

The spatial patterns of the Bordeaux wine sector's role in rural areas

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Abstract

This study focuses on the spatial characteristics of the economic impact of a wine sector on rural and urban local areas. It is applied to the Bordeaux vineyard. A model associating a gravity analysis of indirect effect diffusion and a hierarchical urban system is used to analyse agriculture-industry linkages. Results indicate that the economic impact of winery activities are mainly concentrated in rural communities, even for high-order supplying, instead of being captured by urban cores. We show that the polarization of suppliers appears in rural communities, but this agglomerative process doesn't fit the classical urban hierarchy. It creates a functional system of wine-linked industries inside these rural areas.

Key words: Gravity model, rural areas, wine industry, economic impact.

Introduction

Agricultural structures of production are in a process of reform all over the world and rural communities are facing fairly radical changes, due to various factors. Economic interpretations of the new functions of rural areas indicate a shift in demand for outputs produced in rural spaces: while the production of commodities partially loses its significance for agriculture, there is an increasing demand for landscape -rural amenities - (Vollet, 1998; Gibson, 1993) or very specific goods related to the idea of “terroir”. Some studies outline the influence of population/employment interactions and natural amenities on rural economic dynamics (Schmitt, 1999; Henry et al. 1997). Moreover, the forms taken by spatial multipliers indicate a trend for value concentration on urban areas (Olfert, Stabblar, 1994, 1999; Robison, 1997; Robison, Miller, 1991; Hamilton et al., 1991; Gilmer, Keil, Mack, 1989; Thompson, 1983). According to the hypothesis that in terms of inter-industry linkages, rural economies are badly suited to retaining the benefits of increases in local activity (Roberts, 1998, p. 507), research has sought to broaden study other types of rural dynamics. Both forms of analysis reinforce the idea of a growing dependence of the development of rural areas on urban centres.

In this paper, we focus on the ability of agricultural sectors to structure the economy of rural areas, by creating poles of concentration of value characterised by a complementarity of economic functions. The economic performance of the agricultural sector can be read through its economic performances (competitiveness) and its ability to produce added value and employment at the local level. Our point of view is that the existence of such poles – whose structures are based on inter-sectoral linkages - depends on agricultural dynamics and not only on some revenue-final demand multiplier mechanism.

Moreover, we consider that this rural structure is not the result of a dispersion process (from cities) of activities due to the spacial consumption of agriculture or to transport costs as shown in some models of Economic Geography (Fujita, Krugman, 1995). Instead, they are the result of a polarization process caused by the agglomerative effects generated by inter-industry relationships grounded in the agriculture sector.

The wine sector is used as a demonstration and our empirical study focuses on the famous vineyard of Bordeaux.

Using this example, we test for the presence of added value concentration in rural places and for the presence of a polarization process in these communities, which can both be attributed to the wine sector. We have studied concentration process through agriculture-industry links, and we focus on the main structure of relationships: between wineries and their suppliers. In this way, we incorporate spatial effects into the direct and indirect impacts of the activity of wineries: through the interactions of viticulture with the other sectors in rural areas. In our models, a multiplier does not strictly specify relationships between direct and spatially distributed indirect effects, and this despite the fact that our research perspective is heavily informed by gravity models developed in spatial economics.

We find empirical evidence that the wine sector generates added value not only towards the main urban locations but also essentially among rural communities. We show that the indirect added value concentrates in rural areas, creating poles characterized by functional complementarities.

This article discusses spatial forms of added value flows. It will illustrate these by examining two types of gravity models discovered in our case study of the Bordeaux Vineyard

Two gravity models

In type I models, we focus on the definition of economic potential. We hypothesize that the spatial diffusion of indirect effects doesn't follow a classical structure of polarization grounded on centrality hierarchy. On the contrary, we identify another concentration pattern based on the type of wine specialisation developed in each rural communities. Three ways of weighting the gravity model are tested.

In type II models, we integrate a distinction between a range of different goods used by the wineries. We validate the hypothesis that the tension produced by the distance variable on indirect effects decreases with the hierarchy of sector functions (low-order goods and services, specific goods and services, high-order goods and services).

Plan

Section one discusses some of recent research carried out in the field of rural inter-industrial dynamics. This highlights two sources of concern that limit the effectiveness of the modelling approach. Section two is an overview of the competitiveness of Bordeaux's wines. The role played by wine production in the local economy justifies questions about its structuring function for rural areas. A database is introduced in section three and specification of the model is discussed in section four. Section five shows results of the econometric estimation and we discuss their implication for the perception of rural dynamics. Finally, section six offers a summary and conclusion.

1. Conceptual background

Two important types of theoretical reflection have contributed to linking the dependency of rural areas on urban dynamics: regional development models and spatial multipliers. These models contribute to asserting the idea that agricultural resources are no longer sufficient to

guarantee the development of rural areas, whose future will be determined by their ability to satisfy urban demand for recreational and residential use.

Both types of models consider spread and backwash effects relative to growth pole theory, but the former concentrate more on structural co-evolution of rural and urban places whereas the latter study inter-industry linkages and flows of revenue between these areas. These latter models deal with the ability of rural areas to develop and benefit from an economic structure characterised by a functional complementarity. The general framework is the nodal response one (Parr, 1973): it analyses the spatial characteristics of growth when peripheral areas generate it. The related hypothesis can be summed up through the principle that the urban core benefits from the major part of growth produced in the hinterland.

