires plus faibles. De plus, une hausse des importations des produits agricoles transformés par les firmes agro-alimentaires induit une ré-allocation de la production agro-alimentaire vers les régions avec un faible potentiel agricole.

Mots-clefs : libéralisation des échanges, localisation, industrie agro-alimentaire

Classifications JEL : R12, F12

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1. Introduction

Over the last decade, the agri-food industry has been involved in trade policy reforms including trade agreements (for example the European Union, the North American Free Trade Agrement, the MERCOSUR for example) and World Trade Organization negotiations. The consequences of trade liberalization on trade and foreign investments as well as on the productivity of domestic firms have received much attention, notably in new trade theory following the seminal paper of Melitz (2003). However, academic literature and national governments have devoted relatively little attention to the effects of trade agreements on inter-regional reallocations of production within countries. Yet previous experience suggests that trade liberalization affects the geographical distribution of production within countries. For example, De la Fuente and Vives (1995) reported that the process of economic integration within the European Union fostered international convergence across countries rather than interregional convergence across regions within countries. In North America, as highlighted by Hanson (1998), rapid trade liberalization was accompanied by a significant shift of manufacturing jobs from the region of Mexico City towards the United States' border. Chevassus-Lozza and Daniel (2006) showed a positive correlation between the degree of openness to trade and the degree of spatial concentration of the agricultural and food sectors in France.

In this paper, we study how increasing imports affect the infra-national location of agri-food production from French data for the period 1995-2002. During this period, tariff protections for agri-food products at European borders declined by 41% and French imports of agri-food products from the rest of the world increased by 31% for food products. Hence, competition among agri-food producers is fiercer on the domestic output market what likely affects the location of the agri-food firms. In addition, because agricultural products are intermediate goods processed by the agri-food sector, agri-food firms are also concerned by trade liberalization of agricultural markets. Over the period 1995-2002, tariff barriers for agricultural products at European borders decreased by 30% and French

imports of agricultural commodities increased by 25%. Hence, our analysis focuses not only on the effects of imports of agri-food products but also of agricultural products on the re-allocation of the agri-food firms across regions.

To address our question, we build an econometric model based on economic geography literature (Fujita et al., 1999 and Fujita and Thisse, 2002) for which, in a closed economy, the spatial distribution of production is driven by proximity to markets and by production factor prices. Because of transport costs, firms want to locate close to input or/and output markets in order to produce at a large scale and benefit from increasing returns. However, if the advantages of producing close to input or output markets do not offset high local production costs, firms are encouraged to set up in other places where production costs are relatively low. These mechanisms are particularly relevant in the agri-food sector because shipping agricultural and agri-food products is relatively costly, especially in the case of highly perishable commodities. Moreover, the agri-food sector has some linkages both with suppliers of agricultural products, who are spatially dispersed, and with final consumers, who are mainly located in large cities. As a result, the production level of the agri-food firms should react differently to an increase in imports according to local production costs and their proximity to consumers and to suppliers of agricultural products, leading to a reallocation of production across regions.

Our analysis reveals that, even though proximity to final consumers significantly shapes the spatial distribution of agri-food production, an increase in agri-food imports does not make regions with a high demand more attractive but makes low-wage regions more attractive. In addition, an increase in imports of agricultural products processed by food firms leads to the reallocation of agri-food production from regions with good access to agricultural inputs towards those with limited access.

The article is organized as follows. In the following section, we present a literature review based on economic geography models with international trade. Further, the empirical model and the predictions are described. In the fourth section, we present the data and variables. The econometric issues and the results of our estimations are discussed in the fifth section. The last section summarizes our conclusions.

2. Trade liberalization and the location of production: a review of the literature

We know from the economic geography literature that firms have an incentive to agglomerate in order to take advantage of the increasing returns associated with access to the input market (Abdel Rahman and Fujita, 1990 and Krugman and Venables, 1995) and to the output market (Krugman, 1991). By contrast, the agglomeration of firms triggers high production costs due to competition among firms to attract production factors, especially labor. Hence, firms choose production locations by considering the tradeoff between access to consumers (the so-called *market potential*), access to input suppliers, and production costs. Daniel and Kilkenny (2009) as well as Gopinath et al. (2004) illustrated this tradeoff for food industries.

