\\ 285 \\

Knowledge Spillovers and the Growth of Local Industries

by

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***Abstract*:** The literature on localized knowledge spillovers and growth focus on the relative importance of *intra* vs. *inter*-industry externalities, but the nature and the characteristics of the dynamic linkages across manufacturing sectors are not investigated. In this paper we perform a very disaggregated analysis in order to identify, for each 3-digit industry, which composition of industrial activity is more conducive to growth. We find that diversity matters for growth, but each industry needs its own diversity. We provide some evidence of clustering of industries based on dynamic externalities. We find that many spillovers occur within input-output relationships. They often originate in downstream sectors favoring the growth of upstream industries. Lastly, the importance of spillovers does not depend on the technological intensity of the industry.

Key words: spillovers, growth, geography, clustering
JEL classification: O3, R11, L6

A theory which assumes that most technological change enters the economy 'through a particular door', so to speak, might turn out to be much simpler, and therefore more elegant, than one which assumes that technological changes may be initiated, with equal probability, anywhere in the economy

(Nathan Rosenberg, 1976, p. 31)

1. **Introduction**

The importance of knowledge spillovers for the performance of the economic systems has been forcefully emphasized in the growth literature (Romer 1986, Lucas 1988, Grossman and Helpman 1991). In the usual definition, knowledge spillovers include all the information exchange taking place informally between people working in the same or in unrelated industries. Such flows of information, which are not mediated by the market, may concern the technology of products or processes, specific input requirements, or unsatisfied market needs. As Marshall first noted in the *Principles*, most of these external effects are geographically localized and give rise to local clustering and agglomeration of firms (Krugman 1991, Fujita and Thisse 1996).

Glaeser *et al.* (1992) and Henderson *et al.* (1995) have recently provided indirect empirical evidence of knowledge spillovers for the US standard metropolitan areas (SMAs). According to their approach, technological spillovers increase the productivity and the competitiveness of local industries and thus their growth performance. Technological externalities are then detected by testing whether the long-run growth of a local industry is affected by the sectoral composition of the area where it is located. The main focus of this literature is to assess whether knowledge spillovers arise primarily from firms in the same industry, i.e. they are MAR externalities (Marshall 1890, Arrow 1962, Romer 1986), or whether they stem from firms outside the industry, i.e. they are Jacobs externalities (Jacobs 1969). If only *intra*-industry or MAR spillovers matter for growth, we should expect economic activities to specialize geographically in order to exploit such externalities. On the other hand, if *inter*-industry or Jacobs-type spillovers are prevalent, we should expect a better economic performance of large, diversified cities.

An index measuring the degree of specialization of the local industry is taken as an indicator of the intensity of MAR spillovers, while a concentration index measuring the local `variety' of economic activities is interpreted as reflecting the intensity of Jacobs

spillovers. Empirical results based on US census employment data suggest that local spillovers are important, but evidence about their nature is mixed. Glaeser *et al.* (1992) find that *inter*-industry externalities matter, while *intra*-industry externalities do not. By contrast, Henderson *et al.* (1995) focusing on few manufacturing sectors, some high-tech and some low-tech, find that MAR externalities are important for both groups, whereas Jacobs externalities are important only for high-tech industries.

The results and methodology of these works have been influential in the new economic geography literature. However, the basic contraposition between *intra* and *inter*-industry externalities has remained unquestioned, even if its practical significance is somewhat vague. First, what is the exact meaning of intra-industry spillovers? The definition of industry is crucial here. The more extensive the notion of industry, the higher the number of externalities which will be classified MAR rather than Jacobs. Both of the seminal papers mentioned above use the two-digit SIC industry classification in their empirical analysis (three-digit for high-tech industries in Henderson *et al.*). Such classification could be completely unsuited for the point at issue. The problem is not simply to establish how extensive the notion should be, and choose the corresponding *n*-digit aggregation level in existing industry classifications. The point is that industries may be close to one another according to some technological linkage which is not reflected in existing statistical classifications (see Griliches 1992, pp. S36-37). For instance, meat products and soft drinks may have more technological linkages with machinery for food than between themselves.

More generally, this approach leaves unsolved the problem of the nature of inter-industry spillovers. Are they basically unpredictable, as in the original formulation of Jacobs (1969)[1], or are they closely related to input-output relations, as implicit in the Marshall own account of external economies[2]? Or are they predictably related to a

[1] According to Jacobs, the process of development of new products and ideas "is full of surprises and is hard to predict –possibly it is unpredictable- before it has happened. But after the fact, after the added goods or services exist, their addition usually looks wonderfully logical and 'natural'" (Jacobs 1969, p.59). In particular, the innovative process has nothing to do with input-output relations: "It is important to notice the kind of logic at work here so we will not be confused by supposing that other and quite different kinds of logic direct this development process. For one thing, the logic at work is *not* the logic of customers of the parent work. The new goods and services being added may be irrelevant to what customers of the older work want" (Jacobs 1969, p.60).

[2] According to Marshall, the specialization in one particular trade is accompanied by the development of machinery producers and, more generally, of "subsidiary industries devoting themselves each to one small branch of the process of production, and working it for a great many of their neighbours" (Marshall 1986, p.225). This may suggest a definition of industry which includes the sectors linked by

common technological and scientific base, as argued by Griliches (1992)? If variety matters for growth, we would like to know *what kind* of variety matters –i.e. which particular composition of industries may favor local industry growth. However, the basic methodology developed by Glaeser *et al.* (1992) does not allow us to answer this question.

It is possible to make the notion of variety more precise by following the suggestion of Griliches and by grouping "three-digit SIC categories into clusters based on a priori notions about the extent of commonality in their technological and scientific base" (Griliches 1992, p.S37). Feldman and Audretsch (1999) have recently followed this approach, finding evidence of the importance at local level of the presence of technologically complementary industries for the innovative activity. As Griliches (1992) has noted, however, the a priori identification of a common science base is arbitrary and the results may be quite sensitive to the specific criteria used. Furthermore, many technological interdependencies are unexpected and difficult to detect on a priori basis [3].

In our paper, we try to avoid all the above difficulties by performing a very disaggregated analysis. Our spatial units of observation are the Italian 955 *local labor system*- whose boundaries are defined according to economic rather than administrative criteria (see Istat-Irpet 1986). Unlike previous works, we study the growth of *all* manufacturing sectors. More precisely, our dependent variables are the employment growth rates of the 3-digit ATECO-NACE Italian industries between 1971 and 1991. Instead of using as explanatory variables the own specialization index plus a variety index as in Glaeser et al. (1992), or an index measuring the presence of a cluster of industries a priori defined as complementary according to some technological criteria as in Feldman and Audretsch (1999), we include on the right-hand side the specialization indices for *all* manufacturing sectors. In this way, we are able to investigate the nature of inter-industry dynamic linkages across manufacturing sectors and to identify which sectors are more likely to produce or receive spillovers.

We use the coefficients of the regressions to construct a sort of input-output table, the *spillover matrix*, which shows on the columns the industries which produce

input-output relations. These kind of forward and backward linkages may represent a privileged channel of information transmission and knowledge spillovers.

[3] A good example is provided by Rosenberg (1976), who found technological convergence between guns, sewing machines and bicycles.

externalities and on the rows the industries that benefit from them. This matrix allows us to detect the path of the spillovers and to unveil the complex dynamic interdependencies across sectors, even those that are difficult to be detected on a priori basis[4]. With this approach, we are able to answer to a set of interesting questions that cannot be addressed using the standard specialization and variety indices.

First, customer-supplier relationships can be an important opportunity for technological change and innovative activity (see Rosenberg 1976). Using the matrix, we can understand to what extent spillovers follow the path of input-output transactions. Contrary to Jacobs' idea of basically unpredictable spillovers, we show that many external effects occur within predictable customer-supplier relationships.

Second, some sectors presumably produce or receive more external effects than others. The matrix allows us to identify these sectors and the directions of the spillovers. We can also address the problem of the relation between technological intensity and knowledge spillovers. In the literature, there is a general presumption that technological externalities are positively correlated to the intensity in research and development (see, for example, Kim 1995, Krugman 1991). Accordingly, high-tech sectors should produce more spillovers than low-tech ones. Traditional industries may at most show intra-industry dynamic externalities (Henderson et al. 1995). We test the validity of this hypothesis using our finely disaggregated database. Contrary to the general presumption, our matrix suggests that low-tech industries have a significant number of dynamic linkages both within and outside their two digit sectors. Furthermore, knowledge spillovers tend to be as important for the dynamic performance of low-tech industries as they are for high-tech sectors.

Third, Rosenberg (1976) emphasized the special role played by the machine tool industry as a source of external economies to other sectors of the economy in the industrialization process. This sector represented "a pool or reservoir of skills and technical knowledge which are employed throughout the entire machine-using sectors of the economy" (Rosenberg 1976, p.19). We ask whether the machine tool industry or other sectors of the economy may still play a similar role. Our matrix can provide an

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[4] To some extent, this matrix resembles the "interindustry technology flows" table developed by Scherer (1984), but in the latter the focus is on R&D outlays, and the flows of technology from the industries of origin to the industries of use are estimated using an input-output table. This procedure does not allow to detect spillovers, but it is basically meant to capture flows of technologies incorporated in products and purchased through market transactions.

answer to this issue. As a partial confirmation of Rosenberg's idea, we find that the metal products and machinery sectors have a special characteristic not shared by other industries. They form a sort of local technological and productive layer, which have dynamic linkages with almost all other sectors of the local economy.