1.1. Regional development models: a structural dependency

Rural changes are interpreted by the regional science approach using regional development models. Most of them are extensions of the Carlino and Mills (1987) and the Boarnet (1994) models to test for the presence and direction of rural-urban linkages (Henry, Barkeley and Bao, 1997; Schmitt and Henry, 2000). The general point of view is that population and activity concentrations in the core influence the periphery dynamics (Schmitt, 1999). They highlight agglomerative and dispersive forces at work in rural areas and determine factors of change in rural population and employment. Decreasing commuting costs can explain the suburbanisation of populations, which seek natural amenities. Consequently, in these models, the notion of urban proximity is highly significant to the production of rural dynamics. Also based on rural amenities, the development of recreational and residential activities in rural places creates job concentration. These areas then also benefit from urban consumption.

It appears clearly in these models that the future of rural areas is essentially seen through the behaviour of urban populations and activities.

1.2. Spatial multipliers: a functional dependency

Numerous spatial multipliers models have been developed since the 1970s, based on the principle that growth doesn't spread evenly over space. They are all grounded on economic (export) base theory, input-output matrix, or on regional income multipliers. These models can be classified into three types: small area multipliers, centre/periphery or central place multipliers and gravity multipliers models. Most of them focus on rural places and study interactions between urban and rural industries.

Whereas central place hierarchy or core/periphery multipliers models focus on the variation in size of economic multipliers for communities of different functional classification in the urban hierarchy, gravity models pay more attention to the direction and intensity of income spread effects over space.

Multiplier effects defined for central place or core/periphery systems include community specific multiplier, and cross-community multiplier effects. The resulting multipliers vary with functional level (Olfert and Stabler, 1994, 1999); the biggest community (urban centre) gets the highest multiplier, which decreases with hierarchy. Other spatial input-output models try to measure the intensity of spread and backwash effects between an urban core and its rural hinterland. Spillover effects from rural to urban areas seem to be more important than urban to rural ones (Hughes, Holland, 1994; Hughes, Litz, 1996) except when the formulation is grounded on a SAM (Social Accounting Matrix) bi-regional model (Robert, 1998). In these models, cross-community multipliers do not focus on flows but on the influence of the community's economic structure on the value of the multiplier. They don't take into account the geographic proximity between the urban core and its rural periphery or between the different levels of the urban hierarchy. However, distance matters because it can either isolate or protect rural areas (Huriot, Perreur, 1998). Gravity models raise the importance of geographic proximity and the economic potential of cities to explain

the direction and intensity of economic linkage. They tend to confirm that the biggest cities benefit most from an economic impact, especially when located close to the source of such growth (Erikson, 1977; Biles, 2002). As shown in the Doyle and al. study (1997) based on a gravity model, the ultimate beneficiaries of continued agricultural support are urban centres and not the initially targeted disadvantaged rural areas.

In summary, these models can lead us to the general conclusion that if a process of revenue diffusion exists from cities to rural areas, a polarization of functions towards urban cores nevertheless constitutes a more dominant trend.

The theoretical discussion set out above raises a number of testable hypotheses that are examined in the following sections. As we deal with the wine sector, and more specifically with the activity of wineries located in the hinterland, we test for the presence of nodal response tendencies concerning spill-over effects from the periphery: does the indirect added value benefit more to the urban core? Or do the communities located in the hinterland mainly retain this added value? Impact analysis is used to indicate the level of the key periphery sector's (wine production) spill-over to the core communities.

2. Choice of the study region: the economic dynamics of the Bordeaux Vineyard

Our purpose is to question the hypothesis of a great dependence of a rural areas development on recreational and residential functions. We question whether this is really a general trend. Using the example of the massive vineyard of Bordeaux (124 000 hectares, a 7 million hectolitres production (2000)), we want to show that economic efficiency leads to the construction of a solid economic structure in rural areas.

The ability of a sector to produce economic impact is generally associated with its competitiveness and employment dynamics (Catin, 1998). As for the Bordeaux wine industry, we examine both criteria.

2.1. The competitiveness of Bordeaux wines

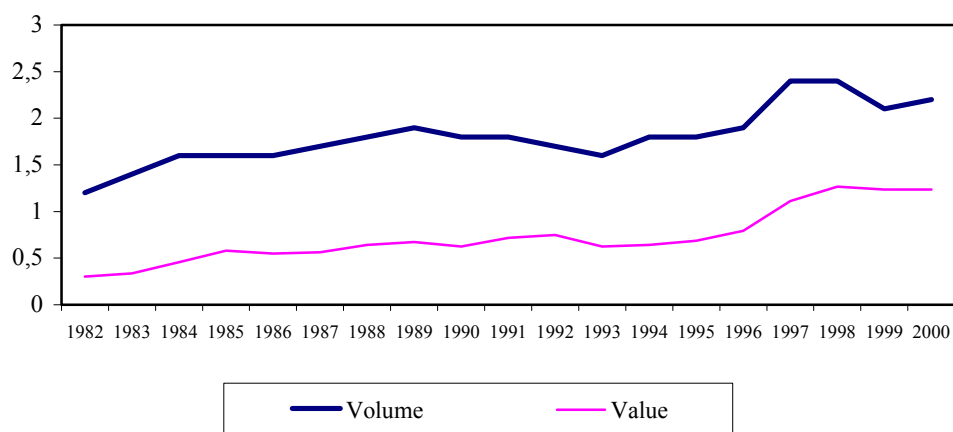
Even if Bordeaux wines encounter loss of market shares in several countries (United Kingdom, United-States) the wine sector remains structurally competitive through the period studied (table 1 and figure &) as exportations have been increasing all this time (1988-2000).

The Bordeaux region is of great significance from the standpoint of exportation. It accounts for 24,1% (year 2000) of national wine exportation, just after Champagne. From a local point of view, the part of wine sales in total exportations has been decreasing for the last four years: it accounted for 15% of the total in 1998, for 10% in 2001. However, the wine sector still ranges second or third, depending on years, in regional exportations.