Some theoretical contributions aimed at evaluating the effects of trade liberalization on the location of production within a country using different economic geography models. Paluzie (2001) and Monfort and Nicolini (2000) extended the model in Krugman (1991) by opening this seminal two-region model to a third foreign region and to two countries and four regions, respectively. They showed that falling international trade costs foster agglomeration in a country that is open to trade. In other words, trade openness strengthens the incentive to locate in the larger markets. However, Krugman and Livas Elizondo (1996) introduced an immobile demand with congestion costs, which becomes the source of dispersion and is enough to turn Paluzie-Monfort-Nicolini's result upside down: lower international trade costs foster dispersion within a country that is open to trade. Behrens et al. (2007) confirmed this result by dropping congestion costs and by including pro-competitive effects, which act as an additional dispersion force. In this case, firms are encouraged to locate in the region that allows them to reduce their production costs when international competition is fiercer.

As a result, in a closed economy, economic geography models show that firms have an incentive to agglomerate in order to benefit to better access to markets or to disperse to enjoy lower prices of production factors. However, it appears that theory has not yet reached a consensus on the impact of trade integration on regional inequalities. Econometric studies are thus needed to identify the mechanisms involved by determining whether freer trade strengthens the role of access to markets (Paluzie, 2001 and Monfort

and Nicolini, 2000) or the role of production costs (Krugman and Livas Elizondo, 1996 and Behrens et al., 2007) in the regional allocation of production. Despite this need, few econometric studies have been conducted. Ades and Glaeser (1995) as well as Davis and Henderson (2003) studied the impact of trade openness on the degree of urban primacy but they did not identify any mechanisms that explain the causal relationship. In addition, even though these studies estimated the relation between trade liberalization and the location of production with countries, they did not distinguish the effects of trade liberalization passing through input markets and output markets, a major issue of our work.

3. The empirical model

Given the discussion in the foregoing section, our aim is to evaluate the impact of agricultural and food imports on the reallocation of agri-food production across regions and, in turn, to what extent imports modify the standards determinants of location. The dependent variable is the agri-food production y_{rst} for sector *s* in region *r* at time *t* which is expected to increase with accessibility to final consumers MP_{rst} (*MP* for market potential) and to agricultural producers A_{rst} and to decrease with production costs w_{rst}. Beside the standard determinants of location, we also consider the direct effects of imports of national agri-food products M_{st} and national imports of agricultural products *a* processed by the agri-food sector, M_{st}^{a}, as well as interaction terms between imports and determinants of location. The functional form of the equation estimated is specified as follows:

$$\ln y_{rst} = c + \underbrace{\alpha_1 \ln w_{rst} + \alpha_2 (\ln w_{rst})^2 + \beta_1 \ln MP_{rst} + \beta_2 (\ln MP_{rst})^2 + \gamma_1 \ln A_{rst} + \gamma_2 (\ln A_{rst})^2}_{\text{location determinants}}$$

$$\underbrace{+m_s \ln M_{st} + m_a \ln M_{st}^{a}}_{\text{direct imports effects}} + \underbrace{\xi_s \left(\ln M_{st} \times \ln MP_{rst}\right) + \xi_w \left(\ln M_{st} \times \ln w_{rst}\right) + \xi_a \left(\ln M_{st}^{a} \times \ln A_{rst}\right)}_{\text{indirect imports effects}} + u_{rst} \tag{1}$$

where *c* is a constant and parameters $\alpha_1, \alpha_2, \beta_1, \beta_2, \gamma_1, \gamma_2, m_s, m_a, \xi_s, \xi_a$, and ξ_w are the coefficients to be estimated whereas u_{rst} is the error term.

