Foreign Affiliates in the French Manufacturing Industry: Source or Recipient of Technology Spillover?

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Abstract

“Technological Outsourcing” is becoming an important motivation for multinational enterprises to locate affiliates abroad, especially in technological leading countries. In this paper we try to verify if foreign affiliates located in France are acquiring technology from the French economy and if they are transmitting some of their know-how to French firms.

We define three channels of technology spillovers, Horizontal presence of firms, backward linkages and forward linkages. Our empirical analysis is based on a database of French manufacturing industries at the firm level and covering the period 1990-2001. Our results show that foreign affiliates benefit from the proximity of French firms and from acquiring their inputs from local suppliers. We also find that foreign affiliates transmit technology to local firms through backward and forward linkages.
I-Introduction:

Traditionally, the economic literature analyzed the international diffusion of technology by focusing on the role of multinational firms in host countries. The major hypothesis behind this analysis are, first, the fact that multinational firms rely generally on their ownership specific advantages in order to be competitive at the international market, second, the fact that multinationals firms transfer know-how and technology to their affiliates located abroad and third, the fact that technology brought in by foreign affiliates will diffuse through the host economy.

This analysis is relevant in the case of developing countries but not necessary in the case of advanced and developed ones. In fact, domestic firms in developed countries generally lack the capacity to innovate and to successfully carry out a research and development (R&D) activity, thus it is pertinent to suppose that those firms rely on foreign sources of technology.

The case of developed countries is different. Domestic firms in those countries possess the necessary infrastructure\(^1\), at the individual and national level, to be innovative and highly competitive on their market. This technological capacity\(^2\) of firms in developed countries makes it more pertinent to suppose a diffusion of technology in both direction\(^3\) between domestic firms and foreign affiliates.

Many recent studies have shown that technology sourcing is an important motivation for firms to locate abroad especially in technologically leading countries, particularly the United-States. In fact, since technology is generally geographically localised [Jaffe, Trajtenberg & Henderson (1993) and Keller (2002)], firms locate some of their activities, particularly R&D activity, close to technological clusters to benefit from the technology and know-how spilling over through the cluster. Generally those affiliates transmit the technology acquired to their parent company.

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1 By infrastructure we mean the human capital available in the labor market, the research institutions present in the country, the technological infrastructure defined as the access to internet, telephony and electricity. (Archibugi & Cocco 2004)

2 Econometric studies of technology transfer through FDI usually find significance evidence on the existence of technology transfer in the case of developed countries and insignificant evidence in the case of developing countries. The lack of absorptive capacity on the part of developing countries’ firms is the most important reason explaining the absence of technology transfer.

3 From and toward foreign affiliates.
Serapio & Dalton (1999) certify that “Foreign parent companies, particularly in drugs/ biotechnology and electronics industries, have established or acquired foreign R&D laboratories in the US in order to gain access to science and technology, and enhance their global capabilities for technology and innovation.”


In this paper we study the case of the French manufacturing industry. We define three channels of technology diffusion, Horizontal, Vertical-Backward, and Vertical-Forward and try to determine the direction of technology diffusion (i.e. from or toward foreign affiliates located in France). We use firm level data extracted from the annual survey “EAE” realized by the French Ministry of Industry. We estimate the effect of foreign presence, at the horizontal and vertical levels, on the productivity of domestic firms and find significant evidence on technology spillover only at the vertical levels. We also estimate the effect of domestic firms on the productivity of foreign affiliates and find a significant and positive effect at the horizontal and Vertical-Forward levels but an insignificant effect at the Vertical-Backward one; we find however no significant difference between the effect of specific and generic linkages.

The rest of the paper is structured as follow; in the second section, we present a detailed analysis of the objectives of the paper. In the third section, we present data and methodology. In the fourth section, we present the results and in section five we present conclusions.
III-Objectives of the paper:

The objective of this paper is the analysis of the structure of technology spillover in the French manufacturing industry. More precisely the paper aims at answering the following questions: Do foreign affiliates investing in France, introduce new technologies and Know-how to the French economy? Does this technology spill over to French firms? Or do foreign affiliates invest in France to benefit from technology and Know-how developed by French firms?