Tableau 1 and Figure 1: Evolution of Bordeaux wine exportations from France: volume (million of hl) and value (million of Euro)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Volume	1,2	1,4	1,6	1,6	1,6	1,7	1,8	1,9	1,8	1,8	1,7	1,6	1,8	1,8	1,9	2,4	2,4	2,1	2,2
Value	0,3	0,3	0,5	0,6	0,5	0,6	0,6	0,7	0,6	0,7	0,7	0,6	0,6	0,7	0,8	1,1	1,3	1,2	1,2

Source : CIVB (Conseil Interprofessionnel des Vins de Bordeaux)¹



2.2. Viticulture employment and the overall impact of the wine sector

The most striking figure is the trend of employment in the vineyards. Employment decline in rural areas arises mainly from agriculture. Census data (1979, 1988, 2000) indicates that employment in agriculture has been deeply decreasing in France for the last twenty years. However, from a regional point of view, it has significantly grown in the Aquitaine region. We use a shift-share model to analyse the French evolution of agriculture employment at a regional level in order to define whether this evolution is only due to the wine specialisation of the region (which appears as a dynamic sector from an employment point of view) or is also dependent on its own local attractiveness. This shift-share model is built on a two factor weighted variance analysisⁱⁱ. Whereas the structural effect indicates the growth a zone would have been expected to experience given its initial agriculture composition, the residual effect measures the net attractiveness of the region compared to others. Indeed, results show that the residual effect is positive and significant for the region (Aquitaineⁱⁱⁱ): it indicates that Aquitaine is characterised by a strong attractiveness (actually it is the sole region whose residual effect is positive and significant). This result shows the dynamism of agricultural structures (Bonnet, 1997). As the wine sector highly dominates the regional agricultural employment, we conclude that its attractiveness is grounded on its dynamism.

From a local point of view, viticulture accounts for 78% of the agricultural sector in Gironde. More generally the whole wine industry (including the typical direct, indirect and induced effects) accounts for 12% of total employment in the 'département'. It also represents 15% of the added value created in the 'département'. This result (the estimation of induced effects) is obtained using a traditional economic base multiplier estimate for the Gironde 'département' (Doucet, 2002).

However, the importance and dynamics of the wine sector in Gironde does not answer the question of what structures the spatial economy of the wine sector. The following sections develop this problematic.

3. The Data Base

All spatially distributed indirect effects are given on an added value basis.

The discussion and analysis focus on the French ‘département’ called the Gironde, whose administrative limits include the whole Bordeaux vineyard. Numerous publications have sought to define the pertinent region for estimating spatial multipliers: nodal region (Brown, Holmes, 1971), metropolitan region (Parr, 1987), functional areas (Vias, Mulligan, 1997 ; Stabler, Olfert, Greuel, 1996), micro-region (Dion, 1987). In the case of the Bordeaux vineyard, it is useful to stress the fact that the delineation of the Bordeaux denomination has been built on the basis of the administrative frontiers of the ‘département’. That is why we use this administrative level for our analysis.

Data was collected to identify i) the detailed demand of the wineries for input and investment related to the specific wine activity and ii) the economic and spatial characteristics of their suppliers. The information was obtained from a survey undertaken using a representative sample of a hundred wineries located in the ‘département’ for the year 1999. This sample is the very one used for all economic information collected on agricultural exploitations. It is built on the FADN basis (Farm Accountancy data network^{iv}). In this survey, the collected information takes into account all the spending flows corresponding to investments and inputs of wineries: they are considered individually for each winery, and classified by type of supplying. Moreover, each spending flow is associated to one supplier whose location is defined^v. All identified suppliers were surveyed to define i) their total turnover and ii) their total added value.

Indirect impact represents added value created by the wineries in the upstream sector (suppliers).

We define an **individualised functional relationship**^{vi} between the winery's w demand for a type of supplying j^{vii} , to a s supplier (D_{wjs}) and the related indirect added value created to this same supplier IAD_{wjs} .

Then, IAD_{wjs} is defined by the relation:

$$IAD_{wjs} = D_{wjs} \cdot \frac{AV_s}{T_s} \quad (1)$$

Where AV_s and T_s are respectively the supplier's total added value and total turnover for the year 1999. That means that a value-added/turnover ratio is calculated for each supplier in the database.

Through this functional relationship, it is possible to estimate the amount of indirect added value created for any input purchased by a winery but also the destination of this value over space. Compared to other gravity models (Erikson, 1977; Richardson, Gordon, 1978; Biles, 2002), effects in the study are considered for a group of one hundred representative wineries located all over the Bordeaux vineyard, and not only from a unique pole. This approach is interesting in the sense that the analysis is carried out on a quite large area (the 'département' of Gironde has an area of 1 million hectares), but the diffusion process is defined at a disaggregated spatial level.

4. Global analysis of spatial diffusion of value and construction of the gravity model

This section is carried out in two stages. First, we define a regional urban structure grounded on the principle of a functional hierarchy. Here, we look at the concentration of indirect added value created by the wineries in relation to their place in a spatial hierarchy. Second, we build gravity models using the 'département' hierarchy as one of the variables weighting the model.

4.1 The regional structure: hierarchy and specialised centres

As far as the empirical analysis is concerned, the first task is to classify communities according to their appropriate level within the urban classification. The system is defined according to an urban hierarchy founded up on urban size and function (it is close to a central place hierarchy concept *à la* Christaller). The communities in Gironde are classified according to their position in the community system defined by the INSEE^{viii} (National Institute for Statistics and Economic Studies), and according to their population and employment profiles. We build a five-level urban hierarchy. The affectation of each community to a level relies on a combination of these three criteria:

- 1) The type of community defined by the INSEE: a classification based on commuting flows
- 2) The population size
- 3) The proportion of total employment in the service sector

Classification of Gironde communities by level:

Level 1: primary wholesale retail centre: Bordeaux and first “crown”

Level 2: secondary wholesale retail centre and its influence area: Libourne, Langon, Arcachon

Level 3: Bordeaux ex-urban cities

Level 4: Isolated communities

Level 5: rural communities

The characteristics of each level are given in table 2.