Last, dynamic industries tend to cluster together according to a definite pattern, which may be due to historical accidents, but which in part is governed by Marshallian external effects and knowledge spillovers. Using our matrix, we identify some of these clusters. In the tradition of Hirschman (1958), this approach may be useful for policy reasons. Hirschman emphasized the importance of backward and forward linkages for development. In his approach, clusters were driven by market size effects rather than by knowledge spillovers. We provide evidence of a clustering process led by the latter.

The paper is structured as follows. Section 2 describes the data set. Section 3 discusses the basic econometric specification. Section 4 presents the spillover matrix with the 22 2-digit sectors as explanatory variables. Section 5 presents the result of the econometric specification using all the 67 3-digit industries as regressors. Section 6 discusses the importance of market size effects for the results obtained. Section 7 presents the own variety index and discusses Jacobs' type effects. Section 8 concludes.

2. The model and the econometric specification

To begin with, let us concentrate on a single sector, say sector h. Following Gleaser *et al.* (1992), we assume the production function

$$Y_{it} = K_{it}\, L_{it}^{(1-a)}, \qquad 0<a<1,$$

where Y_{it} is output of sector h in the economic area i at time t, L_{it} is labor and K_{it} is the stock of technical knowledge. Firms take prices and wages as given and maximize profits $K_{it}\, L_{it}^{(1-a)} - W_t L_{it}$, where W_t is real wage, so that $(1-a)K_{it}L_{it}^{-a} = W_t$. By taking on both sides the first difference of the logs we get

$$\Delta k_{it} - a\Delta l_{it} = \Delta w_t,$$

where lowercase letters denote logs. We assume that wages are equal for different areas, so that employment growth in each area is a linear function of technology growth, with positive slope, i.e.

[1] $\Delta l_i = b + (1/a)\Delta k_i,$

where we have dropped the index t for notational simplicity. Moreover, we assume that technology growth in each area is a linear function of initial employment (taken in logs), a local competition index, c_i, the intensity of local spillovers, s_i, and an unpredictable local technology shock, ε_i:

[2] $(1/a)\Delta k_i = s_i + \gamma c_i + \delta l_i + \varepsilon_i.$

Both c_i and l_i refer to time t-1. In line with the previous literature, the number of local plants divided by L_i gives the competition index c_i.

Finally, we assume that the intensity of local spillovers depend on the local industrial structure at time t-1. To describe this structure, we depart from existing works. We retain the specialization index of sector h, but, in place of an aggregate index of 'diversity', we include a specialization index for each manufacturing sector. In addition, we use the 'size' of the local area, measured by the log of total employment (including non-manufacturing employment), e_i. More precisely, we assume

[3] $s_i = \alpha_1 d_{1i} + \ldots + \alpha_m d_{mi} + \beta e_i,$

where $d_{ji}, j = 1,\ldots,m,$ is the fraction of total employment in sector j at time t-1. The idea behind equation [3] is simply that, if sector j produces spillovers for sector h, the intensity of such spillovers will be greater, the greater is the relative importance of sector j in the local economy. While this assumption seems reasonable, and consistent with the role assigned to the own specialization index in previous literature, it can be argued that the absolute level of employment in sector j is also important. Among areas having the same specialization in sector j, the smaller ones are likely to produce less externalities. We include the log of total employment e_i on the RHS of [3] in order to allow for this size effect. Obviously we expect a positive β. Notice also that the α's should be positive as well, otherwise we should conclude that there are sectors producing negative spillovers, which makes little sense.

Putting together equations [1], [2] and [3] we get:

[4] $$\Delta l_i = b + \alpha_1 d_{1i} + \ldots + \alpha_m d_{mi} + \beta e_i + \gamma c_i + \delta l_i + \varepsilon_i.$$

Equation [4] is the basic reference for the empirical work below. A positive and significant α_j will be interpreted as indicating that sector i benefits from technological externalities originated in sector j.

3. Data set and data treatment

The data set has been specifically built for the analysis of local spillovers. The primary sources are the ISTAT Industry Censuses of 1971 and 1991. Original data include over three millions of data points, i.e. employment and the number of local plants for the mentioned years, 101 three-digit NACE-ATECO industries and 8,086 municipalities. Data have been carefully reclassified by ISTAT in order to harmonize the 1971 and the 1991 sector definitions.

Next data have been spatially aggregated into 955 larger areas, whose boundaries have been identified according to ISTAT-IRPET (1986). These areas are called *local labor systems* and are constructed by using data on the residence and the workplace of workers from the 1981 ISTAT Population Census. The main idea is to cluster municipalities in such a way to get areas which are both small and "self-contained", in the sense that much of the workers living in the area have their workplace within the area [5]. The choice of using local labor systems as our geographically unit of reference seems to be the more appropriate in order to capture Marshallian technological externalities. Spillovers are basically generated by informal exchanges of information on technology and markets, and this flow of information, which requires close proximity between firms, entrepreneurs and workers, is maximized when firms share the same labor market. Notice that these areas are very small, with an average size which is one tenth of that of

[5] The methodology includes a first step, in which municipalities which are "central" in the sense that they employ many workers living elsewhere are identified, and subsequent steps which refine this first choice and cluster other municipalities around the central ones.

an average province and approximately equal to 300 km^2. The most important implication of this is that a lot of trade of manufacturing products presumably takes place across these areas. In most cases the local market absorbs a negligible fraction of the supply of local industries.

In the resulting data set, many industries are absent in many areas either at the beginning or at the end of the period or both. We decided to ignore, for each industry, all of the areas with zero employment either in 1971 or in 1991. The reason is twofold. First, in line with most of the existing works, we are going to estimate regressions where the dependent variable is the employment growth rate, which is not defined when employment is zero. Second, the birth (or the death) of an industry in a given area, although interesting, is perhaps something intimately different from the growth (or the reduction) of an industry which already exists. For instance, a non-existing sector cannot reduce its size and can grow only if a new plant is installed. These differences suggest that different laws govern the two phenomena and should be studied separately.

After eliminating areas with zero employment, we found several huge growth rates in industries having very few workers in 1971. In order to prevent such outliers to disproportionally affect regression results, we reduced the data set further, by considering only industries with more than 20 workers in 1971 and ratio of employment in 1991 to employment in 1971 less than 10.

Finally we decided to consider only industries which, after such reductions, are present in at least 57 areas, in order to have at least 30 degrees of freedom in each equation. After all these exclusions, the total number of sectors considered is 67 and the total number of local industries is 14,301.

4. Results I : the 3-digit $\times$ 2-digit *spillover matrix*

We estimated [4] for each of these 67 industries by applying OLS equation by equation. We did not use the SURE estimator because the areas considered are not the same for different equations, so that a feasible implementation is not trivial. In any case, efficiency is not a big problem here, since for most equations the number of observations is quite large. In this first specification d_{ji} is the specialization index for the *two-digit* sector j in area i (so that m = 22).

Let us begin by looking at the signs of the specialization indexes. Figure 1 shows the significance level of the positive coefficients (matrix A) and the negative coefficients (matrix B). On the rows we have the 67 3-digit manufacturing industries whose economic performance is the dependent variable. On the columns we have the 22 2-digit industries representing a potential source of technological spillovers. Black cells indicate a *p*-value smaller than 1%, dark gray smaller than 5% but larger than 1%, light gray smaller than 10% but larger than 5%. Two observations are in order. First, the negative and significant coefficients are much less than the positive ones. In matrix B, 10% significance occurs in 5.7% of the total number of cells ---a percentage which is very close to the 5% that would be obtained by including as regressors, in place of the specialization indexes, variables independent of everything else in the system. This is comforting, since too many negative externalities would be inconsistent with our interpretation of the indexes as capturing mainly spillover effects. By contrast, in matrix A, colored cells are 13.8% (black cells are 4%) --a percentage which cannot be explained by purely random factors. These numbers indicate that something is there: local externalities do matter.

The second observation is that in matrix B the colored cells seem to be distributed randomly, whereas in matrix A an underlying structure seems to emerge. Such a structure can be better appreciated by looking at Figure 2, where more detailed information is reported. We call this figure the *spillover matrix*, because it shows all the positive and significant dynamic linkages across sectors that occur at local level in the Italian manufacturing industry. By looking at the distribution of the colored cells in the matrix, we are able to draw some interesting conclusions on the nature of inter-industry spillovers.

First, they mainly concentrate on the `diagonal', i.e. the set of cells whose 3-digit industry on the row belongs to the 2-digit sector on the column. The percentage of colored cells in the diagonal is 36.8%, as against the overall 13.8%. To the extent that the ATECO-NACE grouping reflects technological affinities or input-output relations, this finding can be interpreted as providing some support to the Marshallian view. Interestingly, this is not only the case of a number of low tech sectors, such as textiles, metal products, wood products, and food, as one would expect on the basis of the findings of Henderson *et al.* (1995). It is also true for some more research-intensive sectors, such as non-electrical machinery, electrical equipment, rubber and plastics. A high specialization in these 2-digit sectors at the beginning of the period has a first positive impact on the growth performance of the 3-digit industries belonging to them.