The overall impact of agri-food imports

We consider that food imports may impact the inter-regional allocation of food production through three channels: the first is a level effect (m_s) regardless of the region where the firms are located, and the two other channels, which are captured by the interaction terms, are specific to the region through its market potential (ξ_s) and its cost competitiveness (ξ_w). The sign of m_s is expected to be negative because more imports of food reduce the market shares of domestic firms. Concerning the coefficients of the interaction terms, we expect $\xi_s > 0$ and $\xi_w < 0$. An increase in agri-food imports would strengthen the role of proximity to consumers. Indeed, an increase in imports leads to a decrease in the relative prices of both foreign products and local products. The domestic firms located in regions where demand is relatively high may maintain their market share more easily than firms located far from consumers. Hence, more imports may lead to a reallocation of production from remote regions to regions with high demand. In addition, trade openness may increase production in regions with low production costs at the expense of the other regions, leading to the reallocation of production from high-cost regions to low-cost regions. To sum up these three effects, the elasticity of regional production to a change in imports of goods of the same sector s is given by:

$$\varepsilon_{Ms} = \frac{\partial \ln(y_{rst})}{\partial \ln(M_{st})} = \underbrace{m_s}_{-} + \underbrace{\xi_s}_{+} \ln MP_{rst} + \underbrace{\xi_w}_{-} \ln w_{rst} \ . \qquad (2)$$

where the sign of ε_{Ms} is *a priori* undetermined.

The overall impact of agricultural imports

Concerning the impact of imports of agricultural products processed by the agri-food sector, we also distinguish a level effect (m_a) regardless of the region and an indirect direct depending on the region where the firms are located (ξ_a). We expect $m_a > 0$ and $\xi_a < 0$. An increase in imports of agricultural products is expected to increase, *ceteris paribus*, agri-food production regardless of the firm's location and in higher proportion in regions having low access to agricultural production. Thus, the sign of the impact of agricultural product imports on regional agri-food production, given by:

$$\varepsilon_{Ma} = \frac{\partial \ln(y_{rst})}{\partial \ln(M_{st}^{a})} = \underbrace{m_a}_{+} + \underbrace{\xi_a}_{-} \ln A_{rst} \tag{3}$$

is *a priori* undetermined.

To what extent do imports modify the standard determinants of location?

It is also interesting to determine to what extent imports modify the standard determinants of location. The impact of accessibility to consumers and to producers of agricultural products are given by, respectively,

$$\varepsilon_{MP} = \frac{\partial \ln(y_{rst})}{\partial \ln(MP_{rst})} = \underbrace{\beta_1 + 2\beta_2 \ln MP_{rst}}_{+} + \underbrace{\xi_s}_{-} \ln M_{st}^{s} \tag{4}$$

$$\varepsilon_{A} = \frac{\partial \ln(y_{rst})}{\partial \ln(A_{rst})} = \underbrace{\gamma_1 + 2\gamma_2 \ln A_{rst}}_{+} + \underbrace{\xi_a}_{-} \ln M_{st}^{a} \tag{5}$$

whereas the impact of local labor costs is expressed as follows by:

$$\varepsilon_{w} = \frac{\partial \ln(y_{rst})}{\partial \ln(w_{rst})} = \underbrace{\alpha_1 + 2\alpha_2 \ln w_{rst}}_{-} + \underbrace{\xi_w}_{-} \ln M_{st} \tag{6}$$

Following the above discussion, we can conclude that increasing imports of agri-food products can strengthen the positive role of proximity to final consumers (4) or the negative role of the production costs (6) in the location of agri-food production because of fiercer competition between domestic agri-food firms and foreign producers. In addition, increasing imports of agricultural products processed by the agri-food sector can lower the role of the access to agricultural products in the location of production (5).