The first three levels of the Gironde hierarchy are defined on the basis of the taxonomy of main Metropolitan Statistical Areas (MSA) as the INSEE proposes it. Other communities of the ‘département’ can be considered away from metropolitan areas. Two levels are determined: isolated cities and rural communities.

Figure 2 : Urban hierarchy in Gironde

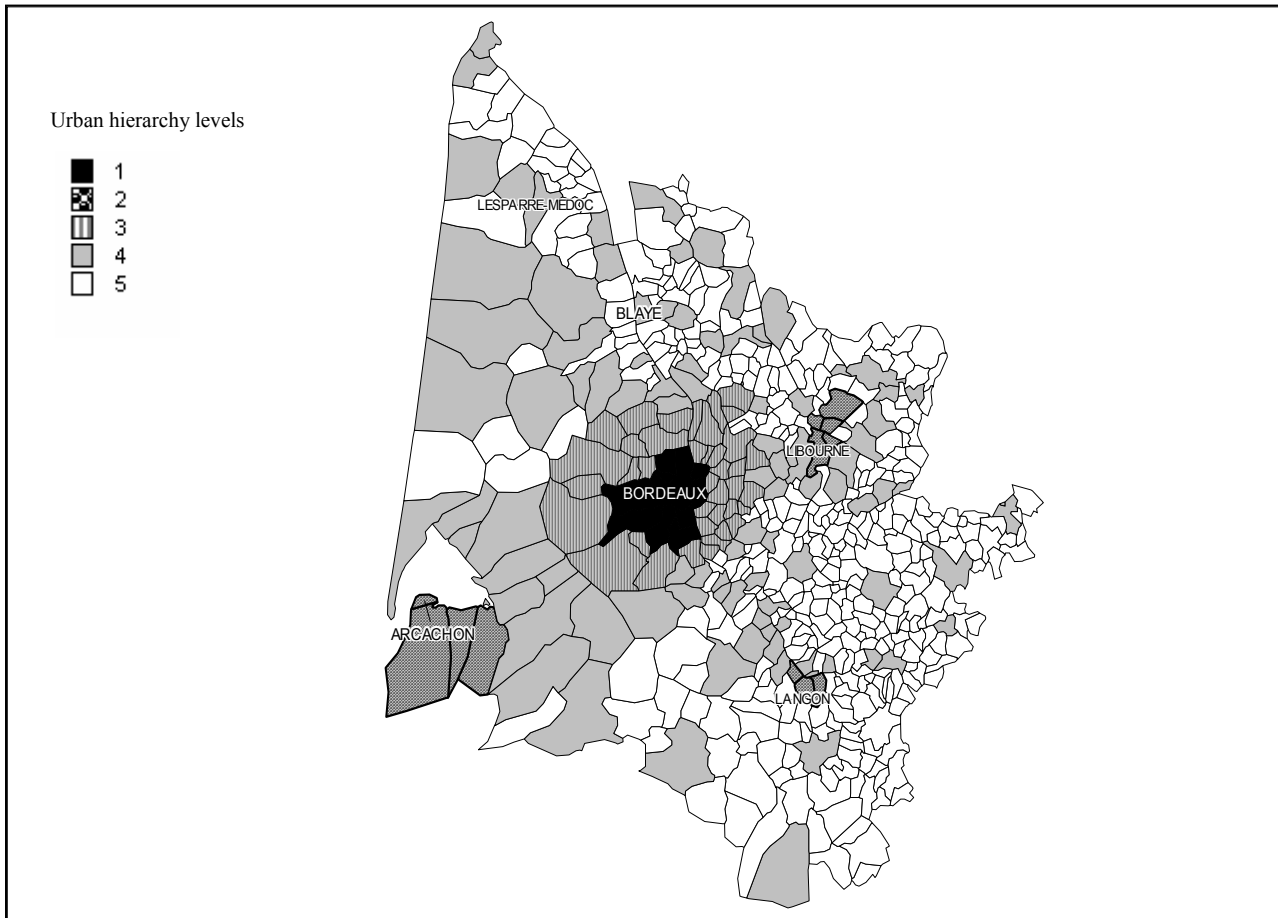


Table 2: Employment and population characteristics of each urban hierarchy level

	Number of communities	Average employment level	% of employment in the industry service sector	Average population	Ratio employ/pop	% of the level in total employment	% of the level in total population
<i>Level 1</i>	12	13812	21,90%	42801	0,32	58,2%	42,3%
<i>Level 2</i>	9	2162	15,13%	8966	0,24	6,8%	6,6%
<i>Level 3</i>	40	1301	13,14%	5192	0,25	18,3%	17,5%
<i>Level 4</i>	128	290	13,18%	2024	0,14	13%	21,3%
<i>Level 5</i>	352	21	5,71%	420	0,069	3,6%	12,2%

All flows of indirect added value captured by communities (suppliers location) are then allocated to the corresponding hierarchy levels. We estimate the overall induced effects captured by a hierarchy level.