Many recent studies [Griffith, Harrison & Reenen (2003), Singh (2003)] argue that multinational firms install affiliates in leading innovative countries to benefit from the technology generated in those countries. The reasons that push us to assume that foreign affiliates in France may be motivated by technology outsourcing are numerous. France is a highly developed country, fifth economy in the world in term of GDP and second in term of outward FDI. Compared to other European countries, France is a leading country in terms of R&D activity (public and private) and in terms of innovative activity (number of patents). Moreover, the French economy is endowed with a highly qualified, educated and productive labour force.

We define three channels of technology spillover, Horizontal, Vertical-Backward and Vertical-Forward. Horizontal technology spillover stands for the technology, knowledge and know-how that are implicitly and involuntary diffused between firms investing in the same sector and/or region and are canalized by mechanism like workers turnover and demonstration effect. Horizontal technology spillover has been frequently analysed econometrically and results differ significantly from country to country but generally significant evidence are found in the case of developed countries. The absence of spillover in the case of developing countries is mostly explained by the weak absorptive capacity of domestic firms [Haddad & Harrison (1993), Aitken & Harrison (1999)].
In the case of the French industry, we assume that both domestic firms and foreign affiliate have sufficient absorptive capacity that allows them to benefit from the technology developed by other firms. Thus we expect the horizontal channel to be efficient for technology spillover.

By vertical technology spillover, we mean technology and know-how that are transferred between firms and their suppliers. Vertical-Backward spillovers refer to the technology transferred from firms to their suppliers. The efficiency of backward linkages as a channel of technology transfer is justified by the idea that firms are willing to transfer some of their knowledge to their suppliers in order to guarantee the quality of their inputs. In the same time, firms also impose quality requirement and quality control that urge the suppliers to upgrade their technological and managerial capacities [Kugler (2000), Moran (2001)]. Evidence on technology transfer through backward linkages has been provided by recent studies like those of Smarzynska (2002) on Lithuania, Blalock and Gertler (2003) on Indonesia and Jabbour and Mucchielli (2003) on Spain.

Vertical-Forward spillovers refer to the technology transferred from suppliers to their customers. In fact we suppose that the technology and Know-How of a firm is reflected in the quality of its products. When those products are used as inputs by another firm, their quality affect positively its productivity. In other words, technology and Know-How of suppliers are transmitted to their customers through the quality of inputs.

The intensity of technology spillovers through backward and forward linkages depend on several elements, particularly the nature of those linkages. More precisely we assume that the foreign firms will be more willing to share their know-how and their technology with their suppliers if the intermediate product supplied is specific to the production process of the foreign firms. The more the supplied product is specific and specialised, the higher the quality requirement of the foreign buyer will be and the more specialised and strategic the transferred technology will be. If the local supplier produces a “generic” intermediate output, (not strategically related to the production process of the foreign buyer), its possibility of learning is weak and limited to general techniques of production.
Similarly, if the input is specific to the production process of production of the firm that buy it, it will have a greater effect on the productivity of this firm. We associate “specific” and “specialised” linkages to backward and forward linkages between firms belonging to the same industry, and “generic” linkages to linkages between firms belonging to different industries.

To verify the existence of technology spillover, we estimate the effect of Horizontal and Vertical channels on the total factor productivity of firms. We consider a positive and significant effect as evidence on technology spillover. To determine the direction of technology diffusion, we split the data in two samples, a sample of foreign affiliates and a sample of domestic firms. We estimate the horizontal and vertical effects of domestic firms on foreign affiliates to verify if foreign affiliates outsource technology by investing in France, and we estimate the horizontal and vertical effects of foreign affiliates on domestic firms to verify if foreign affiliates in France are a source of technology spillover.