4. Data and variables

The dataset is a region-industry panel composed of 31 food sectors (listed in Appendix A) and 21 regions (all French administrative regions except Corsica plus overseas departments and territories) covering the years 1995-2002 i.e a total of 5,208 observations. Data on regional production by sector is not available but we have access to data on national production by sector (y_{st}), total employment in sector *s* in region *r* at time *t* (L_{rst}) and total

employment in sector *s* (L_{st}). For each sector, we distribute national production among regions according to the regional distribution of employees and labor productivity. Hence, we use the following dependent variable as a proxy for the production of the agri-food sector:

$$y_{rst} = y_{st} \frac{\phi_{rst} L_{rst}}{\phi_{st} L_{st}}$$

where ϕ_{rst} is labor productivity in sector *s* in region *r* at time *t* and ϕ_{st} labor productivity in sector *s* at *t*. French production is extracted from the national accounts (the Employment-Resource Equilibrium, ERE) provided by INSEE (French National Statistics Office). Labor productivity ϕ_{rst} is measured by using the average size (i.e. the number of workers) of plants by sector, region and year. This variable is a proxy of scale economies (and thus of productivity) and is extracted from the Annual Surveys of Enterprises, provided by INSEE, which covers firms with more than 20 employees.

As a proxy of regional production costs, we use the regional wages given by $w_{rst} = R_{rst} / L_{rst}$ where R_{rst} is the sum of wages paid by firms belonging to sector *s* and located in *r* at *t*. Note that when $y_{rst} = 0$, w_{rst} is undetermined. In this case, we use the average regional labor cost.

To measure access to final consumers, we adopt a standard approach in economic geography by using the index of Market Potential (see Head and Mayer, 2004, for more details): $MP_{rst} = (W + I)E_{r'st}$ where I is the identity matrix and *W* is a spatial weight matrix in which the elements are $\varphi_{r,r'} = 1/d_{r,r'}$ with $r \neq r'$ and $d_{r,r'}$ the distance between the centroids of regions *r* and *r'*. $\varphi_{r,r'} = 0$ when $r = r'$. $E_{r'st}$ is a vector of the level of expenditures devoted to sector *s* and in region *r'* at time *t*. $E_{r'st}$ is derived from the national expenditures for sector *s* (obtained from the ERE), divided by the regional distribution of the population.

The access to agricultural inputs A_{rst} is built as follows: $A_{rst} = \sum_a \mu^{s,a} A^a_{rt}$ with $A^a_{rt} \equiv (W + I) P^a_{r't}$ where $P^a_{r't}$ is the level of production of agricultural product *a* in region *r'*

and at time *t* (ERE - INSEE). The list of agricultural products processed by the agri-food industry is reported in table A2 in Appendix A. As a result, for each agricultural product *a* at time *t*, A_{rt}^{a} is the sum of production weighted by distance from the centroid of region *r*. $\mu^{s,a}$ is a dummy variable with $\mu^{s,a}=1$ when the agricultural good *a* is significantly used by the agri-food sector *s* and $\mu^{s,a}=0$ otherwise. The μ coefficient is based on the input/output matrix. Hence, A_{rst} is specific to each sector/region pair and measures accessibility in region *r* to agricultural inputs intensively used by sector *s*.

French imports of agricultural inputs by sector *s* at time *t* are measured as follows: $M_{st}^{a}=\sum_{a}\mu^{s,a}M_{t}^{a}$ where M_{t}^{a} are French imports of agricultural product *a* at time *t*. Information on the latter variable is provided by the Directorate General of French Customs. The same source gives imports of sector *s* at time *t* (M_{st}).

Table 1: Summary statistics (n = 21 regions * 31 sectors * 8 years = 5208 obs.)