Let $IAV_{j,z}$ be the proportion of the total indirect added value captured by any zone z for any supplying j :

with $z=1,\dots,5$; $w=1,\dots,100$ and $j=1,\dots,15$

$IAV_{j,z}$ is defined as the ratio between the indirect added value created by all wineries w of the sample for any supplying j and captured by any zone z (among the five hierarchy levels), and the total indirect added value created by the wineries.

$$IAV_{j,z} = \frac{\sum_w \sum_s IAV_{wjzs}}{\sum_z \sum_j \sum_w \sum_s IAV_{wjzs}} \quad (2)$$

IAV_z is then the proportion of total added value captured by the z zone. It simply equals:

$$IAV_z = \sum_j IAV_{j,z} = \frac{\sum_j \sum_w \sum_s IAV_{wjzs}}{\sum_z \sum_j \sum_w \sum_s IAV_{wjzs}} \quad (3)$$

and $R_{j,z}^{IAV}$ is the proportion of indirect added value of a supplying j captured by the z zone :

$$R_{j,z}^{IAV} = \frac{\sum_w \sum_s IAV_{wjzs}}{\sum_z \sum_w \sum_s IAV_{wjzs}} \quad (4)$$

The resulting allocations of flows of indirect added value to the various levels of the urban hierarchy are given in table 3. It shows that 66% of the indirect added value are kept in rural areas, whereas only 34% of this value goes to urban places. The second point is that the concentration on rural spaces not only concerns low-order goods, but also other industry services (rental, wine analysis) and specialised goods (labels, barrels, wine material...). So, i) the intensity of the concentration observed is opposite to the principles associated to the concept of nodal response and ii) the structure of concentration (type of activities) is the opposite of the principle that industries located in rural places seek unskilled and cheap workforce.

Table 3: Distribution of indirect added value to each level of the hierarchy ($R_{j,z}^{IAV}$)

Type of supplying	Hierarchy level				
	1	2	3	4	5
<i>Fertilizers, plant-care products</i>	3%	10%	6%	52%	29%
<i>Viticulture works</i>	0%	9%	18%	33%	39%
<i>Wine works (bottling...)</i>	0%	3%	1%	28%	68%
<i>Oenological analyses and consulting</i>	26%	5%	5%	19%	46%
<i>Wine retailing</i>	6%	12%	7%	63%	12%
<i>Cork, bottles, cap</i>	35%	4%	23%	33%	6%
<i>Miscellaneous packing</i>	1%	9%	27%	60%	4%
<i>Labels</i>	28%	12%	12%	42%	6%
<i>Transport</i>	41%	48%	7%	4%	0%
<i>Wine production equipment</i>	4%	13%	19%	41%	23%
<i>Tank</i>	21%	3%	14%	57%	5%
<i>Barrels</i>	3%	39%	3%	55%	0%
<i>Communication, advertising</i>	82%	9%	1%	7%	2%
<i>Data processing and electronic equip</i>	93%	0%	5%	2%	0%
<i>Material renting</i>	33%	2%	1%	40%	24%
<i>Total (IAV_z)</i>	11%	10%	13%	40%	26%

4.2. Spatial diffusion of indirect effects: a gravity model

To link rural development with a structuring role of viticulture, it is necessary to go beyond the global effect - at a local level - of the wineries' economic impact. We need to estimate the spatial distribution of economic effects. To carry out this task, we built a model grounded on gravity analysis. Actually, our starting point of the methodology for estimating indirect impact is close to a type I input-output model (that generally considers only direct and indirect effects), as it details inter-industry linkages, but specific to wine production. Nevertheless, by limiting the analysis to indirect impact, and by taking advantage of very precise and individual data for the wineries and their suppliers, we avoid methodological shortcomings often encountered on spatial multiplier models. These are commonly due to the creation of local information that doesn't exist (conversion of national input-output matrix to regional scales, heroic assumptions concerning production factors...).

Gravity models are quite conventional approaches to modelling the spatial characteristics of economic impacts including the notion of geographic proximity (Erikson, 1977; Richardson, Gordon, 1978; Biles, 2002). They are based on the concept of *economic potential*, which is an indicator of the *accessibility* and *spatial influence* of a region, a functional area, or a community. The likelihood of economic transactions between two places is supposed to depend on both variables (Doyle and al, 1997). To measure economic potential, traditional variables like distance and economic importance (typically population or employment) are commonly used (Biles, 2002).

In the case of economic impact analysis, gravity models can be specified by a general equation of the following type:

$$I_{i,j} = C \cdot (D_i)^\alpha \cdot (P_j)^\beta \cdot (DIST_{i,j})^\delta, \quad (5)$$

where, the value of induced effect (employment or revenue) generated from a place i and captured by a place j , I_{ij} , depends on the direct effect created in i (D_i), on the economic potential of j and on the distance between i and j .

Like economic base models, (Biles, 2002), we first assume that indirect effects depend on direct effects created by wineries. So all the models built in this section are grounded on the principle that the indirect added value created by a winery for a type of input j to a supplier p is a function of the winery's direct added value, the distance between the winery and the supplier d_{ip} , and a final variable indicating the economic potential of the community where the supplier is located.

To analyse the spatial structure of indirect effect, we distinguish between two types of gravity models: type I models are quite general gravity models where the variables indicating the economic potential are discussed, whereas type II models focus on a distinction between the spatial pattern of flows when types of supply are distinguished.

According to the concept of nodal response, we test the hypothesis that the value created by wineries polarises toward main cities. Gravity models are generally weighted by the population of the city that gets the benefit of the spillover process. In such cases, as indicated above, the induced added value is a function of direct added value, population and distance, without any other variable being introduced in the model. Our empirical test of the spatial characteristics of indirect added value diffusion shows that, for the Bordeaux wineries activity, this model is not valid. Population or functional level cannot explain the concentration of value on some communities. It is necessary to introduce another variable to weigh the gravity model. The one chosen indicates the functional specialisation of the community in wine-linked industries. This specialisation is defined according to the supplier database. We calculate the number of firms located in a community providing

goods or services to the wineries. This number^{ix} is used as the indication of community specialisation.