Second, some groups of 2-digit sectors tend to reinforce each other in the process of growth at local level. For this reason we can define them as clusters or local agglomerations of dynamically linked industries. We can recognize these clusters by looking at the concentration of colored cells around the diagonal. Three main clusters can be identified. The first one, in the upper-left corner of the figure, includes textiles, clothing and footwear. The second one, in the lower-right corner, includes metal products and machinery sectors. The last one, in the middle, links wood products with 'furniture and other manufacturing' (we shall see in the next section that furniture is responsible of such links). Again, some of these linkages occur within input-output relations involving different 2-digit sectors, as in the case of wood products and furniture, but in other cases the industries in the clusters are not involved in vertical transactions.

Third, there is a set of industries which seem to play a special role in the local economies. These are the metal products and machinery sectors. They are dynamically linked with many other 2-digit sectors of the local economies, and their economic performance seems to be strictly dependent on the spillovers they receive from them. These industries form a sort of 'metal-machinery layer' formed by firms which provide tools, technical equipment, and specialized machinery to local specialized industries. This layer is clearly visible in the lower part of Figure 2. We shall come back to these three features in the next section.

Finally, some sectors show a limited number of inter-industry linkages. This is the case of petroleum products, chemicals, office and computing equipment, motor vehicles, and other transport industries. This result is partly unexpected because some of these industries invest heavily in R&D and have a lot of input-output relations with other industries. There are two possible explanations for this. First, these industries are on average less represented in the Italian industrial structure. As a consequence, the number of observations is lower than the average and it is more difficult to obtain statistically significant coefficients. Second, and probably more importantly, for many of these sectors spillovers may be relatively unimportant at local level, while they may produce external effects and have technological linkages over a wider geographical scale.

Now let us look at Table 1, where the other regression results are reported. The adjusted R^2 is low on average (about 15%), indicating that causes of variation which are not considered here, like the effects of local administrations (municipalities) or local policies of the central government, may have played a major role. While the average is low, the R^2 differs sharply across sectors, ranging from small values to about 50%.

As usually found in the literature, for many industries the competition index c is positively related to economic performance (15 sectors exhibit 95% significance). This is a confirmation of Porter's idea (Porter 1990) that the presence of a large number of small firms working in the same industry favors the innovative activity and thus spurs growth. This result is also consistent with the Italian literature on industrial districts, which emphasizes how small-firm specialized industrial systems have been the most dynamic industries of the Italian manufacturing sector in the period under analysis (see Brusco and Paba 1997). Also in line with the literature, the initial condition has always the expected negative sign and is significant for 32 industries.

The coefficient β of total employment is positive for most industries and is significant at the 95% level for almost half of them (30). This gives supports to the idea that a size effect should be added to a specialization effect in order to capture the spillover generating process. This result suggests that the higher the absolute number of workers employed in the specialized sector, the higher the probability of knowledge spillovers among firms. The overall significance of the `spillover' proxies, i.e. the specialization indexes plus total employment, is confirmed by the probability values of the F-tests, which is lower than 5% for 34 sectors.

The above findings provide evidence that knowledge spillovers do matter for the growth of local industries. But how important are these factors? In order to evaluate the specific contribution of the `spillover' variables, we computed the increase in the adjusted R^2 due to the inclusion of the 22 specialization indexes plus total employment. The average contribution is 9.2% (see the last column of Table 1). This value is quite high and indicates that most of the explained variance is captured by such variables. Again, differences across sectors are quite large, ranging from -0.5% to +40%.

In disagreement with part of the literature, such differences seem to be poorly related to technological intensity. Henderson et al. (1995) found that inter-industry spillovers are important for high-tech sectors but not for mature industries. Kim (1995) even argued that knowledge spillovers are *by definition* confined to industries where technological knowledge matters –i.e. high tech sectors. Contrary to these findings, our evidence shows that inter-industry spillovers affect the growth of research intensive *and* mature industries. In the case of high-tech sectors the average contribution is 9.8% as against 9.0% for low-tech sectors[6]. However, in the case of high-tech sectors, spillovers may well be more important but much less geographical localized than in the case of low-tech industries.

There is some evidence that technological externalities are more important for the growth of sectors producing intermediate or instrumental goods (the average contribution is 10.7%) than for final sectors (7.2%)[7]. Moreover, within industries producing intermediate or instrumental goods, the average contribution of spillover variables is particularly high for metal products and machinery industries (14.1%). These figures suggest, somewhat surprisingly, that many spillovers follow an upstream path, running from output to input sectors rather than vice versa. We will discuss this result in more detail in the next section.

5. Results II : the 3-digit x 3-digit spillover matrix

In order to investigate with greater detail the flows of intra and inter-industry spillovers, we have done the same exercise using as explanatory variables the local specialization index of all the 67 3-digit sectors (so that m of equation [4] is equal to 67). The results are reported in Figure 3. First of all, the number of crossings has obviously increased, due to the finer disaggregation of data, but the general picture is quite similar to the previous one. As before, the black cells (indicating the most significant coefficients) crowd particularly the 2-digit diagonal and it is still possible to identify a "metal-machinery" layer. Finally, it is now evident that the large number of linkages of the 2-digit "other manufacturing industries" is basically due to the furniture sector.

The 3-digit matrix is useful for another reason. By looking at the 3-digit diagonal, it is now possible to assess the importance of pure intra-industry spillovers. Glaeser et al. (1992) and Feldman and Audretsch (1999) find a negative impact of own specialization

[6] Research intensive industries are indicated in Table 2. We followed Davies and Lyons (1996) for the identification of high-tech sectors.

[7] We classified sectors as final, intermediate and instrumental simply on the basis of the sector definitions and considering as 'final' also sectors producing intermediate goods for non-manufacturing sectors. The resulting classification is reported in Table 2.

on the dynamic and innovative performance of local industries. By contrast, Henderson et al. (1995) find positive effects in several manufacturing sectors. Our results are more in line with the latter work. Own specialization has a positive sign in 72% of the sectors, and the positive effect is significant at the 10% level for about one fifth of the sectors.

The data reported in Table 2 allow us to identify the industries with more dynamic linkages with other 3-digit sectors. The industries with the highest number linkages (more than 20) are clothing, furniture, knitting, metal treatment and metal structures. 23 other industries have more than 10 and less than 21 linkages.

More interestingly, we are able to identify net producers and net recipients of spillovers. To this respect, the most important result is that final industries are usually net producers of external effects. See, for example, the case of clothing, furniture and domestic electrical appliances. Conversely, many downstream industries are net recipients of spillovers. This is particularly true for machinery and metal producers, upstream textile industries, rubber and plastics. For the final sectors as a whole, the difference between the number of spillovers received and the number of spillovers produced is positive and equal to 40. In this case, knowledge spillovers originate in downstream sectors and affect the dynamic performance of upstream industries.

To the extent that these linkages capture flows of technological information, the above result provides a strong confirmation of the idea, puts forward by Rosenberg (1976), that the innovative process is strictly dependent upon a successful collaboration between producers of the final product and specialist makers of components. Rosenberg emphasized this point with reference to machinery producers and their customers, but the argument can easily be applied to other component producers. He stressed the role of "interchange of information and communication of needs to which the machinery producers respond in a highly creative way. They learn to deal with the requirements of their customers at the same time the machinery user learn to rely heavily on judgement and initiative of the machinery supplier. (..) This is a process which involves an intimate knowledge of customer activities and needs and which presupposes frequent face-to-face confrontations and exchange of information" (Rosenberg, 1976, p.164). Rosenberg was well aware of the fact that this view of the innovative process implies geographical proximity between firms[8]. It is also interesting to note that in this context the industry

[8] "Physical proximity between the producer and user of machinery seems to have been indispensable in the past for reasons which we do not really understand but which seem to be rooted basically in the

producing spillovers is in fact transmitting information about its specific input or machinery requirements, but it is not necessarily involved in innovative activity. Innovation in final industries is probably relatively more affected by the presence of universities, research laboratories and institutions, as confirmed by the literature. Our data cannot control for such influences.

The third result concerns the relation between knowledge spillovers and technological intensity of industries. The more disaggregated approach confirms the basic findings of the 3x2-spillover matrix. By roughly measuring the spillover intensity with the number of linkages, we can see from the table that the average number of spillovers received is 4.1 for high-tech industries and 5.5 for low–tech ones. The number of spillovers produced by three-digit sectors is a new information of the 3x3-spillover matrix. Again, spillovers seem to be produced by both low and high tech sectors. The average number for the former is actually higher (5.7) with respect to the latter (3.6).

6. Knowledge spillovers and market-size effects

We have seen that many inter-industry external effects occur within input-output relations. To give a rough idea of the overall importance of these linkages, we compared our spillover matrix with the input-output table of the Italian economy published by Eurostat (1990) and relative to 1985. Unfortunately, due to the different classification of industries, we had to re-aggregate our data in order to make the comparison possible. We consider only input-output transactions representing at least 1% of the value of total intermediates. In Figure 4, we show the matching between the input-output linkages and our spillover matrix (re-aggregated by considering the coefficients with at least 10% significance). The figure indicates that one third of total spillovers occur within input-output transactions. The result suggests that industries linked by a customer-supplier relationship may benefit from the continuous interchange of information and communication of needs which takes place at local level. This exchange may favor

problem of communications. Successful technological change seems to involve a kind of interaction that can best be provided by direct, personal contact. Successful instances of technological change in the past have involved a subtle and complex network of contacts and communication between people, a sharing of interests in similar problems, and a direct confrontation between the user of a machine, who appreciates problems in connection with its use, ant the producer of machinery, who is thoroughly versed in problems of machinery production and who is alert to possibilities of reducing machinery (and therefore) capital costs" (Rosenberg 1976, p.168).

innovative activity and improvements in productivity, thus affecting the employment dynamics of local industries.