Variables	Label	Mean	Std. Dev.	Median	Q1	Q3	Mini	Maxi
Production ($y_{rst}>0$)	$\ln y_{rst}$	4.99	1.96	5.22	3.76	6.39	0.0004	9.99
Labor costs	$\ln w_{rst}$	0.69	0.55	0.58	0.32	0.85	0.02	4.64
Access to agricultural inputs	$\ln A_{rst}$	2.50	2.24	3.25	0	4.26	0	6.91
Access to final demand	$\ln MP_{rst}$	3.04	0.99	3.05	2.45	3.69	0.02	5.82
Imports in sector *s*	$\ln M_{st}^{s}$	6.27	1.46	6.63	5.86	7.07	0.88	8.70
Imports of agricultural inputs	$\ln M_{st}^{a}$	2.80	3.44	0	0	6.14	0	8.92

Note: Q1 and Q3 mean respectively first and third quartile.

The descriptive statistics are listed in table 1 and the growth rates of production and imports by agri-food sectors in table A1 in Appendix A. Two comments are in order. First, a significant number of region/sector pairs have no production (in 2002, 151 of the 651 region/sector pairs). Second, some agri-food sectors have no linkages with the agriculture ($\mu^{sa}=0$) regardless of *a* so that $A_{rst}=0$ and $M_{st}^{a}=0$. These two problems are taken into account in our estimation strategy, which is described in the following section.

5. Econometric analysis

Estimation Strategy

In our dataset, there are about 20% of observations where production equals zero ($y_{rst} = 0$). Thus, our sample is characterized by a significant number of corner solutions because some regions are not profitable for some sectors. This problem is addressed by using a Tobit estimation procedure.

In addition, there are two potential problems of endogeneity: access to agricultural production and regional production costs are not exogenous. For each sector/region pair, the labor cost is affected by its level of production; and both vertical linkages and scale economies in producing agri-food goods and transport costs favor the co-agglomeration of agri-food and agricultural production (Gopinath et al., 1996). In order to take these potential biases into account, we adopt an instrumental variable (IV) procedure. The costs of labor or access to agricultural production in previous years are used as instruments, which have been validated by the Sargan test.

Further, we consider heterogeneity across sectors because technology and market structure can vary greatly among agri-food sectors. We know that sectoral specificities play a role in the spatial allocation of firms. For example, high fixed costs favor agglomeration while a very competitive sector promotes the spatial dispersion of production (see Fujita and Thisse, 2002). Characteristics that are specific to a region also influence the spatial distribution of firms regardless of the type of sectors: for example, physical geography, climate, endowments in natural resources and in production factors that are not specific to sectors (land, general skills, public infrastructure, education, ...). We also consider that agri-food production is likely to vary with time because of macroeconomic factors or common technology shocks across regions and sectors. The error term in (1) is then given by $u_{rst} = \varsigma_s + \upsilon_r + \nu_t + \varepsilon_{rst}$ where ε_{rst} is a random error, ς_s, υ_r, ν_t are respectively sector, region and time-specific components.

Finally, in the presence of heteroskedasticity, our estimates are biased because we use a log model so that we correct for heteroskedasticity in the Tobit model. An alternative strategy consists in implementing the Pseudo Poisson Maximum Likelihood (PPML) estimation

technique proposed by Santos Silva and Tenreyro (2006). This method is consistent in the presence of heteroskedasticity and provides a way of dealing with zero values of the dependent variable. However, using Monte Carlo simulations, Martin and Pham (2009) show that the PPML estimator may be biased when the dependent variable is frequently equal to zero. We use the PPML estimator to test the robustness of results.

Imports and the location of agri-food production

We first estimate two models from our entire sample in order to isolate (i) the direct effects of imports (model I) and of (ii) their interactions on the location of agri-food production (model II). Results are listed in table 2. Standard errors are clustered by industry-region cell. Coefficients associated with labor costs, access to consumers and access to agricultural production are stable and have the expected sign.