### III- Data description and Methodology:

The data base used in this paper is derived from the firm annual survey “EAE” conducted by the French Ministry of Industry. This survey is exhaustive, obligatory and concerns all firms with more than twenty employees. The data base we use covers the period 1990-2001 and sixteen manufacturing sectors. The sectoral classification of firms follows the three digits French classification NAF36. The data base is an unbalanced panel with a number of firms per year varying from 24506 firms in 1990 to 22053 firms in 2001.

The survey provides data on the productive activity of firms: output, exports, number of employees, stock of capital, investment, use of intermediate inputs and

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subcontracting activity conducted and confided by the firm. All the variables are deflated using sectoral price indices.

To distinguish between foreign affiliates and domestic firms we completed our data with financial data provided by the financial liaisons survey “LIFI” conducted by the French national statistic office “INSEE”. This is an obligatory survey that gives information on the ownership of an enterprise and on relations between an enterprise and its parent company and identifies the home country of the enterprises. The “LIFI” survey is addressed to firms verifying at least one of these criteria: more than 500 employees, value of stocks higher than 1.2 millions euros, parent company in the previous year, directly controlled by foreign company in the previous year, turnover value higher than 30 millions euros.

Since the criteria of the “LIFI” survey are different from those of the “EAE” survey and concern relatively large scale firms, some of the small and medium enterprises, present at the “EAE” data base, may not be covered by the “LIFI” survey. We define foreign affiliates as firms with thirty percent or more of their capital controlled by foreigners. Generally, and following the definition of the OECD and the IMF, the cut-off capital participation rate for the definition of foreign affiliates is set at ten percent. We consider that the ten percent cut-off rate does not represent sufficient control over the activity of a firm.

We consider all the firms not covered by the “LIFI” survey, and for which we do not possess information on the ownership structure, as local firms. This lack of information and the criteria of the “LIFI” data base may lead to biased estimation of the presence of foreign affiliates. Foreign investors are mostly present in the Pharmaceutical and Chemical industries with fifty percent and forty percent share of total employment respectively.

To verify the existence of technology transfer through horizontal and vertical channels we estimate the following equation:

\[ PTF_{it} = \alpha + \beta_1 \text{Horizontal}_{jt} + \beta_2 \text{Backward-linkages}_{ijt} + \beta_3 \text{Forward-linkages}_{ijt} + d_i + d_t + \varepsilon_{ijt}. \]

(Eq 1)
- i, j, and t represent respectively firms, sectors, and time and $\varepsilon_{ijt}$ is a error term.

- PTF$_{it}$ represents total factor productivity of firm i at time t. We estimated total factor productivity using the semi parametric estimation suggested by Olley and Pakes (1996), which allows avoiding the selection and the simultaneity problems. In order to estimate the PTF we used data on employment, measured by the number of employees, on the stock of capital, which is equal to the value of fixed assets, on the use of intermediates, which it is equal to the purchased value of intermediates adjusted for changes in stock, and on investment.

- Horizontal$_{jt}$ is a sector specific variable that represents the foreign (local) presence in sector j at time t and it is defined as the part of foreign (local) firms in the total employment of the sector.

  \[
  \text{Horizontal}_{jt} = \frac{\sum_{i \in j} for_{it} \times l_{it}}{\sum_{i \in j} l_{it}}
  \]

  Where for$_{it}$ (local$_{it}$) is a dummy that takes the value of one if a firm is defined as a foreign (local) one and zero otherwise.

  The variable Horizontal$_{jt}$ captures the effect of foreign (local) affiliates on their local (Foreign) competitors. A positive coefficient on this variable reflects the existence of horizontal technology transfer.