We show that wine production creates a polarization of activities in rural areas, which does not depend on the classical criteria of urban centrality.

Type I models

Type I models test the influence of the distance variable (between the winery and its supplier) and of three different variables indicating the economic potential of communities. Distance matrix is given on a Euclidian distance basis between the inducting pole (where the winery is located) and the destination zone of added value flow.

The database gives individual flows of indirect added value between the wineries and their suppliers. Flows related to the same winery, and allocated to the same community are all aggregated in these type I models. There is no distinction between types of supplying in these models. We build a $I\Delta V_{ij}$ generic matrix. The terms $I\Delta V_{ij}$ indicate the indirect added value created by a winery located in the community i^x and captured by the community j .

Type I models are formulated according to a classical gravity pattern in order to explain the intensity of added value flows between two locations: the distance between both locations and a weighting variable. As a result, weighting variables introduced in the gravity models are:

POP: population of the community

LEV: level of the community I in the urban hierarchy

NSUP: number of wineries' suppliers located in the community

Two models are first estimated to compare the incidence of two classical weighting variables on the indirect added value.

The first one (model 1) explains the community's attraction of indirect added value by the direct added value, the distance between the winery's location and the supplier's one, and by the size of the city where the supplier is located (POP_j).

In the second model (model 2), the variable indicating the size of the community (POP_j) is simply replaced by the hierarchy level of the community (LEV_j).

The correlation coefficients between explaining variables of the three models indicate the weak collinearity of these variables. However, it is indubitable that the POP, LEV and NSUP variables are strongly correlated. This justifies the respective estimations of the models.

Table 4 : correlation coefficients between independent variables

	<i>POP</i>	<i>DIST</i>	<i>NSUP</i>	<i>LEV</i>	<i>VA</i>
<i>POP</i>	1				
<i>DIST</i>	0,087	1			
<i>NSUP</i>	0,665	0,0820	1		
<i>LEV</i>	-0,523	-0,136	-0,514	1	
<i>VA</i>	0,142	-0,025	0,179	-0,217	1

All models are estimated through an OLS method.

Model 1:

$$IAV_{i,j} = C \cdot (AV_i)^\alpha \cdot (POP_j)^\beta \cdot (DIST_{i,j})^\delta \quad (6)$$

Model 2:

$$IAV_{i,j} = C \cdot (AV_i)^\alpha \cdot (LEV_j)^\beta \cdot (DIST_{i,j})^\delta \quad (7)$$

In the third model, NSUP, indicating the wine specialisation of the community, replaces POP or LEV as a weighting variable.

The model formulation thus becomes:

Model 3:

$$IAV_{i,j} = C \cdot (AV_i)^\alpha \cdot (NSUP_j)^\beta \cdot (DIST_{i,j})^\delta \quad (8)$$

Type II models

Jayet (1996, p. 385) indicates that to obtain a classical scheme of centrality hierarchy, it is necessary that distance effects should decrease and simultaneously that scale effects should rise when elevating in the levels of hierarchy. Thus, the role of transport costs – due to the commuting of a good, a service or their user – must decrease when you pass from a low hierarchy level to a high level.

In this study, the diffusion of added value flows does not respect a classical central place framework. On the contrary, it suggests the existence of other types of polarization phenomena. If these flows respect the theoretical principle of a distance effect decay related to the progression along the sector hierarchy, then we put the stress on an original phenomenon: the wine industry induces functional centrality among linked industries, but these centralities are independent from the urban hierarchy framework. Moreover, these centralities all show the attributes of polarizing functionality that are usually not existent in rural areas.

The basic principle of the building of Type II models is a distinction between different types of supply. On the basis of individual data, flows of indirect added value are now aggregated according to a distribution into three sector levels. These levels are defined on the basis of a functional hierarchy applied to different types of good and services.

Group 1: Low-order goods and services: Fertilizer, wine retail, miscellaneous packing...

Group 2: intermediate goods and services: Sampling, bottling, material renting, and tanks, wine material...

Group 3: low-order goods and services: data processing material, oenological analyses and consulting, communication and commercials, barrels, bottles...

As for the former models, the indirect added value is explained by direct added value, the distance variable and the specialisation of the community in wine related activities:

Models 4, 5 and 6:

$$IAV_{i,j,g} = C \cdot (AV_i)^\alpha \cdot (NSUP_j)^\beta \cdot (DIST_{i,j})^\delta \quad (9)$$

With $g = 1, 2$ or 3

5. Empirical results and comments

Type I models

Tests on the three type I models show the results given in table 5.

The application of White's general test allows us to conclude that there is no heteroscedasticity among the disturbances for the three models.

Table 5: Empirical results for type I models

Variable	Coefficient	t-stat	Prob.
Dependant variable :			
LOG(IAV)			
MODEL 1			
C	2,581	2,426	0,015
LOG(AV)	0,585	10,202	0,000
LOG(POP)	0,028	0,575	0,565
LOG(DIST)	-0,238	-3,264	0,001
R ²	0,181		
Ajusted R ²	0,176		
White test	13,364		
prob	(0,146)		
F stat	41,664		
(prob (F))	(0.000)		
MODEL 2			
C	2,254	1,94	0,053
LOG(AV)	0,689	10,61	0,000
LOG(LEV)	0,087	0,62	0,533
LOG(DIST)	-0,214	-3,038	0,003
R ²	0,183		
Ajusted R ²	0,181		
White test	11,602		
(prob)	(0,236)		
F stat	41,681		
(prob (F))	(0,000)		
MODEL 3			
C	3,764	3,310	0,001
LOG(AV)	0,574	9,715	0,000
LOG(NSUP)	0,316	4,223	0,000
LOG(DIST)	-0,350	-4,759	0,000
R ²	0,231		
Ajusted R ²	0,226		
White test	10,291		
(prob)	(0,327)		
F Stat	52,879		
(prob (F))	(0,000)		
<hr/>			
<i>Sample size</i>	584		

Centrality without hierarchy

The AV_i coefficient is positive and significant (at a 1% confidence level) for the three models. This result fits the general economic multiplier models. It indicates the high dependence of the intensity of indirect added value flows on the level of direct added value created by wineries. In our case study, the significance of this relationship can be considered as an indicator of the qualitative options of a winery (Doucet, 2002).