When we consider the two variables measuring imports without any interaction (model I), the effects of both food and agricultural products imports are not significant. The non-significant effect of food imports may be due to the fact that imported food products may be also used as intermediate products by firms belonging to the same sector, given the level of aggregation of sectors in our data (the agri-food sector is divided into 31 sectors). Hence, more imports of food products may have an ambiguous effect on agri-food production. The non-significant effect of imports of agricultural products is rather surprising. However, when we introduce interactions between imports and location variables (model II), the results differ significantly. First, imports of agricultural inputs have a significant impact on the production level both directly and indirectly. On the one hand, an increase in imports of agricultural products processed by agri-food firms increases *ceteris paribus* agri-food production in each region ($m_a > 0$). On the other hand, the indirect effect via access to agricultural production is negative ($\xi_a < 0$). This is why table 3 shows that ε_{Ma} can take positive or negative values for plausible values of A_{rst}. It appears that $\varepsilon_{Ma} > 0$ if and only if $\ln A_{rst} < 3.39$. More than half the region/sector pairs may gain from an increase in imports of agricultural products processed by agri-food sectors. The losers are the regions located close to the area where agricultural goods are massively produced. Their competitive advantage in being located close to the production area is reduced relative to the other

regions. Conversely, regions with a disadvantage in terms of location vis-à-vis producers of agricultural goods benefit from trade openness of the agricultural sector.

Second, imports of agri-food products have only an indirect impact through their interaction with labor costs. Although market potential plays a significant role in the location of agri-food production, *more agri-food products imports do not make regions with a high market potential more attractive*. However, a region with low unit labor costs becomes, *ceteris paribus*, progressively more attractive with an increase in imports of agri-food products. Hence, our findings confirm the hypothesis under which more imports of agri-food products induces a reallocation across regions within the agri-food sector. More precisely, *the impacts of trade liberalization on regions depend on their characteristics in terms of the cost of labor and access to agricultural inputs*.

Table 2: Results - Dependent variable: production by sector and by region at time *t*

		Model I full sample		Model II full sample		Model II full sample		Model II No linkage		Model II With linkage	
Variables		coeff	SD	coeff	SD	coeff	SD	coeff	SD	coeff	SD
Regional labor cost	α_1	-9.05***	0,46	-7.09***	0.46	-3.32***	0.28	-5.26***	0.79	-8.35***	0.48
(Regional labor cost)²	α_2	2.04***	0,14	1.86***	0.14	0.86***	0.09	1.22***	0.20	2.61***	0.18
Access to customers	β_1	3.18***	0,98	3.35***	1.12	1.13**	0.63	6.73***	2.47	2.19***	0.88
(Access to customers)²	β_2	-0.43***	0,11	-0.40***	0.11	-0.11	0.07	-0.98***	0.39	-0.22***	0.08
Access to agricultural products	γ_1	1.44***	0.67	1.47***	0.62	1.00***	0.36	-	-	2.29***	0.54
(Access to agricultural products)²	γ_2	0.04	0.08	0.12	0.08	0.01	0.05	-	-	-0.07	0.07
Agri-food products imports	m_s	0.007	0.12	0.38	0.34	0.03	0.16	0.08	0.69	0.57	0.39
Agri-food imports*Access to customers	ξ_s	-	-	-0.05	0.11	0.06	0.04	0.00	0.33	-0.09	0.10
Agri-food imports*Labor costs	ξ_w	-	-	-0.21***	0.03	-0.37***	0.04	-0.18***	0.03	-0.23***	0.06
Imports of agricultural inputs	m_a	0.10	0.14	0.55***	0.21	0.32***	0.13	-	-	0.46***	0.18
Access to Inputs*Agricultural imports	ξ_a	-	-	-0.16***	0.05	-0.06***	0.03	-	-	-0.11***	0.05
Estimator		**IV Tobit**		**IV Tobit**		**IV PPML**		**IV Tobit**		**IV Tobit**	
Log-Likelihood		-8.103.9		-7,972.6		-4,751.9		-3,186.5		-4,315.6	
LR chi2		2,008.8***		2,089.7***		1,308.9***		801.8***		1,951.8***	
Number of observations		4,557		4,557		4,341		1,764		2,793	
Number of uncensored observations		3,475		3,475				1,208		2,267	

Notes: ***: significant at 1%; **: significant at 5%; *: significant at 10%. Region, sector and time dummies have been included in the estimations. SD = Standard Errors adjusted for clusters by industry-region cell.