The importance of input-output relations may suggest some caution in interpreting all these linkages as genuine knowledge spillovers. Industries and firms may have incentives to cluster in the same area for reasons of pecuniary externalities (transport costs, for example), or static localization economies (Henderson 1988). As in Glaeser et al (1992) and Henderson et al. (1995), our methodology cannot clearly identify the relative contribution of knowledge spillovers and market size effects in fostering the growth of local industries. However, two main arguments suggest that market-size effects and pecuniary externalities probably do not play a major role in our results.

First, we tested the *dynamic* performance of industries with respect to the historical conditions of the areas in which they are located. We found that the *presence* of specialized industries at the beginning of the period affected the subsequent growth of local industries. If market-size effects are important and industries decide to settle in the area simply in order to satisfy local demand and save on transport costs we would expect the growth of a local industry to be correlated not with the presence but with the *growth* of its input-output related sectors.

Second, and more importantly, for demand externalities to be important for a particular industry, its market should be mostly local. This is certainly the case of non-traded service sectors, like restaurants, auto dealers or wholesale trade, for which local demand effects are likely to be large. For manufacturing industries, on the contrary, which are the focus of our work, markets are usually national or international, certainly much larger than the local level, particularly when the latter is identified, as in our case, by very small geographical areas. Not only a lot of trade of manufacturing products takes place across these areas, but for many industries where spillovers proved to be important Italy is a leading world exporter. This is true for final products, like footwear, domestic appliances or spectacles, which are widely internationally traded, but it is also true for most intermediate and component producers and for investment goods. Italy, for example, is a leading world exporter of specialized machinery for many specific industries (textile, food, wood, marble, plastic), as well as of woolen yarns and fabrics, tanned hides, hydraulic pumps, compressors, ironware and metal products, packing goods and so on (see Fortis 1998)[9].

7. Does variety matter?

Gleaser *et al.* (1992) find that an index measuring the degree of `variety' of the local economy enhances the growth of local industries. To see whether variety matters in our data set, we computed the Herfindhal-Hirschman concentration index $x = \Sigma l_i^2 / (\Sigma_{li})^2$ and defined the variety index as $v = n(1-x) / (n-1)$, n being the number of sectors, so that the index varies between 0 and 1. The main difference with respect to previous works is that we computed v by considering, for each sector, only industries having a t-value larger than 1 in the regression of Section 5. This index can be called `own variety' [10]. Then we computed, for each sector, an overall specialization index d, defined as the sum of the specialization indexes of the sectors having a t-value larger than 1 in the regression of Section 5. Finally, we regressed each 3-digit sector on d and v, in addition to total employment, the competition index and the initial condition.

Results are reported in Table 3. In this regression the average corrected R^2 is higher than in the previous ones (19.8%), owing to both the contribution of the variety index and the reduced effect of the correction in this more synthetic specification. The average increase in the R^2 due to the `spillover' variables, including the variety index, is 14%. Previous results on variety are confirmed. Own variety has a positive coefficient in almost all equation (63) and is significant at the 5% level in almost half of them (31). This means that, holding constant the size of the sectors originating spillovers, areas

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[9] If local market size effects are important for a particular industry, exports should be negatively correlated with the importance of local externalities. In order to test this, we performed the following exercise. First, we tried to evaluate the market size of each industry by looking at the percentage of output exported. Since export data for the three-digit ATECO-NACE classification do not exist, we were forced to look at a more aggregate information, i.e. the percentage of output exported by the 27 NACE sectors (which are aggregates of our 3-digit sectors) of the 1985 input-output tables published by Eurostat (1990). Then we evaluated the importance of local externalities for these 27 sectors, by computing, for each sector, the average of the contribution to explained variance reported in the last column of Table 1 for the corresponding 3-digit sectors. Finally, we computed the correlation coefficient that turned out to be very low and equal to 0.02, i.e. the market size is almost orthogonal to local externalities. We interpret this result as indicating that demand effects cannot be large and therefore providing an indirect confirmation for the spillover interpretation.

[10] We considered also a variety index including all 3-digit sectors, but we found that this index is significant only for a few sectors once the own variety index is included.

where employment is uniformly distributed across such sectors performs better on average than areas where only few of them are represented. In other words, different industries complement each other in such a way that their joint effect is larger than the sum of the effects that each one of them would have when taken in isolation. In our context, this `variety effect' reinforces the idea that `balanced' clusters of sectors are more likely to be successful.

8. Conclusions

This paper is a contribution in the empirics of localized knowledge spillovers. We developed a new approach in order to investigate the inter-sectoral dynamic relations across industries. We provided indirect evidence of the importance of knowledge spillovers for the growth of 3-digit industries at a very finely disaggregated geographical level –the Italian local labor systems. The main results are the following.

First, we have seen that variety matters for growth, but each industry needs its own variety. Second, many dynamic external effects occur between industries linked by input-output relations, both within and across 2-digit sectors. Third, in many cases spillovers follow an upstream path. They originate in downstream producers of final goods and benefit specialist makers of components and machinery producers. Fourth, the metal products and machinery sectors form a sort of local technological and productive layer which have dynamic linkages with almost all other industries. Finally, the technological intensity does not affect the extent and the nature of spillovers. In particular, there is strong evidence that low-tech sectors have many intra and inter-sectoral dynamic linkages.

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FIG. 1 - SIGNIFICANT COEFFICIENTS FOR THE 22 SPECIALIZATION INDEXES

t-Student significant at 1% (black cells), 5% (dark gray cells), 10% (light gray cells)

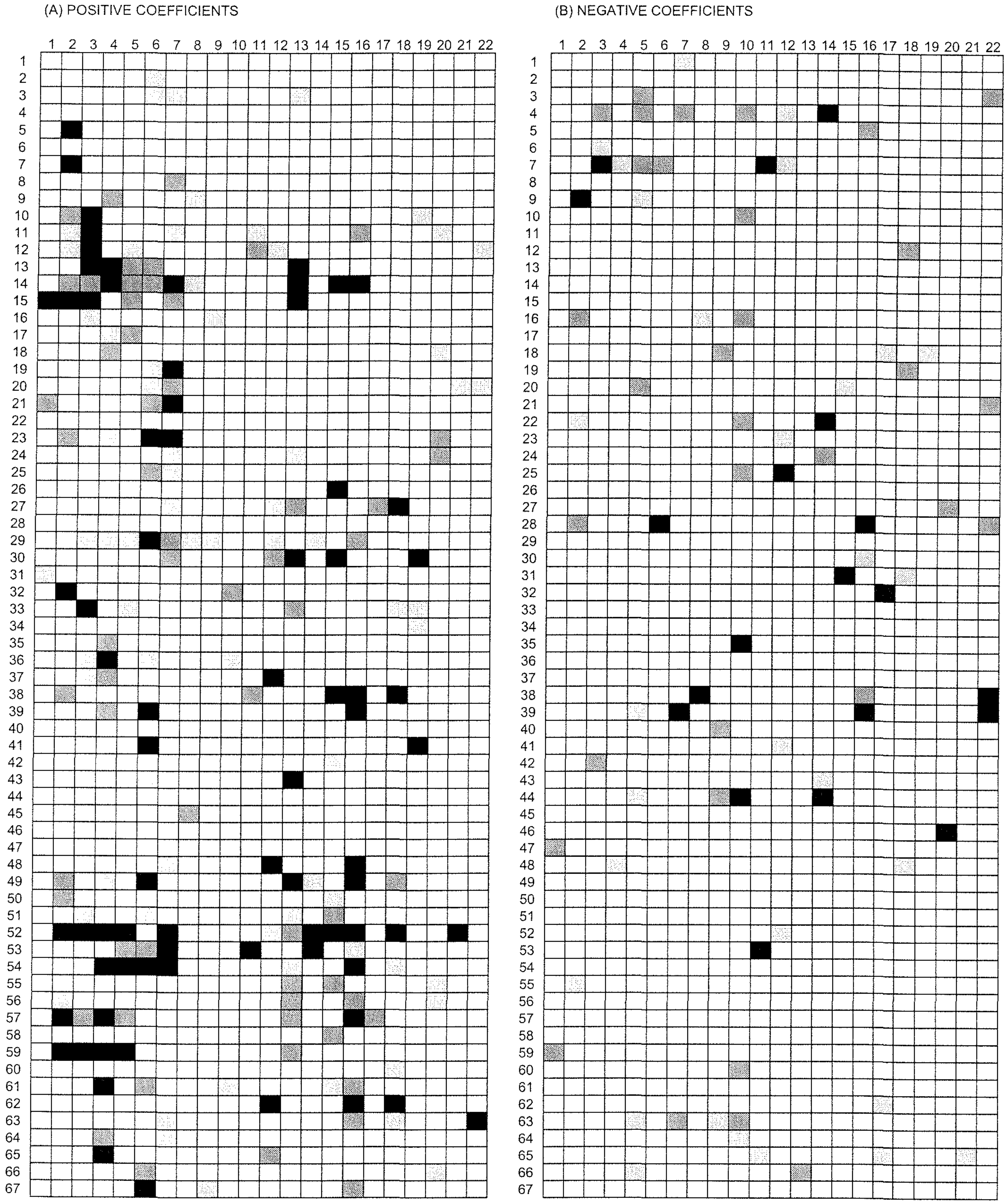


FIG. 2 - LOCAL INTER-INDUSTRY TECHNOLOGICAL SPILLOVERS

t-Student significant at 1% (black cells), 5% (dark gray cells), 10% (light gray cells)