The empirical results show that the distance variable is of great significance to explain the intensity of indirect added value flows attracted by a community. This indicates that those flows are decreasing when the distance between the winery and the supplier increases. The result confirms the hypothesis developed in models using gravitary formulation (Biles, 2002; Erikson, 1977). It also complies with the results of other studies using distance weight matrix in regional development models in order to analyse the process of urban diffusion on rural areas (measure of suburbanization) (Schmitt, Henry, 2000; Henry et al., 1996).

However, in the two former models, the weighting variable indicating the economic potential of the communities is not significant. Big cities do not benefit from the indirect added value flows. The estimation's results seem to confirm our first assumption concerning the agriculture-industry structure of the Bordeaux wine sector: there is no polarization on main cities of the induction process from wineries. Moreover, the idea that flows of value should respect an urban functional hierarchy is not confirmed as the LEV variable is not significant (model 2). We cannot conclude that the spatial characteristics of the wine sector's economic impact respect a pattern of functional hierarchy. These results are likely to strengthen the idea of Jayet (1996, p. 385): "the formation of centralities in space and their hierarchy are not two phenomena necessarily depending on each other".

Even after controlling for the impact of the distance variable, the residual effect of city size or functional level is not significant.

As spatial structures of agriculture-industry linkages do not fit the classical patterns of agglomeration, these lead us to consider another explanation for the spatial process of value diffusion.

When considering the latter model (model 3), it appears that community specialisation in wine related activities is highly significant (at a 1% confidence level), contrary to the former models. It positively influences the ability of a community to get benefit of the creation of indirect added value, which is quite trivial. The combination of both results leads to even more interesting conclusions: whereas direction and intensity of flows generated by wine-industry relationships are influenced by the community specialisation in the wine sector, they do not depend on community size or its level in the urban hierarchy. The polarization of added value on specific communities reveals strong centrality logics but these logics do not fit a hierarchical pattern.

The spatial structure of the wine sector's economic impact doesn't fit the classic urban functional hierarchy. The wine specialisation of communities upon which the agglomerative process is based is different from this hierarchy. That is, spatial characteristics of the impact of wineries on the local economy are more network-like than centripetal.

Inter-industrial relationships appear quite important locally. The resulting structure of production allows us to go beyond the logic of a revenue-final demand multiplier to explain economic dynamics in the Bordeaux rural areas. The location of wineries produces a network of activities in rural areas, generating added value and conserving a part of high skilled employment. Their perennality depends on the competitiveness of the wine sector.

The negative effect of distance on the diffusion of added value towards a community together with the positive influence of this community specialisation, produces local forms of attractive forces. Distance turns out to stimulate agglomerative effects.

Tradeoff between economies of scale and transport costs, based upon the market areas provides some classical explanation of the concentration of the suppliers of banal or high order goods and services in rural areas. However, this phenomenon is accentuated by the polarization of these indirect effects towards centres characterized by complementarity of the functions involved in making wine. Two types of economic interpretation can explain this. Inspired by Economic Geography, the first considers that pecuniary externalities linked to the practice of multi-buying by winemakers favors the effects of agglomeration. The nature of the economies of agglomeration therefore needs looking at in detail: the traditional distinction between the economy of localization and the economy of urbanisation, which in turns distinguishes between the intra and inter-sectoral nature of externalities can be put to good use here. The discovery of poles of winemaking specialization seems to belong to the first of these orders. In this way, we have come across a classical research finding according to which the economies of localization are most favourable to medium sized towns (Henderson, 1997).

The second interpretation stems instead from the analysis of innovative districts because it highlights non pecuniary externalities that are specific to a particular industry (the diffusion of knowledge, technological externalities). The concentration of different activities linked to the wine sector in zones of inferior rank, is linked to the question of the effects of agglomeration defined with the notion of hierarchy (Carlier, 1999; Courlet, 1999).

Type II models

Tests on the three type II models show the results given in table 6.

Again, the application of White's general test allows us to conclude that there is no heteroscedasticity among the disturbances for the three models

In these models, the influence on indirect added value of the direct added value created by a winery is still positive and significant whatever the goods or services.

Erikson (1977), Shahidsaless, Gillis and Shaffer (1983) have suggested that distance could become secondary when local space can't meet the demand for some specific goods or services. Shahidsaless, Gillis and Shaffer and show that this phenomenon is more sensitive for effects linked to the service sector whereas Erikson suggests that this effect only concerns specific military industry inputs. However, he doesn't validate this hypothesis. In this study, the three models proposed answer this type of question, and validate the main conclusions. Indeed, they show that the negative influence of distance on the diffusion of value decreases with the hierarchy of goods and services. It is not significant for high ordered goods, whereas its influence is quite considerable for low-order goods (cartons, wine retail, fertilizer), or for specific agricultural services (vineyard-works).