Table 3: Summary statistics of the elasticities estimated from model II (Tobit estimation) (all sectors)

Elasticities	Equation	Q1	Median	Q3
ε_{Ms}	(2)	-0.184	-0.123	-0.068
ε_{Ma}	(3)	-0.144	0.021	0.553
ε_{MP}	(4)	0.398	0.916	1.394
ε_{A}	(5)	0.466	1.469	1.469
ε_{w}	(6)	-7.318	-6.234	-4.961

Note: Q1 and Q3 mean respectively first and third quartile.

Imports and the tradeoff between proximity to the markets and production costs

We now turn to the impact of increasing imports on the fundamental tradeoff of new economic geography between accessibility to the markets and production costs. As expected, the role played by accessibility to producers of agricultural products in the spatial distribution of agri-food production is weakened by imports of agricultural products ($\xi_a < 0$). However, as suggested by table 3, this negative effect is limited because ε_A remains positive with high imports of agricultural products. It is worth noting that the location of production is more sensitive to a change in access to agricultural production than in access to final consumers, even though increasing imports of agricultural products reduce the incentive to locate close to agricultural producers (see table 3).

In addition, spatial variations in labor costs strongly affect the location of agri-food production. This result is not surprising because the agri-food industry is very labor intensive. Hence, the location of agri-food firms seems to be the result of a tradeoff between agglomeration, in order to enjoy the benefits of a good access to agricultural production, and dispersion, in order to reduce labor costs. In other words, the location of agri-food production is mainly driven by spatial heterogeneity in input markets (labor and intermediate products).

Robustness checks

Additional estimations are needed to check the robustness of our results. When we estimate model II by implementing the PPML estimator, the coefficients have the same sign so that our conclusions remain valid. In addition, it should be noted that some agri-food sectors have no linkages to any agricultural sector (12 sectors in our sample). Thus, we estimate model II when we keep exclusively all sectors with no linkage to the agricultural sector in our sample and when the agri-food sectors that do not process agricultural products are excluded. The results associated with the two estimations are given in table 2 (see model II "no linkage" and model II "with linkage").

When we only focus on the 12 agri-food sectors with no linkage with the agricultural sector (see column "no linkage"), there is no interaction between agri-food imports and access to consumers while more imports of agri-food products render low-wage regions more attractive, confirming our results. Observe also that there is no significant direct effect of agri-food imports on production, regardless of location. These different results hold for the agri-food sectors for which there are some vertical linkages with the agricultural sector (see column "with linkage"). Hence, trade liberalization strengthens the role of production costs in the regional allocation of agri-food production in the sectors that process or not agricultural products. It should be also noted that, as shown in the "no linkage" column in table 2, market potential is a key determinant of production location for these sectors. As expected, the elasticity of regional production to a change in market potential is higher in these 12 sectors than in the whole sample.

Because the 12 agri-food sectors have no linkage with the agricultural sector, we also re-estimate equation (1) from a sub-sample excluding these sectors in order to check if the results concerning agricultural imports effects hold. Results are given in column **"**with linkage**"** of table 2. The effects of agricultural imports on regional production in each agri-food sector have the expected signs because $m_a > 0$ and $\xi_a < 0$ and the sign of ε_{Ma} is ambiguous. These findings confirm our results mentioned above. Furthermore, the maximum value of ε_{M^a} reaches 0.4 and its minimum is about -0.3. The median is close to

zero so that an increase in agricultural imports increases agri-food production for half of the region/sector pairs.

Finally, as mentioned above, increasing imports of agricultural products processed by the agri-food sector weaken the role of access to agricultural production in the location of agri-food production. Despite this negative effect of agricultural imports, the values taken by the elasticity of regional production to a change in accessibility to producers of agricultural goods keep positive whatever the levels of agricultural imports. In addition, the regional level of agri-food production reacts more to a change in access to agricultural products than in access to consumers, confirming our results.