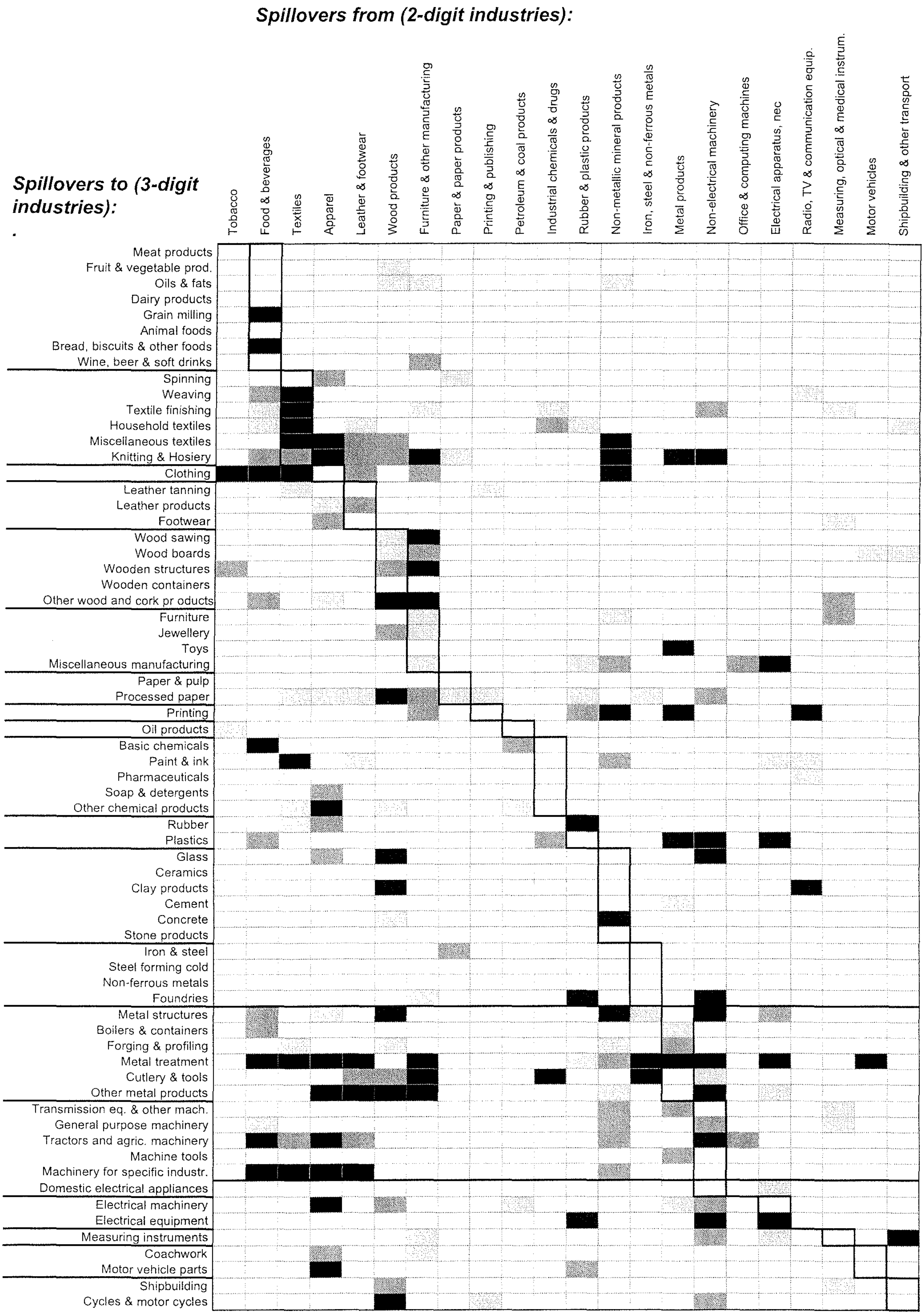


FIG. 3 - LOCAL INTER-INDUSTRY TECHNOLOGICAL SPILLOVERS. t-Student significant at 1% (black cells), 5% (dark gray cells), 1% (light gray cells)

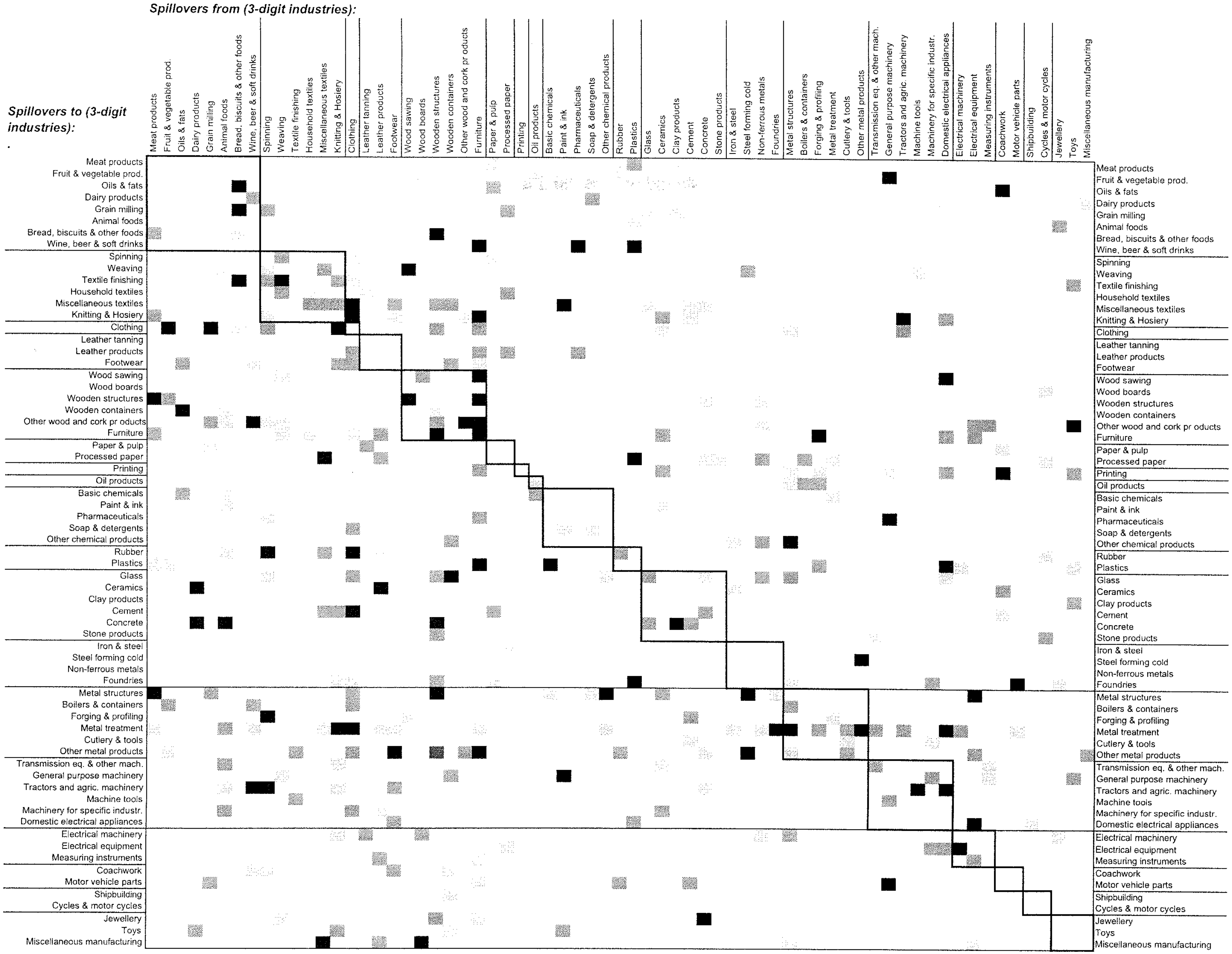
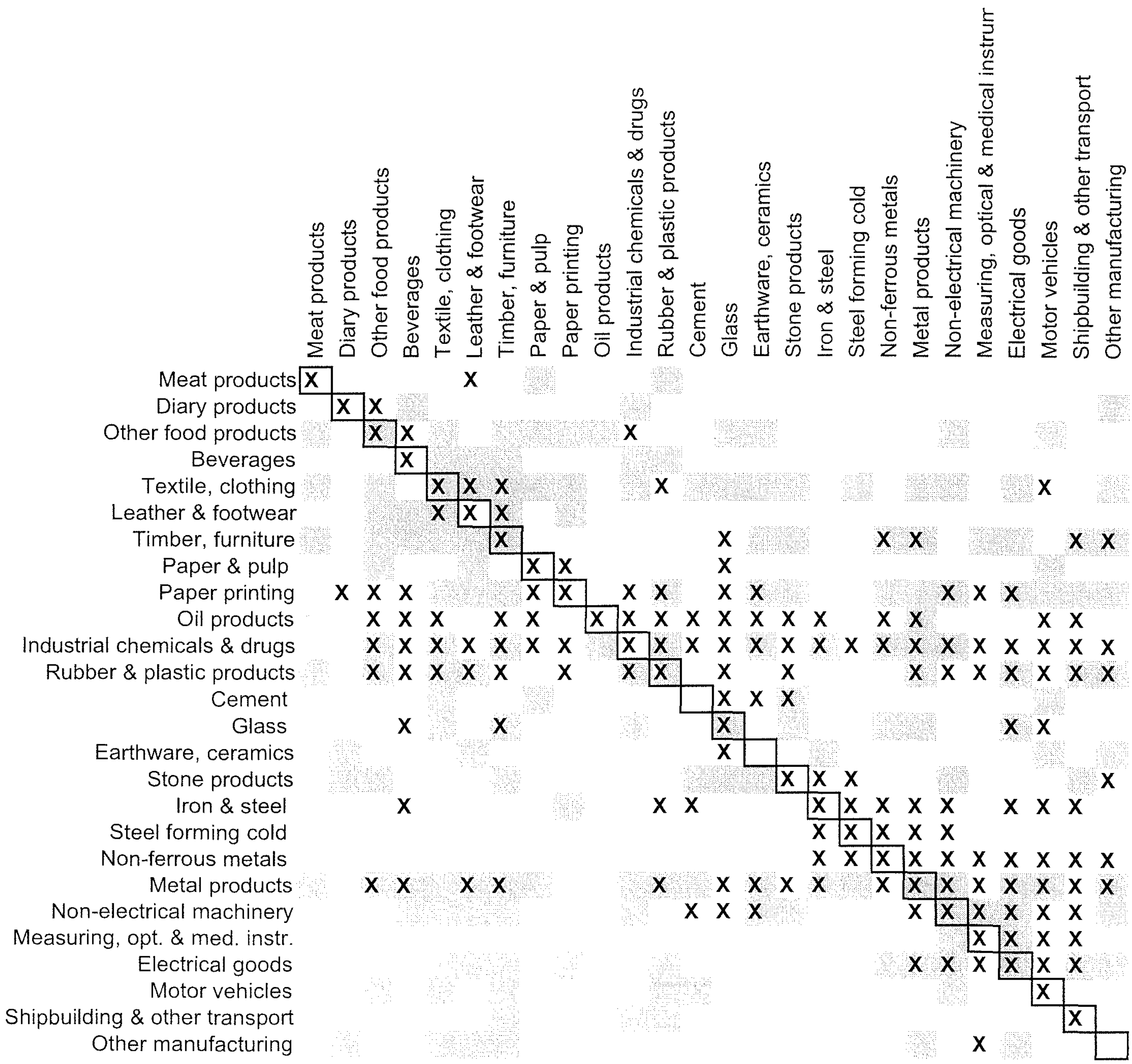