Table 6: Empirical results for type II models

MODEL 4			
Dependant variable: LOG(IAV)			
Sample size : 395			
Variable	Coefficient	t-Stat	Prob.
C	6,861	4,35	0.000
LOG(VA)	0,402	4,09	0.000
LOG(NFOUR)	0,131	1,45	0.148
LOG(DIST)	-0,444	-5,18	0.000
R ²	0,109		
Ajusted R ²	0,096		
F-statistic	14,533		
(Prob(F))	(0,000)		
White test (prob)	0,841 (0,57)		
MODEL 5			
Dependant variable : LOG(IAV)			
Sample size : 286			
Variable	Coefficient	t-Stat	Prob.
C	3,638	2,271	0.024
LOG(VA)	0,501	5,315	0.000
LOG(NFOUR)	0,177	1,964	0.050
LOG(DIST)	-0,181	-1,731	0.084
R ²	0,11		
R ² ajustés	0,10		
F-statistic	11,592		
Prob(F-statistic)	0,000000		
White test (prob)	0,71 (0,70)		
MODEL 6			
Dependant variable : LOG(IAV)			
Sample size : 185			
Variable	Coefficient	t-Stati	Prob.
C	-1,24	-0,53	0.59
LOG(VA)	0,51	3,73	0.0003
LOG(NFOUR)	0,33	2,69	0.0079
LOG(DIST)	0,10	0,70	0.4802
R-squared	0,12		
Adjusted R ²	0,10		
F-statistic	8,46		
Prob(F-statistic)	(0,000)		
White test (prob)	1,437 (0,17)		

For high-order goods, the influence of transport costs is more limited whereas the scale or agglomeration economies are increasingly necessary for their production. Market areas increase with the wine specialisation of input. These empirical results comply with the theoretical principles of agglomerative effects. However, they cannot lead us to the conclusion that value induced by the demand for high ordered goods or services is polarized on main urban cores, as suggested by central place theory (Lösch, Christaller). Indeed, we show that indirect effects linked with demand for high ordered goods also concentrates on rural communities, and not only on urban cores. In the third model too, the variables indicating a hierarchy level or a city size are not significant.

However, empirical results indicate that the influence on value concentration of the community's specialisation in wine-linked industries is all the more important (positive and significant) as goods and services are high ordered. Indeed the variable is not significant in the first model; it is significant for a 5% probability in the second one, and for a 1% probability in the last one.

In summary, we reach the conclusion that effects of community specialisation are more important for high ordered goods and services, and the influence of distance decreases with the goods hierarchy as transport costs are no longer significant. Agglomerative effects exist for the location of industries providing high ordered goods and services in the case of wine activities. However, the polarization process doesn't match the classical framework of central place theory, because communities where such industries concentrate are not located at the top of the hierarchy.

6. Summary and conclusion

In this paper, we used a gravity model to determine the spatial characteristics of the impact of winery activity on the local economy. The case study of the Bordeaux vineyard offers an example of a very specialised agricultural region in a dynamic sector.

Indirect effects are considered in the models, based on agriculture-industry relationships. Direct and indirect effects were not estimated but measured using detailed information obtained from a sample of wineries. We focused on the direction and intensity of the indirect added value through rural and urban places, in order to use Bordeaux vineyard case to test the idea that rural economies were poor at retaining the benefit of local activity. The allocation of all indirect added value flows to a urban hierarchy gives an indication of the concentration pattern of wine-related industries: the biggest part of the flows is kept by rural areas, even when we consider high order or wine-specific goods and services. It follows that when looking for the correct specification of the gravity model, the economic potential of communities benefiting from the diffusion process cannot be specified by classical variables of urban hierarchy models. Instead, the criteria of wine industry specialisation is shown as an influence upon the spatial pattern of diffusion. What is interesting is that the degree of wine specialisation and the level in the urban hierarchy do not fit each other in the case of the Bordeaux vineyard.

The results lead us to consider that some rural zones are able to concentrate on high value adding activities and are able to produce agro-related centres characterised by a relative complementarity of economic functions. Their autonomisation, and the way they contribute to regional development as urban spaces do, challenge the basic notion of peripheral areas for rural zones.

Footnotes

ⁱ Bordeaux wine interprofession

ⁱⁱ The traditional shift-share analysis is equivalent to a one-way weighted variance analysis, the regional effects being considered random events, with an expectation equal to zero. Using a two-factor ANOVA model permits us to convert this assumption into a testable one (Berzeg, 1978).

ⁱⁱⁱ The model is built for comparisons at the regional level : Gironde is included in the Aquitaine region. This is not a problem for our analysis of the agricultural sector as the Gironde represents 60% of the Aquitaine jobs (and 85% for viticulture).

^{iv} The FADN is a European data network created in 1965. It aims at gathering accountancy data from farms for the determination of incomes and business analysis of agricultural holdings.

^v As 89% of wineries demand concentrates in the 'département', the gravity model is built on the 'département' flows.

^{vi} In this case, whether the supplier is a commercial intermediary or a manufacturer does not introduce bias into the analysis because an individualized coefficient is used. Breaking down suppliers using a principal activity coding shows that 60% of each wine producer's demand is satisfied by manufacturers and 40% by commercial intermediaries. The proportion of manufacturers is higher for both intermediary consumption and highly specialized investments such as barrels, labels, corks and winemaking equipment.

^{vii} A disaggregation into fifteen sector levels is finally chosen according to the nature of input obtained in the database.

^{viii} Institut National de la Statistique et des Etudes Economiques.

^{ix} We show that wine production creates a polarization of activities in rural areas, which doesn't depend on classical criteria of urban centrality ; so the pertinence of such variable to indicate economic potential in the case of wine production is tested.

^x The *i* and *w* indexes are equals as in the sample, there is never two wineries located in the same community.

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