6. Concluding remarks

This article analyzes the effects of the openness of the European market for agri-food and agriculture on the intra-national location of agri-food production in France. Our results enable us to identify the relevant mechanisms in the economic geography literature on the relationship between imports and location of production. We show that freer trade does not make regions with a high market potential more attractive but leads to an increase in the agri-food production mainly in regions with low production costs, confirming the theoretical predictions in Krugman and Livas Elizondo (1996) and Behrens et al. (2007). A next stage of our research could study the relationship between exports and location. For example, in accordance with Behrens et al. (2006), Crozet and Koening-Soubeyran (2004) show that industrial reallocations across Romanian regions are driven mostly by access to European markets.

In addition, our analysis reveals that the gains from freer trade for agricultural products in terms of agri-food production occur mainly in the regions with relatively low access to agricultural inputs. The role played by structural changes in the agricultural sector in the location and performance of the agri-food sector merits more attention in future research. The new economic geography may be a useful framework to treat this question.

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Appendix A. Additional information

Table A1: Growth rates of production and imports by agri-food sector (1995-2002)

Sectors		Growth rate production	Growth rate Imports
Not intensive in agricultural inputs			
Distilled potable alcoholic beverages		-39%	55%
Ethyl alcohol		158%	-19%
Champagnes		38%	183%
Wines		65%	10%
Beers		17%	32%
Malt		-8%	-33%
Mineral waters and soft drinks		-34%	97%
Fish and fish products		39%	36%
Chocolate and confectionery		43%	33%
Tea and coffee		-9%	12%
Condiments and seasonings		61%	88%
Other food products		13%	50%
Intensive in agricultural inputs			
Production and preserving of meat	[1]	14%	-21%
Grain mill products	[2]	-5%	50%
Prepared feeds for farm animals	[3]	12%	300%
Prepared pet foods	[4]	76%	23%
Bread, fresh pastry goods	[5]	14%	50%
Rusks and biscuits; preserved pastry goods and cakes	[6]	29%	46%
Sugar	[7]	5%	69%
Macaroni, pasta, couscous and similar farinaceous products	[8]	13%	44%
Production and preserving of poultrymeat	[9]	20%	18%
Production of meat and poultrymeat products	[10]	31%	31%
Prepared potatoes and vegetables	[11]	-38%	33%
Vegetable and fruit juices	[12]	95%	32%
Prepared fruits	[13]	8%	35%
Homogenized food preparations and dietetic food	[14]	20%	56%
Liquid milk, cream, yoghurt, milk-based soft drinks	[15]	30%	30%
Butter	[16]	6%	-17%
Cheese	[17]	5%	31%
Other milk products	[18]	122%	6%
Ice creams	[19]	4%	71%

Source: own calculation from the ERE

Table A2: List of agricultural products processed by the agri-food sectors

Agri-food sectors	Agricultural product processed by the sector
[1]	Cattle, dairy cows, sheep, goats, horses, pigs
[2]	Durum wheat, soft wheat, maize, barley, other cereal grains
[3]	Durum wheat, soft wheat, maize, barley, other cereal grains, oilseeds or oleaginous fruit…
[4]	Durum wheat, soft wheat, maize, barley, other cereal grains, cattle, dairy cows, sheep, goats, horses, pigs, poultry, eggs
[5]	Soft wheat, eggs
[6]	Soft wheat, eggs,
[7]	Sugar beet
[8]	Durum wheat,
[9]	Poultry, eggs
[10]	Poultry, eggs
[11]	Potatoes, fresh vegetables
[12]	Fresh vegetables, fruits
[13]	Fruits
[14]	Fresh vegetables, fruits, raw milk
[15]	Raw milk (no imports)
[16]	Raw milk (no imports)
[17]	Raw milk (no imports)
[18]	Raw milk (no imports)
[19]	Raw milk (no imports)

Note: figures in brackets refer to the sectors listed in table A1.

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