FIG. 4 - LOCAL INTER-INDUSTRY SPILLOVERS AND INPUT-OUTPUT RELATIONS



X : input-output relations (at least 1% of total value of intermediate goods)

: spillovers (t-student with at least 10% significance)

Matchings = 0.33 of total spillovers and 0.34 of total input-output (0.38 excluding oil products)

TABLE 1 - EMPLOYMENT GROWTH IN THE LOCAL INDUSTRIES (1971-1991) - Regression results

Explanatory variables (besides the specialization indexes of the 22 two-digit sectors):

Dependent variables (log of employment growth 1971-91)	1971 empl. in the local industry	t	Competition index	t	1971 empl. in the local economy	t	Adjusted R2	F-test	Number of observations	Contribution of spillovers to R2
Meat products	-0,051	0,5	2,346	2,2	0,066	0,7	-0,004	0,036	246	-0,045
Fruit & vegetable prod.	-0,015	0,1	1,425	0,6	-0,057	0,4	-0,071	0,061	157	-0,068
Oils & fats	-0,007	0,1	1,042	3,3	0,166	3,6	0,074	0,996	350	0,063
Dairy products	-0,131	2,0	-0,685	1,7	0,151	2,4	**0,104**	0,999	299	0,087
Grain milling	-0,140	1,3	-0,588	1,7	0,088	1,3	0,004	0,476	344	-0,003
Animal foods	0,140	0,7	0,780	0,3	-0,033	0,2	-0,056	0,288	93	-0,052
Bread, biscuits & other foods	-0,629	17,5	-0,216	1,1	0,617	17,4	**0,509**	1,000	584	0,405
Wine, beer & soft drinks	0,029	0,4	-1,057	1,6	-0,071	1,0	0,005	0,625	376	0,004
Spinning	-0,276	2,2	-1,914	0,8	0,035	0,3	**0,110**	0,983	182	0,094
Weaving	-0,393	3,7	1,555	1,5	0,245	1,7	**0,122**	0,983	165	0,105
Textile finishing	-0,640	3,4	4,211	0,7	0,235	0,9	**0,185**	0,763	73	0,073
Household textiles	-0,266	1,8	0,656	1,0	0,386	2,4	**0,222**	1,000	187	0,216
Miscellaneous textiles	-0,466	5,0	-1,075	3,5	0,478	5,0	**0,298**	1,000	215	0,180
Knitting & Hosiery	-0,013	0,2	0,233	0,7	0,052	0,7	**0,103**	1,000	449	0,103
Clothing	-0,080	0,8	-0,819	4,0	0,067	0,6	**0,110**	1,000	813	0,055
Leather tanning	0,261	1,7	7,099	1,7	-0,512	2,5	**0,226**	0,945	70	0,198
Leather products	-0,162	1,4	1,496	1,5	0,126	1,0	-0,003	0,221	130	-0,045
Footwear	-0,026	0,3	0,050	0,0	0,113	1,1	0,046	0,941	240	0,050
Wood sawing	-0,437	3,3	0,463	0,7	0,314	3,4	**0,203**	1,000	212	0,183
Wood boards	-0,553	3,3	-10,409	2,4	0,033	0,2	**0,236**	0,965	85	0,173
Wooden structures	-0,207	4,3	-0,070	0,6	0,124	3,0	0,060	1,000	822	0,042
Wooden containers	-0,276	2,2	0,487	0,6	0,134	1,3	0,041	0,808	201	0,030
Other wood and cork pr oducts	-0,450	4,5	1,954	3,6	0,497	5,2	**0,418**	1,000	189	0,259
Furniture	-0,108	1,9	0,642	2,0	0,165	2,6	0,062	0,972	474	0,030
Paper & pulp	-0,195	1,8	-3,907	1,0	0,027	0,2	**0,136**	0,798	106	0,056
Processed paper	-0,328	3,1	3,177	1,9	0,318	3,0	**0,191**	0,986	219	0,073
Printing	-0,452	4,7	0,107	0,2	0,435	4,2	**0,282**	1,000	300	0,161
Oil products	-0,679	3,4	-10,862	1,9	0,480	2,2	**0,185**	0,946	82	0,167
Basic chemicals	-0,178	1,0	7,373	1,6	0,115	0,6	**0,109**	0,806	155	0,038
Paint & ink	-0,277	1,1	1,804	0,5	0,292	1,3	**0,119**	0,713	75	0,057
Pharmaceuticals	0,203	0,8	12,286	1,0	-0,605	1,9	-0,022	0,540	71	0,008
Soap & detergents	-0,232	1,3	0,319	0,1	-0,022	0,1	**0,175**	0,889	69	0,154
Other chemical products	-0,255	1,3	3,206	1,4	0,438	2,4	**0,202**	0,983	110	0,156
Rubber	-0,361	2,6	-0,196	0,2	0,321	1,9	0,029	0,788	172	0,033
Plastics	-0,329	4,6	2,784	2,8	0,239	3,3	**0,274**	1,000	306	0,085
Glass	-0,176	1,9	3,083	2,5	0,270	2,2	**0,238**	0,968	158	0,080
Ceramics	0,180	1,9	5,237	4,5	-0,132	1,2	0,042	0,054	192	-0,051
Clay products	-0,166	1,5	-1,338	0,4	-0,060	0,6	**0,163**	1,000	218	0,143
Cement	0,063	0,4	1,973	0,9	-0,068	0,6	**0,179**	0,999	140	0,193
Concrete	-0,302	4,3	2,239	3,1	0,235	3,6	**0,172**	0,914	388	0,022
Stone products	-0,017	0,3	2,405	6,1	0,043	0,9	**0,145**	0,322	368	-0,009
Iron & steel	0,114	0,3	19,772	0,7	0,058	0,2	-0,072	0,336	62	-0,066
Steel forming cold	-0,361	1,6	11,075	1,7	0,141	0,6	**0,246**	0,123	-	-0,096
Non-ferrous metals	0,007	0,0	5,640	1,6	0,146	0,8	**0,106**	0,830	81	0,097
Foundries	-0,142	1,2	2,346	1,0	-0,064	0,5	0,041	0,674	157	0,018
Metal structures	-0,552	9,8	-0,014	0,0	0,467	7,8	**0,395**	1,000	398	0,201
Boilers & containers	-0,253	1,0	10,424	1,4	0,353	1,5	**0,125**	0,585	75	0,018
Forging & profiling	-0,722	3,7	1,756	0,4	0,754	4,3	**0,469**	0,996	72	0,262
Metal treatment	-0,605	6,2	-0,828	1,7	0,529	5,1	**0,231**	1,000	326	0,229
Cutlery & tools	-0,255	2,1	3,036	2,0	0,390	3,2	**0,215**	0,997	123	0,186
Other metal products	-0,203	3,6	-0,022	0,1	0,256	5,4	**0,147**	1,000	623	0,142
Transmission eq. & other mach.	-0,201	1,9	2,946	1,1	0,291	2,3	0,048	0,771	154	0,034
General purpose machinery	-0,872	7,3	-1,507	2,9	1,062	8,8	**0,278**	1,000	230	0,275
Tractors and agric. machinery	-0,056	0,7	1,348	2,6	0,034	0,5	0,083	0,990	271	0,070
Machine tools	-0,474	3,8	0,788	0,2	0,369	2,6	**0,209**	0,829	116	0,053
Machinery for specific industr.	-0,410	5,1	1,158	0,6	0,478	5,3	**0,208**	1,000	235	0,124
Domestic electrical appliances	-0,132	0,5	4,986	0,7	-0,033	0,1	-0,007	0,331	106	-0,035
Electrical machinery	-0,582	2,9	1,775	0,4	0,756	3,4	**0,276**	0,991	133	0,128
Electrical equipment	-0,940	7,6	-0,736	1,1	1,169	9,9	**0,377**	1,000	338	0,300
Measuring instruments	-0,467	2,1	0,050	0,0	0,297	1,2	**0,172**	0,930	81	0,155
Coachwork	-0,281	1,4	6,742	0,8	0,193	1,3	**0,162**	0,382	77	-0,030
Motor vehicle parts	-0,326	2,0	2,034	0,4	0,005	0,0	**0,170**	0,961	102	0,142
Shipbuilding	-0,321	2,0	-3,774	2,0	0,578	2,6	0,084	0,663	64	0,054
Cycles & motor cycles	0,021	0,1	7,404	1,2	0,167	0,5	0,069	0,271	59	-0,084
Jewellery	-0,384	2,1	0,912	0,6	0,651	3,1	**0,312**	0,975	88	0,166
Toys	0,129	0,6	6,422	1,5	0,233	1,0	0,058	0,504	72	-0,004
Miscellaneous manufacturing	-0,394	3,4	0,976	0,9	0,749	5,5	**0,386**	1,000	104	0,334