- Backward-linkages: this variable captures the effect of firms on their suppliers. We use the amount of subcontracting realized by each firm and reported in the “EAE” to calculate two Backward-linkages variables:

  The foreign Backward-linkages variable, which estimates the subcontracting activity realized by firms and addressed to foreign affiliates, is calculated as follow:

  \[
  \text{Foreign Backward-linkages}_{it} = \log \left( \sum_{k} \alpha_{jk} \times \text{Foreign}_{it} \times \text{Subcontracting}_{it} \right)
  \]

  Where $\alpha_{jk}$ is equal to the proportion of sector j output that is supplied to sector k. The proportions are taken from the input-output matrix at the three digit level of the NAF. Foreign$_{it}$ represents the foreign presence in sector k and

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5 The firm i is a firm of the sector j.
Local \( j \) represents the local presence in sector \( j \). We include, in the calculation of the Backward-linkages variables, the amount of linkages within a sector. In fact a significant part of the subcontracting activity takes place in the same sector of activity. If we exclude subcontracting activity within the same sector, their effect will be captured by the Horizontal variable and the coefficient on this variable will be biased. A significant and positive effect of this variable on the productivity of domestic firms is evidence on the existence of technology transfer from foreign affiliates to local suppliers.

The local Backward-linkages variable, which estimates the subcontracting activity realized by firms at the benefit of local firms, is calculated as follow:

\[
\text{Local Backward-linkages}_{it} = \log \left( \sum_k \alpha_{jk} \times \text{Local}_{it} \times \text{Subcontracting}_{it} \right)
\]

A positive and significant effect of this variable on the productivity of foreign firms is evidence of the technology diffusion toward foreign suppliers.

The variable Backward-linkages constructed using the subcontracting activity of each firm is more precise than the sector specific one constructed with the Input-Output Table, used in the previous works on backward linkages, since it is a firm specific variable.

- Forward linkages: this variable measure the extent of technology contained in intermediate products and transferred from suppliers to their customers. We use the confided subcontracting activity reported in “EAE” data base to estimate two backward linkages variables, a foreign backward-linkages variable and a local foreign backward-linkages variable.

The foreign Forward-linkages variable is calculated as follow:

\[
\text{Foreign Forward-linkages}_{ijt} = \log \left( \sum_k \beta_{jk} \times \text{foreign}_{it} \times \text{confied} - \text{Subcontracting}_{it} \right)
\]

\( B_{jk} \) represents the share of the total inputs of sector \( j \) that is supplied by sector \( k \). The \( \beta_{jk} \) proportions are derived from the Input-Output Table. A positive

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6 Foreign and Local are respectively Foreign Horizontal and Local Horizontal.  
7 Particularly when the aggregation of the data is limited at the three digit level.
coefficient on this variable is evidence on technology spillovers through backward linkages from foreign suppliers to local buyers.

**The local Forward-linkages variable** is calculated as follow:

Local forward-linkages\(_{ijt}\) = \(\log(\sum_k \beta_{jk} \times \text{local}_{kt} \ast \text{confied} - \text{Subcontracting}_{it})\)

A positive and significant effect of this variable on the productivity of firms is synonymous of technology spillovers through forward linkages from local suppliers to foreign buyers.

- **“Specific” Linkages:** to test the difference between “specific” linkages and “generic” linkages we constructed four specific linkages variables, two for backward linkages and two for forward linkages, which are defined as follow:

  Foreign Backward-linkages\(_{it}\) (intra) = \(\log((\alpha_{ji} \times \text{Foreign}_{it} \ast \text{Subcontracting}_{it})\)

  Local Backward-linkages\(_{it}\) (intra) = \(\log((\alpha_{ji} \times \text{Local}_{it} \ast \text{Subcontracting}_{it})\)

  Foreign Forward-linkages\(_{ijt}\) (intra) = \(\log((\beta_{ji} \times \text{Foreign}_{jt} \ast \text{confied} - \text{Subcontracting}_{it})\)

  Local Forward-linkages\(_{ijt}\) (intra) = \(\log((\beta_{ji} \times \text{Local}_{jt} \ast \text{confied} - \text{Subcontracting}_{it})\)

- **“Generic” linkages:** We construct four generic variables, two for backward linkages and two for forward linkages, which are defined as follow:

  Foreign Backward-linkages\(_{it}\) (inter) = \(\log((\sum_{k \neq j} \alpha_{ki} \times \text{Foreign}_{ik} \ast \text{Subcontracting}_{it})\)

  Local Backward-linkages\(_{it}\) (inter) = \(\log((\sum_{k \neq j} \alpha_{ki} \times \text{Local}_{ik} \ast \text{Subcontracting}_{it})\)

  Foreign Forward-linkages\(_{ijt}\) (inter) = \(\log((\sum_{k \neq j} \alpha_{kj} \times \text{confied} - \text{Subcontracting}_{it})\)

  Local Forward-linkages\(_{ijt}\) (inter) = \(\log((\sum_{k \neq j} \alpha_{kj} \times \text{local}_{kj} \ast \text{Subcontracting}_{it})\)
Foreign Forward-linkages_{ijt}^{(inter)} = \log\left(\sum_{k \neq j} \beta_{ij} \cdot Foreign_{ik} \cdot confied \right) - \log\left(\sum_{k \neq j} \beta_{ij} \cdot Subcontracting_{ik} \right)

Local Forward-linkages_{ijt}^{(inter)} = \log\left(\sum_{k \neq j} \beta_{ij} \cdot Local_{ik} \cdot confied \right) - \log\left(\sum_{k \neq j} \beta_{ij} \cdot Subcontracting_{ik} \right)

**IV- Results:**

Before estimating the different version of Eq (1), we can predict the direction of spillovers by comparing the performance of domestic firms and foreign affiliates. We choose the labour productivity as criteria of comparison, since we focus our analysis on the productivity of firms. We interpret a higher productivity as a sign of a better technological performance. If foreign affiliates are significantly more productive than domestic firms we expect technology to diffuse from foreign affiliates to domestic firms and vice versa. In each sector, we compare\(^8\) the productivity of domestic firms to that of foreign affiliates and find that, on the exception of the leather industry, the pharmaceutical industry and the home equipments industry\(^9\), foreign affiliates are significantly more productive than domestic firms. Thus we expect technology diffusion to be more intense toward domestic firms. However the difference in productivity may simply reflect the difference in size between foreign affiliates and domestic firms.

Table one show the results for the sample of domestic firms. The first column shows that the presence of foreign affiliates has a significant negative impact on the productivity of domestic firms. This result is contrary to our expectations. Generally we explained this kind of negative impact as the result of the competition between domestic firms and foreign affiliates (Aitken & Harrison 1999). Column two show positive and significant evidence on technology spillovers through backward linkages.

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\(^8\) We perform a mean comparison test.

\(^9\) For those industries, there is no significant difference between the productivity of domestic firms and that of foreign affiliates. For the sector Gas, Water and Electricity, the foreign presence is very limited making the comparison statistically impossible.
This result confirms the hypothesis that backward linkages are more efficient than the simple presence of foreign affiliates as a channel of technology spillovers. The result in column four is a confirmation of technology spillovers through forward linkage. However the extent of spillover through forward linkages is higher than that of backward linkages.

Table I

<table>
<thead>
<tr>
<th>Domestic firms</th>
<th>Horizontal (Foreign)</th>
<th>-0.257* (.034)</th>
<th>-0.295* (.034)</th>
<th>-0.258* (.034)</th>
<th>-0.257* (.034)</th>
<th>-0.359* (.033)</th>
<th>-0.237* (.033)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Backward linkages</td>
<td>.000897** (.0003)</td>
<td>.0262* (.0004)</td>
<td>.00106* (.0004)</td>
<td>.00135* (.0004)</td>
<td>.03104* (.0005)</td>
<td>.031* (.0005)</td>
<td></td>
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<td>Foreign Forward linkages</td>
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<tr>
<td>Foreign Backward linkages (intra)</td>
<td></td>
<td></td>
<td>.00106* (.0004)</td>
<td>.00135* (.0004)</td>
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<td>Foreign Forward linkages (intra)</td>
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<td>Foreign Forward linkages (inter)</td>
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<tr>
<td>Time dummies</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>R²</td>
<td>0.1017</td>
<td>0.1164</td>
<td>0.1017</td>
<td>0.1017</td>
<td>0.1189</td>
<td>0.1195</td>
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<td>Nb of observations</td>
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<td>196014</td>
<td>196014</td>
<td>202678</td>
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</tbody>
</table>