TABLE 2 - NUMBER OF LOCAL TECHNOLOGICAL SPILLOVERS IN THE ITALIAN MANUFACTURING INDUSTRY

(*)	(**)	3-digit industries	(1) *Spillovers produced* Significance: 1%	5%	10%	(2) *Spillovers received* Significance: 1%	5%	10%	(3) *Difference (1) - (2)* Significance: 1%	5%	10%	(4) *Total (1) + (2)* Significance: 1%	5%	10%
F		Meat products	2	5	7	0	1	2	2	4	5	2	6	9
F		Fruit & vegetable prod.	0	3	5	1	1	3	-1	2	2	1	4	8
F		Oils & fats	1	3	3	2	3	4	-1	0	-1	3	6	7
F		Dairy products	2	3	3	0	2	3	2	1	0	2	5	6
		Grain milling	1	4	6	1	2	5	0	2	1	2	6	11
F		Animal foods	1	4	10	0	1	2	1	3	8	1	5	12
F		Bread, biscuits & other foods	2	3	5	0	2	3	2	1	2	2	5	8
F		Wine, beer & soft drinks	2	4	7	3	3	4	-1	1	3	5	7	11
		Spinning	1	5	12	0	1	3	1	4	9	1	6	15
		Weaving	1	3	8	0	3	6	1	0	2	1	6	14
		Textile finishing	0	2	2	1	5	6	-1	-3	-4	1	7	8
F		Household textiles	0	1	3	0	2	4	0	-1	-1	0	3	7
		Miscellaneous textiles	2	6	7	1	8	11	1	-2	-4	3	14	18
F		Knitting & Hosiery	2	7	11	2	6	10	0	1	1	4	13	21
F		Clothing	7	13	18	2	7	10	5	6	8	9	20	28
		Leather tanning	0	2	4	0	0	0	0	2	4	0	2	4
F		Leather products	1	5	8	0	4	4	1	1	4	1	9	12
F		Footwear	1	4	7	0	4	6	1	0	1	1	8	13
		Wood sawing	1	2	3	1	3	4	0	-1	-1	2	5	7
		Wood boards	1	3	4	0	0	1	1	3	3	1	3	5
		Wooden structures	5	12	14	3	4	6	2	8	8	8	16	20
		Wooden containers	2	5	8	1	1	3	1	4	5	3	6	11
		Other wood and cork pr oducts	1	2	3	4	8	12	-3	-6	-9	5	10	15
F		Furniture	7	12	17	3	8	11	4	4	6	10	20	28
		Paper & pulp	0	2	5	0	1	3	0	1	2	0	3	8
F		Processed paper	0	3	5	3	5	9	-3	-2	-4	3	8	14
		Printing	0	0	0	0	5	9	0	-5	-9	0	5	9
	R&D	Oil products	0	1	3	0	2	4	0	-1	-1	0	3	7
	R&D	Basic chemicals	1	1	2	0	2	4	1	-1	-2	1	3	6
	R&D	Paint & ink	0	3	4	0	0	2	0	3	2	0	3	6
F	R&D	Pharmaceuticals	1	2	2	1	2	3	0	0	-1	2	4	5
F	R&D	Soap & detergents	0	1	3	0	1	3	0	0	0	0	2	6
	R&D	Other chemical products	0	1	3	2	3	4	-2	-2	-1	2	4	7
	R&D	Rubber	0	3	3	2	4	7	-2	-1	-4	2	7	10
		Plastics	3	5	6	2	4	8	1	1	-2	5	9	14
		Glass	0	2	4	1	6	10	-1	-4	-6	1	8	14
		Ceramics	0	5	8	2	3	4	-2	2	4	2	8	12
		Clay products	1	1	2	0	1	1	1	0	1	1	2	3
		Cement	0	3	6	1	5	6	-1	-2	0	1	8	12
F		Concrete	0	2	8	4	6	6	-4	-4	2	4	8	14
F		Stone products	0	0	1	1	2	3	-1	-2	-2	1	2	4
		Iron & steel	0	0	3	0	0	1	0	0	2	0	0	4
		Steel forming cold	1	3	3	1	1	1	0	2	2	2	4	4
		Non-ferrous metals	0	3	7	0	0	0	0	3	7	0	3	7
		Foundries	1	1	2	1	4	9	0	-3	-7	2	5	11
		Metal structures	2	5	11	4	8	11	-2	-3	0	6	13	22
		Boilers & containers	1	2	2	0	4	4	1	-2	-2	1	6	6
		Forging & profiling	1	4	5	0	2	4	1	2	1	1	6	9
		Metal treatment	0	0	3	7	12	22	-7	-12	-19	7	12	25
F		Cutlery & tools	0	2	3	0	0	3	0	2	0	0	2	6
		Other metal products	2	2	2	4	11	14	-2	-9	-12	6	13	16
	R&D	Transmission eq. & other mach.	0	2	3	0	2	5	0	0	-2	0	4	8
	R&D	General purpose machinery	3	4	5	0	4	6	3	0	-1	3	8	11
	R&D	Tractors and agric. machinery	0	3	3	3	5	8	-3	-2	-5	3	8	11
	R&D	Machine tools	1	1	2	0	2	2	1	-1	0	1	3	4
	R&D	Machinery for specific industr.	0	3	4	1	3	4	-1	0	0	1	6	8
F	R&D	Domestic electrical appliances	3	8	9	1	2	4	2	6	5	4	10	13
	R&D	Electrical machinery	2	2	3	0	3	6	2	-1	-3	2	5	9
	R&D	Electrical equipment	2	5	7	1	3	4	1	2	3	3	8	11
F	R&D	Measuring instruments	0	1	3	0	1	3	0	0	0	0	2	6
		Coachwork	1	3	5	0	1	4	1	2	1	1	4	9
	R&D	Motor vehicle parts	0	1	2	1	4	5	-1	-3	-3	1	5	7
F		Shipbuilding	0	0	1	0	0	1	0	0	0	0	0	2
F	R&D	Cycles & motor cycles	0	1	4	0	0	0	0	1	4	0	1	4
F		Jewellery	0	1	3	0	2	4	0	-1	-1	0	3	7
F		Toys	1	5	6	0	3	4	1	2	2	1	8	10
F		Miscellaneous manufacturing	0	1	2	2	3	5	-2	-2	-3	2	4	7

(*) Final sectors

(**) Research intensive industries according to Davies and Lyons (1996)

TABLE 3 - REGRESSION RESULTS WITH THE ESTIMATED 'OWN VARIETY'

Dependent variables (log of employment growth 1971-91)	Constant	Empl. share own variety sectors	t	Own variety index	t	1971 empl. in the local economy	t	Competition index	t	1971 empl. in the local industry	t	Adjusted R2	Number of observations	Contribution of spillovers to R2
Meat products	61,561	-1,665	0,5	-55,025	1,6	0,020	0,3	2,352	2,5	-0,023	0,3	0,059	246	0,018
Fruit & vegetable prod.	-6,169	3,021	1,2	4,638	0,6	0,048	0,6	1,686	0,8	-0,040	0,4	-0,007	157	-0,004
Oils & fats	-10,369	5,040	4,8	7,465	2,2	0,071	2,5	1,029	3,6	0,061	1,1	0,107	350	0,097
Dairy products	-7,521	7,100	2,7	6,550	0,5	0,063	1,5	-0,555	1,4	-0,145	2,6	0,065	299	0,048
Grain milling	-0,159	3,788	3,1	-0,967	0,2	0,040	0,8	-0,464	1,4	-0,091	1,0	0,083	344	0,076
Animal foods	-5,164	6,365	1,3	3,221	0,2	-0,077	0,9	2,834	1,5	0,229	1,5	0,029	93	0,032
Bread, biscuits & other foods	-13,624	3,647	4,9	10,465	2,5	0,533	20,8	0,182	1,0	-0,552	18,4	0,496	584	0,392
Wine, beer & soft drinks	0,386	2,451	2,3	-0,573	0,2	-0,099	2,1	-0,830	1,3	0,063	1,0	0,051	376	0,050
Spinning	-7,590	7,073	4,1	6,823	1,4	-0,065	0,8	-2,000	0,9	-0,217	2,5	0,144	182	0,129
Weaving	-20,931	10,803	4,0	16,496	2,6	0,383	3,5	1,208	1,3	-0,485	4,4	0,122	165	0,105
Textile finishing	-11,115	6,447	2,4	7,571	1,3	0,379	2,4	4,415	1,0	-0,501	3,4	0,191	73	0,079
Household textiles	-27,747	11,333	6,8	21,935	4,4	0,457	3,7	0,206	0,4	-0,485	3,9	0,283	187	0,277
Miscellaneous textiles	-17,362	8,257	6,7	12,489	3,2	0,537	7,8	-1,237	5,2	-0,571	7,3	0,373	215	0,255
Knitting & Hosiery	-13,958	6,619	8,6	10,134	4,5	0,208	3,5	0,371	1,2	-0,117	1,9	0,156	449	0,157
Clothing	-11,570	6,324	9,5	9,751	5,1	0,109	2,1	-0,571	3,3	-0,124	2,1	0,162	813	0,107
Leather tanning	-20,330	13,326	1,3	13,954	0,2	-0,414	3,1	9,560	2,6	0,304	2,4	0,167	70	0,139
Leather products	-14,587	6,526	3,5	11,437	1,9	0,192	2,0	1,252	1,4	-0,130	1,3	0,134	130	0,093
Footwear	-7,071	5,233	4,7	4,899	2,3	0,039	0,6	1,576	1,7	-0,005	0,1	0,092	240	0,096
Wood sawing	-7,854	5,635	3,7	5,213	1,0	0,194	3,9	0,735	1,3	-0,253	2,3	0,220	212	0,201
Wood boards	-10,669	8,414	2,8	9,792	1,3	0,022	0,2	-10,299	2,6	-0,461	3,4	0,231	85	0,169
Wooden structures	-4,431	2,833	6,4	3,884	2,5	0,084	2,9	0,033	0,3	-0,173	4,4	0,107	822	0,089
Wooden containers	-7,340	4,359	2,1	5,480	0,8	0,122	1,9	0,635	0,9	-0,236	2,2	0,042	201	0,032
Other wood and cork pr oducts	-8,447	6,436	4,8	3,865	0,9	0,401	6,8	2,450	5,1	-0,308	3,9	0,439	189	0,280
Furniture	-5,096	3,368	5,1	3,181	1,5	0,187	4,2	0,883	3,0	-0,155	3,5	0,115	474	0,084
Paper & pulp	-1,497	3,184	1,1	2,689	0,2	-0,146	2,4	-0,324	0,1	-0,149	1,8	0,123	106	0,043
Processed paper	-9,872	4,915	6,8	6,490	4,6	0,320	4,2	3,049	2,0	-0,254	3,3	0,277	219	0,159
Printing	-4,542	2,150	4,7	2,907	1,9	0,322	5,4	0,304	0,7	-0,330	6,1	0,283	300	0,161
Oil products	-56,656	20,546	2,9	39,250	1,7	0,532	3,8	-1,927	0,4	-0,407	2,6	0,169	82	0,152
Basic chemicals	-42,556	16,653	4,7	36,630	3,6	0,342	2,6	4,431	1,2	-0,392	3,2	0,190	155	0,118
Paint & ink	-21,287	13,744	2,9	15,940	1,9	0,263	1,9	3,066	1,3	-0,147	1,0	0,189	75	0,128
Pharmaceuticals	-34,607	14,528	2,8	30,559	0,7	-0,374	2,0	9,671	1,1	0,312	1,7	0,133	71	0,162
Soap & detergents	#######	27,574	4,4	153,593	2,7	0,081	0,6	3,035	1,3	-0,237	1,8	0,258	69	0,237
Other chemical products	#######	19,317	3,3	152,019	3,2	0,278	2,0	2,869	1,4	-0,336	2,4	0,210	110	0,164
Rubber	-7,517	7,364	3,7	4,592	0,6	0,161	1,7	0,602	1,0	-0,162	1,8	0,175	172	0,178
Plastics	-7,636	3,835	5,1	6,105	2,2	0,220	4,1	3,088	3,3	-0,287	5,1	0,296	306	0,107
Glass	-19,792	8,367	5,0	16,595	2,5	0,148	1,8	3,691	3,4	-0,190	2,6	0,306	158	0,148
Ceramics	2,524	4,987	2,6	-2,937	0,3	-0,194	2,8	5,893	5,8	0,230	3,3	0,174	192	0,081
Clay products	-13,896	6,789	2,4	12,556	1,2	-0,040	0,6	-0,905	0,3	-0,212	2,0	0,059	218	0,039
Cement	-5,230	5,952	2,6	3,626	0,4	-0,132	1,5	2,675	1,2	0,199	1,4	0,087	140	0,101
Concrete	-12,917	5,761	4,1	11,020	1,6	0,134	2,8	2,612	3,9	-0,254	3,9	0,217	388	0,066
Stone products	-5,974	3,069	4,1	4,779	2,1	-0,005	0,2	2,513	7,0	-0,009	0,2	0,201	368	0,047
Iron & steel	-61,782	23,852	1,7	30,024	1,5	-0,022	0,2	23,457	1,4	0,072	0,4	0,009	62	0,014
Steel forming cold	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-ferrous metals	-45,058	13,285	1,8	32,787	0,7	0,021	0,2	2,679	0,9	-0,044	0,3	0,056	81	0,048
Foundries	-15,366	6,927	4,0	12,798	1,8	0,023	0,3	4,467	2,3	-0,086	1,0	0,135	157	0,112
Metal structures	-6,958	3,081	6,2	4,822	2,9	0,520	10,3	0,061	0,1	-0,613	12,0	0,401	398	0,206
Boilers & containers	-74,018	23,367	3,5	59,954	1,8	0,348	2,5	7,093	1,3	-0,329	1,7	0,280	75	0,172
Forging & profiling	-53,127	15,520	3,9	42,733	2,5	0,476	4,7	8,537	2,5	-0,327	2,9	0,428	72	0,221
Metal treatment	-14,191	6,469	12,7	11,711	6,5	0,363	4,9	-0,752	1,8	-0,452	6,3	0,355	326	0,353
Cutlery & tools	-18,144	8,204	4,2	13,713	2,5	0,361	4,8	1,570	1,2	-0,259	3,0	0,249	123	0,220
Other metal products	-5,284	3,149	8,0	3,496	2,8	0,228	6,5	-0,068	0,5	-0,208	4,7	0,194	623	0,190
Transmission eq. & other mach.	-12,866	7,408	4,1	8,373	1,9	0,429	4,0	1,302	0,6	-0,291	3,2	0,144	154	0,130
General purpose machinery	-22,037	8,349	7,7	15,925	4,5	0,874	8,8	-1,174	2,6	-0,772	7,7	0,371	230	0,367
Tractors and agric. machinery	-10,173	4,972	5,4	7,800	2,4	0,080	1,6	1,259	2,6	-0,084	1,2	0,137	271	0,124
Machine tools	-50,934	11,495	2,2	42,975	1,2	0,238	2,2	4,125	1,3	-0,462	4,3	0,218	116	0,062
Machinery for specific industr.	-10,282	5,065	5,8	7,231	2,8	0,398	5,6	2,460	1,3	-0,344	5,4	0,271	235	0,187
Domestic electrical appliances	-23,860	10,975	2,6	19,883	1,2	-0,006	0,0	10,655	1,9	0,048	0,3	0,090	106	0,062
Electrical machinery	-25,185	12,141	5,3	18,083	3,2	0,600	5,1	3,587	1,1	-0,449	4,0	0,374	133	0,227
Electrical equipment	-48,016	12,543	7,7	37,136	3,5	1,068	10,6	-0,935	1,6	-0,883	8,1	0,420	338	0,343
Measuring instruments	-34,051	13,122	3,9	27,327	2,2	0,367	2,8	1,565	0,7	-0,360	2,4	0,249	81	0,232
Coachwork	-15,961	7,068	2,9	13,266	2,6	0,172	1,9	2,897	0,4	-0,358	2,8	0,258	77	0,066
Motor vehicle parts	-54,219	17,038	4,6	50,097	3,4	-0,066	0,6	4,820	1,1	-0,072	0,6	0,184	102	0,156
Shipbuilding	#######	40,116	2,1	545,760	1,4	0,038	0,3	-0,682	0,4	-0,140	1,3	0,095	64	0,066
Cycles & motor cycles	-56,730	19,337	1,2	42,693	0,5	-0,216	1,6	14,532	3,5	0,156	1,0	0,182	59	0,029
Jewellery	-20,604	12,207	4,6	14,148	2,2	0,301	2,1	3,022	2,7	-0,165	1,3	0,318	88	0,172
Toys	-56,301	21,798	3,8	45,804	2,4	0,166	1,3	6,894	2,1	0,004	0,0	0,230	72	0,169
Miscellaneous manufacturing	-27,553	11,435	3,6	21,194	0,6	0,568	6,6	0,861	1,0	-0,447	4,7	0,409	104	0,356

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