*: indicates difference in means is significant at the 1% level

**: indicates difference in means is significant at the 5% level

**: indicates difference in means is significant at the 10% level.
Table two presents the results for the sample of foreign affiliates. The result in column one is evidence on horizontal spillover from local firms towards foreign affiliates. However if we assume that competition between foreign affiliates and domestic firms is the reason for the negative effect on table one, we expect that competition to have the same effect on foreign affiliates. But we can suppose that horizontal variable reflect the positive spillovers towards foreign affiliates resulting from the quality of the French industrial infrastructure, and that overcomes the negative impact of competition.

Column two presents insignificant coefficients on the backward linkages variables. This result is contrary to our expectations, since we consider backward linkages as the most efficient channel of spillovers. One explanation to this result is the idea that domestic firms have their established supplying network before the entry of foreign affiliates. Thus we expect the subcontracting activity confide to foreign affiliates to be small.

The result in column four shows significant evidence on technology spillovers toward foreign affiliates through forward linkages with domestic firms.

For both samples and contrary to our expectations we find no significant difference between “specific” and “generic” linkages. This can be the result of our definition of the “specific” linkages variable.

In an unreported result, we find evidence on technology spillovers between domestic firms through backward and forward linkages, and on technology spillovers between foreign affiliates only through forward linkages\(^\text{10}\).

\(^{10}\) We preformed all regressions using OLS and we find similar results.
<table>
<thead>
<tr>
<th>Foreign Affiliates</th>
<th>Horizontal (local)</th>
<th>Local Backward linkages</th>
<th>Local Forward linkages</th>
<th>Local Backward linkages (intra)</th>
<th>Local Backward linkages (inter)</th>
<th>Local Forward linkages (intra)</th>
<th>Local Forward linkages (inter)</th>
<th>Time dummies</th>
<th>R²</th>
<th>Nb of observations</th>
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<td>-0.00121 (0.008)</td>
<td>0.01415* (0.011)</td>
<td>-0.00138 (0.009)</td>
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Table II
V- Conclusion:

In this paper we tried to answer the following question: Are foreign affiliates investing in France diffusing technology in the French economy or are they outsourcing technology?

We define three channels of technology spillovers, the horizontal channel which refers to technology implicitly spilling over between firms investing in the same sector, the backward linkages channel which refers to the technology transferred from firms to their suppliers and forward linkages channels which refers to the technology transferred from suppliers to their customers and canalised by the intermediate products.

We find that foreign firms benefit from their presence in the French industry and from the proximity with domestic firms. We also find that foreign affiliates benefit from buying their inputs from domestic suppliers. However we find insignificant impact of their supplying activity.

Our results also show that domestic firms benefit from supplying goods to foreign affiliates and from buying intermediated products from them.

For domestic firms as well as foreign affiliates, forward linkages seem to the most efficient channel for technology transfer. In fact, firms operating in the French industry are highly productive and efficient, thus it is normal for their efficiency to be reflected in the quality of their products. In the same time, considering this efficiency, firms do not need to transfer great amount of knowledge to their suppliers to guarantee the quality of inputs. We expect backward linkages to have greater effect in the case of less competitive suppliers.

For the theorists on technology outsourcing, locating R&D activity in the host country is essential to acquire the technology and knowledge developed in that country. Unfortunately, the “EAE” data base does not provide data on the R&D activity. Thus we were not able to test the effect of R&D activity on technology diffusion towards foreign affiliates and further research is certainly necessary to bring clarification to that question.
Reference:


