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# Foreign Affiliates and Technology Spillovers in the French Manufacturing Sector: An Analysis using Panel Data

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**ABSTRACT**

The question of whether foreign direct investment (FDI) contributes to the enhancement of technological capacities of foreign firms operating in host countries has long captured the attention of economists and politicians. Still more intriguing is the question of determining what are the most effective methods of technology transfer. In that light, the econometric study presented here has drawn on a panel database of French firms covering the period from 2008 to 2010. Horizontal and vertical FDI spillovers are examined in upstream markets while considering their impact on the productivity of local firms. Our results show that vertical technological spillovers occur across all industry sectors whereas evidence of horizontal spillovers is revealed solely in medium- and high-tech industries. Hence, it can be said that these spillovers are inversely proportional to the technological effort exerted by domestic firms in terms of R and D expenditures. Similarly, domestic firms with an international outlook seem to have a greater capacity to absorb foreign technology.

**Keywords:** Foreign Direct Investment, Technology Spillovers, Vertical Linkages, Horizontal Linkages, French Manufacturing Sector, Panel Data
**JEL Classifications:** F23, L00, O33

## 1. INTRODUCTION

Recent economic research has brought about closer attention to the question of international technology transfer, especially the deployment of technology through foreign direct investment (FDI) (Lafi, 2008), Hisarcıklılar et al. (2014). This renewed interest in technology transfer stems, no doubt, from the introduction of a new theory on economic growth (Romer, 1990), which suggested that technological progress is the principal motor for economic development. Hence, countries seeking to boost economic growth must find a way to develop their technological capacity. However, they often do not have the ability to undertake the research and development (R and D) initiatives and generate technological innovation. As a consequence, they resort to copying foreign innovations, in their quest for growth. And economic research has largely inspired pessimism as to the ability of foreign affiliates to deploy technology internationally. In spite of several studies that reveal evidence of positive spillovers associated with FDI in more developed economies (Haskel et al., 2002), most literature has expressed doubts about achieving spillover success in developing countries, suggesting a negative or insignificant correlation between foreign investment and the effects on the productivity of local enterprises. That lack of technology spillovers is usually explained by the absence of absorptive capacity among local firms. However, most of these studies have focused on technology transfers between foreign affiliates and local firms operating in the same industrial sector, that is, technological spillover arising from firms' sectoral proximity, which is commonly referred to as horizontal transfers. A plausible explanation for the absence of this type of technology transfer is that the dissemination of their technology and know-how to rival local firms was not in the strategic interest of foreign affiliates, especially when the foreign affiliates' technology is the prime factor behind their competitive advantage on the host-country market.

We have sought to consider how foreign affiliates might be motivated by technological developments employed by local suppliers. The creation of backward linkages (between foreign investors and their local suppliers in upstream sectors) could prove to be a more efficient route for transferring and absorbing new technologies. Similarly, forward linkages between local manufacturers and foreign suppliers could facilitate the dissemination of foreign technology within the local economy.

Indeed, the productivity of local firms could improve if the latter used more cutting-edge, high quality technological inputs.

Empirical literature on FDI and technology spillover shows mixed results in this regard, while making reference to impacts on productivity levels achieved by local firms. Such research has been pursued along three distinct avenues. First-generation research, which was based mainly on cross-sectional industry data, reported positive horizontal spillover effects. However, the empirical findings of these studies are debatable due to issues of reverse causation and the omission of unobservable time and industry-specific factors (Tang, 2008). Second-generation research used firm-level panel data and concluded that the presence of foreign companies has either no effect or adverse effects on productivity levels in developing economies. Third-generation research stressed the importance of inter-sectoral linkages in generating positive effects. A meta-analysis based on 57 empirical studies conducted between 2003 and 2013 showed the relative importance of vertical linkages as a potential channel for local firms to make technology transfers (Havránek and Iršová, 2011).

Literature on technology transfer via vertical linkages is relatively scarce but we should nonetheless cite studies by Smarzynska (2004) on Lithuania, Garrick and Gertler (2008) on Indonesia, and Jabbour and Mucchielli's (2007) on Spain. Although these studies confirm the lack of intra-sectoral spillover, they provide econometric evidence of the presence of vertical spillover effects between foreign affiliates and local firms.

This paper is intended to offer an applied empirical analysis of the manufacturing sector in France. It seeks, above all, to verify the presence of technological spillovers obtained through backward horizontal and vertical linkages. We will also examine which types of French firms are in the most favorable position to assimilate technology, while making a distinction between firms essentially catering to the local market and those that are more export oriented. That distinction is significant for policymakers wishing to improve the technical capacity of their domestic firms. We assess their output level using a panel data model with error components. This method took into account the endogeneity of input demands and thereby enhanced the quality of the estimate. As regards horizontal spillovers, we noted a significant negative correlation between the presence of foreign companies and the output level of domestic firms in low-technology sectors, and a positive correlation in medium- and high-technology sectors. Furthermore, the findings show a positive significant correlation between foreign suppliers and local firms.

The remainder of this paper is structured as follows: In the second section, we will present the analytical framework of our research. In the third section, we will discuss the data and methodology we used. In the fourth section, we will measure the effects of the presence of foreign-owned companies. In the last section, we will summarize the results of our findings.

## 2. CONCEPTUAL FRAMEWORK

FDI has a number of consequences on the host country's economy. The arrival of multinational firms affects, among other things, the job market, the size of the marketplace, the balance of payments, as well as industrial development. The implication of these factors can be positive or negative, and the net effect of FDI in the host country is usually difficult to predict. In this paper, we are especially interested in looking at the effects of FDI on industrial development through the creation of linkages with French firms. Economic research has laid out two main models for analyzing the correlation between FDI, horizontal and vertical linkages, and industrial development. The models formulated by Markusen and Venables (1999) and Rodriguez-Clare (1996) examine the impact of FDI on industrial development, based on its effect on the intensity of linkages. The underlying idea behind these models is that the intensity of backward and forward linkages within various sectors of an economy is a driving force for industrial dynamism and development. FDI has two opposing effects on the intensity of linkages. On the one hand, the arrival of foreign firms creates a new source of demand for local suppliers of intermediate goods. On the other hand, it heightens the level of competition faced by local businesses and forces some of them to either leave the marketplace or improve their competitiveness. And so, the net effect of foreign firms will depend on the linkages that they generate compared to linkages that would have been created by local firms that are displaced from the market. Models like Pack and Saggi's (2001) analyze more explicitly the inter-sectoral transfer of technology. The basic idea behind this model is that foreign firms are prepared to transfer certain technology and know-how to their suppliers, in order to ensure the quality of their intermediate goods.

Case studies and interviews with managers working for national suppliers show that foreign firms apply more demanding standards regarding design and quality of products, as well as delivery time. They also show that these firms frequently impose quality control guidelines. Foreign affiliates help local suppliers improve their manufacturing process, by relying on training and job rotation. Foreign purchasers schedule field visits by their technical staff with the local supplier, and assist in providing plans and information on production techniques. Domestic suppliers can also benefit from the presence of foreign firms, which can motivate them to make their output and production process more specialized, flexible, and adaptable, to meet international market requirements (United Nations Conference on Trade and Development [UNCTAD], 2001). The intensity of backward linkages between foreign firms and domestic suppliers and the degree to which these linkages will generate technology transfers depend on several factors, notably the local industry's technological capacity, the mode of foreign market entry, and the nature of their business activity.

### 2.1. Effect of the Technological Gap

The degree of technology transfer will depend on the technological capability enjoyed by domestic firms. Indeed, the lack of absorptive capacity is a factor that traditionally explains the absence of horizontal technology spillovers. We feel that the technological gap can also have an impact on spillovers arising from vertical linkages. More specifically, if the technological gap between the local supplier and the foreign firm is wide, the latter can seek to obtain intermediate goods from international suppliers. Similarly, if the technological gap between foreign suppliers and local firms is substantial, the latter will not succeed in absorbing the foreign technology incorporated in imported inputs. A "sufficiently high" local learning capacity would seem to be a prerequisite for assimilating technology introduced by multinational firms into host countries. Whenever the technological gap is wide, in the context of a substantial foreign presence, multinational firms risk being confined to niches, i.e., limited to operating in isolated segments of the market where products and technologies are very different from those used by local businesses. Spillovers into the productivity of local firms will therefore be limited.

R and D expenditures are the primary means by which local firms improve their learning efforts and their capacity to assimilate knowledge and generate innovations. We can expect an increase in spillovers according to the level of sector-wide technology and the level of intangible capital.

### 2.2. The Effect of the Mode of Market Entry

The motivation for foreign affiliates to create linkages with host-country firms may depend on their mode of market entry. It has been pointed out that foreign affiliates that penetrate the market in the host country via mergers and acquisitions (M and A) or joint ventures are more likely to strengthen links with domestic firms than with firms that enter the host country to pursue greenfield projects (UNCTAD, 2001). In fact, foreign affiliates can benefit from their local partners' knowledge about local market conditions as well as from their role and clout within the supplier network. However, entirely foreign-owned firms tend to be more technologically advanced than partially foreign-owned firms. And it is fair to assume that, in order to prevent technology leaks into the host country economy, multinational firms that enter the marketplace via M and A or joint ventures are more reluctant to transfer their cutting-edge technology to their affiliate companies (Ethier and Markusen, 1996).

### 2.3. Foreign Trade Regimes

Bhagwati (1978) was the first scholar to forcefully argue that the extent of the impact of the FDI on growth depends on the openness or restrictiveness of the commercial policy adopted, i.e., the degree of reliance on an export-promotion or import-substitution trade strategy. All other things being equal, export-oriented economies are more likely, first, to attract greater FDI, and, secondly, to maximize FDI effects, owing to fewer market distortions. Conversely, import-substitution policies rely on tariffs and quotas, which lead to product and factor market distortions.

Openness to trade also serves as a key indicator of a country's success in attracting foreign investors and, in addition, has significant influence on FDI in the host country. Indeed, Marino (2000) found that, out of 42 countries surveyed, the most "open" economies (measured as a trade-to-GDP ratio) attracted more foreign capital than so-called "closed" economies (which were classified as such solely on the basis of their average tariff rate on imports). FDI has a positive impact on growth for the former group and a negative impact for the latter. That correlation is not surprising, given that FDI generally goes hand-in-hand with greater trade integration. It is often a clear indication of strengthened vertical integration of multinational firms and the deeper role played by foreign affiliates in the distribution strategies implemented by multinational firms. In fact, a developing country's ability to attract FDI will depend largely on the import and export opportunities provided to the investor (OECD, [2002]). Carstensen and Toubal (2003) have shown that, in the case of Central and East European Countries, a reduction in tariff barriers stimulates investments from abroad, thereby attesting to the strong complementary relationship between trade and FDI. Hence, we can assume that there is a growing relationship between export rates and the level of technology dissemination.

## 3. DATA AND DESIGN METHODOLOGY

### 3.1. Data Sources and Description

Two databases were used as sources of our econometric estimates. The first was the Enquête Annuelle d'Entreprise (EAE) (ABS or Annual Business Survey) conducted by the SESSI statistical organization, which limited the report's scope to French industrial enterprises with twenty or more employees or producing a sales turnover of at least 5 million euros. The EAE ABS sets out a definition for the concept of a firm's "average number of employees," which is calculated according to the time spent by employees at the firm over a period of one year. It includes employees hired under permanent, fixed-term or apprenticeship contracts, or personnel working on a part-time or temporary basis, or under secondment (internal transfer) or loan.

Our second source is "LIFI" or the Financial Links between Enterprises Survey, carried out by INSEE, the National Statistics Office of France, among resident firms with more than 1.2 million euros in equity securities, or having a workforce of more than 500 employees, or which produced a sales turnover of more than 60 million euros. Firms not meeting one of these criteria but recognized as a head holding company in the year prior to the survey were also included, as were firms owned by foreign companies in the year preceding the survey. The LIFI survey enabled us to identify companies belonging to foreign groups. The sample that was ultimately selected, after cross-matching the two surveys and data cleansing for accuracy, included 17,710 firms under French ownership, surveyed over a three-year period (2008–2010).

Foreign firms own 9.34% of the enterprises with 20 or more employees in the French manufacturing sector, excluding the agri-food industry. Foreign affiliates operating in France account for approximately 19% of the workforce in the manufacturing sector. They have a high export effort (33%). As they are not based in France, they usually import new additions to their product range from affiliates located outside metropolitan France or bring them in directly from their parent company, merely reselling them in their original state.

Foreign affiliates tend to be oriented toward high technology. French affiliates play a major role in the manufacturing sector as a whole but less so in high-tech and medium-tech sectors. (Table 1). Foreign firms operating in France are particularly present in the pharmaceutical, perfume, and beauty products industry (32%), the automotive industry (22%), the naval and aeronautics industry (14%), and the chemicals industry (12%).

French industrial affiliates are especially present in the "medium-high technology" sector, owing to the weight of the automotive industry, and notably that of the PSA group and Renault in this sector (77%). The weight of French affiliates is still greater in "medium-low technology" sectors, especially household equipment (94%), mechanical equipment (93%), and electrical and electronic equipment (91%) Table 2.

Foreign firms account for nearly one-fifth of industrial employment. They prefer overwhelmingly to invest in highly skilled, labor-intensive sectors. Foreign affiliates employ nearly 31% of the workforce in the pharmaceuticals perfume, and beauty products sector, more than 27% of workforce in the naval, aeronautics sector, and nearly 23% in the mechanical equipment sector. On the other hand, the proportion represented by foreign firms in the low-tech sectors is lowest, accounting for merely 6% of the workforce in the clothing and leather industry, as well as in the publishing and printing sectors.

For the manufacturing sector as a whole, there is a large difference between the export rate (exports-to-sales turnover ratio) for foreign-owned firms and the rate for French firms (Table 3). The export effort exerted by foreign affiliates is higher in all sectors, especially the automotive and mechanical equipment, electrical equipment, electrical components, electrical and electronic equipment, and textiles sectors, where the rates are above 40%. The export focus of foreign-owned firms is further confirmed in five other sectors, where the export rate is above 30%, namely in the pharmaceuticals, perfume and beauty products (33%), naval, aeronautics (35%), household equipment (35%), chemicals, rubber (34%), and textiles (33%).

## 3.2. Methodology

Our examination into backward horizontal and vertical linkages with foreign firms affecting the productivity level of local firms, was conducted using panel data in first differences, in order to avoid the problem of exogeneity of regressors. Individual specific effects were not taken into account, except for an examination of residuals: each firm i has a firm-specific time-invariant characteristic t (αi) that is not observable, which justifies the decision to rely on a component errors model. As dependent variable, we evaluate the Naperian logarithm for the output of firm i belonging to sector j in year t (Log $Y_{it}$). We have used the three types of Horizontal variables defined in economic literature, which represents the intra-sectoral effect (within sector j):

- Horizontal_$Y_{jt}$: The intra-sectoral effect of foreign presence measured in terms of the foreign affiliates' share of the total sectoral output for sector j in year t: $\frac{\sum_{i\in j} FS_{ijt}Y_{ijt}}{\sum_{i\in j} Y_{ijt}}$ where $Y_{ijt}$ is the output of firm i belonging to sector j at time t, weighted by the share of foreign capital $FS_{ijt}$ (source: LIFI). Hence, the Horizontal variable grows with the foreign firms' output and share of capital. $FS_{ijt}$ is equal to zero if the firm is domestic. The denominator is simply the total real output for sector j at time t.
- Horizontal_$L_{jt}$: The intra-sectoral effect of foreign presence measured in terms of the foreign firms' share of total employment (workforce) in sector j in year t: $\frac{\sum_{i\in j} FS_{ijt}L_{ijt}}{\sum_{i\in j} L_{ijt}}$ where $L_{ijt}$ is the output of firm i belonging to sector j at time t weighted by $FS_{ijt}$.
- Similarly, Horizontal_$VA_{jt}$: The intra-sectoral effect of the foreign presence measured in terms of the foreign firms' share of added value contributed to the total added value of sector j in year t: $\frac{\sum_{i\in j} FS_{ijt}VA_{ijt}}{\sum_{i\in j} VA_{ijt}}$ Where $VA_{ijt}$ is the output of firm i belonging to sector j at time t, weighted by variable $FS_{ijt}$.

The Backward[1] variable, which measures inter-sectoral effects, is defined in relation to the Horizontal variable, in the equations presented below.

$$\text{Backward\_Yjt}=\sum_{ksik\neq j} \alpha_{jk} *Horizontal\_Y_{kt}$$

$$\text{Backward\_Ljt}=\sum_{ksik\neq j} \alpha_{jk} *Horizontal\_L_{kt}$$

$$\text{Backward\_}VA\text{jt}=\sum_{ksik\neq j} \alpha_{jk} *Horizontal\_VA_{kt}$$

Where $\alpha_{jk}$ is the proportional share of inputs provided by sector j within sector k. These proportional shares are taken from the inputs/outputs charts. The proportional share is calculated while excluding goods intended for final consumption. As the equation indicates, we have not included intra-sector inputs (imported from within the same sector of activity), so as to consider merely inter-sectoral effects[2].

Random effects models have been used. They are of Log-Log type, so as to allow for a direct interpretation of estimated coefficients in terms of elasticity for each variable defined relative to the explanatory variables:

### *3.2.1. Family 1: Spillovers measured through output Y*

**Model 1.1:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_Y_{it}+\beta_5 LogBackward\_Y_{it}+\varepsilon_{it}$$

**Model 1.2:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_Y_{it}+\beta_5 LogBackward\_Y_{it}+\beta_6 LogK_{it}\_Inc+\varepsilon_{it}$$

1 Backward spillovers can occur when foreign affiliates acquire inputs from local firms.

2 We have borrowed the example proposed by Smarzynska (2004) in his article (p. 10): "*To illustrate the meaning of the variable, suppose that the sugar industry sells half of its output to jam producers and half to chocolate producers. If there are no multinationals producing jams but half of all chocolate production comes from foreign affiliates, the Backward variable will be calculated as follows ½*0 + ½*½ = 0.25.*"

**Table 1: Sectoral breakdown of employment by French - and foreign-owned firms**

| Sector | Technology | Number of firms | | |
|---|---|---|---|---|
| | | French-owned | Foreign-owned | Total |
| | | Workforce (%) | Workforce (%) | Workforce (%) |
| C1 - Clothing and leather industry | Low | 1363 (88.10) | 184 (11.89) | 1547 (100) |
| C2 - Publishing. printing or copying | Low | 539 (88.94) | 67 (11.05) | 606 (100) |
| C3 - Pharm, perfume, beauty prod | High | 490 (67.71) | 114 (32.29) | 604 (100) |
| C4 - Household equipment | Medium-low | 1208 (94.08) | 76 (5.92) | 1284 (100) |
| D0 - Automobiles | Medium-high | 471 (77.46) | 137 (22.53) | 608 (100) |
| E1 - Naval aeronautic | High | 264 (85.71) | 44 (14.28) | 308 (100) |
| E2 - Mechanical equipment | Medium-low | 3039 (93.27) | 219 (6.72) | 3258 (100) |
| E3 - Electrical and electronic équipements électriques équipements électriques équipements électriques équipements électriques | Medium-low | 981 (91.11) | 93 (8.88) | 1074 (100) |
| F1 - Mineral products | Medium-low | 1085 (92.26) | 91 (7.74) | 1176 (100) |
| F2 - Textiles | Low | 1278 (90.71) | 131 (9.29) | 1409 (100) |
| F3 - Timber, paper, paperboard | Low | 1047 (89.18) | 127 (10.82) | 1174 (100) |
| F4 - Chemicals, rubber, plastics | Medium-high | 1851 (87.18) | 272 (12.82) | 2123 (100) |
| F5 - Metals and metal products | Medium-low | 3318 (94.56) | 191 (5.44) | 3509 (100) |
| F6 - Electrical components | Medium-high | 776 (90.86) | 78 (9.14) | 854 (100) |
| Total | | 17,710 (90.66) | 1824 (9.34) | 19,534 (100) |

Scope: Manufacturing sector firms (excluding the agri-food industry) with 20 employees or more. Sources: Authors' calculations using LIFI and EAE databases

**Table 2: Sectoral breakdown of employment by French - and foreign-owned firms**

| Sector | Employment | | |
|---|---|---|---|
| | French-owned | Foreign-owned | Total |
| | Workforce (%) | Workforce (%) | Workforce (%) |
| C1 - Clothing and leather industry | 117,388 (93.95) | 7559 (6.04) | 124,947 (100) |
| C2 - Publishing. Printing or copying | 180,557 (93.64) | 12,260 (6.35) | 192,817 (100) |
| C3 - Pharm., perfume, beauty prod | 152,325 (68.80) | 69,068 (31.20) | 221,393 (100) |
| C4 - Household equipment | 162,835 (78.91) | 43,514 (21.09) | 206,349 (100) |
| D0 - Automobile | 343,042 (79.61) | 87,891 (20.39) | 430,933 (100) |
| E1 - Naval aeronautic | 85,817 (72.44) | 32,643 (27.56) | 118,460 (100) |
| E2 - Mecanical equipment | 312,581 (77.30) | 91,746 (22.70) | 404,327 (100) |
| E3 - Electrical and electronic | 292,700 (81.95) | 64,466 (18.01) | 357,166 (100) |
| F1 - Mineral products | 148,162 (81.71) | 33,164 (8.28) | 181,326 (100) |
| F2 - Textiles | 115,547 (92.47) | 9409 (7.53) | 124,956 (100) |
| F3 - Timber, paper, paperboard | 111,481 (71.95) | 43,461 (28.05) | 154,942 (100) |
| F4 - Chemicals, rubber, plastics | 434,703 (81.71) | 97,297 (18.29) | 532,000 (100) |
| F5 - Metals and metal products | 332,316 (84.46) | 61,135 (15.54) | 393,451 (100) |
| F6-Electrical components | 280,163 (81.21) | 84,840 (18.79) | 345,003 (100) |
| Total | 3,069,617 (81.03) | 718,453 (18.97) | 3,788,070 (100) |

Scope: Manufacturing sector firms (excluding the agrifood industry) with 20 employees or more. Sources: Authors' calculations using LIFI and EAE databases

**Model 1.3:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_Y_{it}+\beta_5 LogBackward\_Y_{it}+\beta_7 LogK_{it}\_Inc+\beta_8 LogTxExp+\varepsilon_{it}$$

*3.2.2. Family 2: Spillover measured in terms of employment (workforce) L*

**Model 2.1:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_L_{it}+\beta_5 LogBackward\_L_{it}+\varepsilon_{it}$$

**Model 2.2:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_L_{it}+\beta_5 LogBackward\_L_{it}+\beta_6 LogK_{it}\_Inc++\varepsilon_{it}$$

**Model 2.3:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_L_{it}+\beta_5 LogBackward\_L_{it}+\beta_7 LogK_{it}\_Inc+\beta_8 LogTxExp+\varepsilon_{it}$$

*3.2.3. Family 3: Spillover measured in terms of added value VA*

**Model 3.1:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_VA_{it}+\beta_5 LogBackward\_VA_{it}+\varepsilon_{it}$$

**Model 3.2:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_VA_{it}+\beta_5 LogBackward\_VA_{it}+\beta_5 LogK_{it}\_Inc+\varepsilon_{it}$$

**Table 3: Export rates of French - and foreign-owned firms**

| Sector | Export rate in percentage terms | |
|---|---|---|
| | French | Foreign |
| C1 - Clothing and leather industry | 17.11 | 33.07 |
| C2 - Publishing, printing or copying | 5.32 | 10.14 |
| C3 - Pharm., perfume, beauty prod | 26.59 | 33.20 |
| C4 - Household equipment | 19.54 | 35.33 |
| D0 - Automobile | 16.60 | 42.49 |
| E1 - Naval aeronautic | 27.98 | 35.25 |
| E2 - Mechanical equipment | 16.36 | 41.98 |
| E3 - Electrical and electronic | 21.52 | 42.09 |
| F1 - Mineral products | 11.73 | 19.54 |
| F2 - Textiles | 25.52 | 42.02 |
| F3 - Timber, paper, paperboard | 14.87 | 21.31 |
| F4 - Chemicals rubber, plastics | 19.67 | 34.55 |
| F5 - Metals and metal products | 13.92 | 26.94 |
| F6 - Electrical components | 20.24 | 40.89 |
| Total | 18.36 | 32.77 |

Scope: Manufacturing sector excluding the agri-food industry, firms with 20 employees or more. Sources: Authors' calculations using LIFI and EAE databases

**Model 3.3:**

$$LogY_{it}=\alpha+\beta_1 LogK_{it}+\beta_2 LogL_{it}+\beta_3 LogM_{it}+\beta_4 LogHorizontal\_VA_{jt}+\beta_5 LogBackward\_V_{jt}+\beta_7 LogK_{it}\_Inc+\beta_8 LogTxExp+\varepsilon_{it}$$

$$\varepsilon_{it}=\mu_i+v_{it}$$

Where disturbance has two components: $\mu_i$ represents the individual specific effect and $v_{it}$ white noise.

All nominal variables are deflated in real terms to base year 2000, to allow for meaningful comparisons across years, using the appropriate corresponding index. They are defined as follows:

- **$Y_{it}$**: The real output of firm i at time t deflated by the price index for output in each sector, defined by net sales turnover (source: EAE).
- **$L_{it}$**: The real output of firm i at time t, defined by net sales turnover deflated by the price index for output in each sector (source: EAE).
- **$VA_{it}$**: The added value contributed by firm i at time t deflated by the price index for output in each sector (source: EAE). However, output and intermediate consumption are not deflated by the same indexes, producing a distortion in the real valuation of each firm's added value.
- **$K_{it}$**: The tangible capital factor is equivalent to the value of the fixed assets of firm i at time t deflated by the average price index for the various sectors (source: EAE).
- **$L_{it}$**: The workforce factor measured in terms of the full-time equivalent workforce employed by firm i at time t (source: EAE).
- **$M_{it}$**: The value of firm i's intermediate consumption adjusted for changes in inventories at time t (goods purchased + raw materials purchased – changes in inventories and raw materials) deflated by the output price index (source: EAE).
- **$K_{it}$_Inc**: Firm i's intangible capital at the end of financial year t (comprised of start-up costs, R and D, and other intangible asset items (source: EAE).
- **$TxExp_{it}$**: Firm i 's export rate at time t. It is a control variable that measures the effect of international market orientation (source: EAE).

## 4. RESULTS AND INTERPRETATION

The estimators may become biased if individual characteristics are correlated with exogenous variables. The question as to whether the correlation is present or absent led us to compare the efficiency of the component errors model to that of another model known as the covariance matrix model. The latter model assumes that the individual specific effects $\alpha_i$ are fixed and not random. By comparing the chi-squared value with its tabulated value with (k-1) degrees of freedom[3], we can determine if our model is specified correctly. If the empirical value is lower than the theoretical value, we can accept the assumption $H_0$, i.e., that the random effects model is the best specification in this case. Otherwise, we accept assumption $H_1$, which suggests that the fixed effects model is the better specification. Before discussing our findings, we shall look briefly at the effects of industry-level control variables on manufacturing output growth of French-owned firms.

Industry-level control variables consist of the stock of physical capital, employment, and intermediate consumption. The base model includes the factors of production (physical capital, employment and intermediate consumption), together with horizontal and backward spillover variables, while successively adding intangible-capital and export-rate variables, to examine their effect on the quality of the estimates and on coefficients.

A breakdown of the results, showing estimates for the various sectors, is set out in the appendix. The sum of the intra-sectoral effects is dependent on the specific characteristics of each sector. Our results show a positive effect, as confirmed by a $\beta_4$ coefficient above zero, and statistically significant across all sectors except low-tech industries, namely: The clothing and leather goods industry, textiles, publishing, printing, copying, and timber, paper, and paperboard. In these sectors, the negative effects prevail over positive effects owing to the fact that a foreign presence exerts a crowding-out effect or business attraction effect through competition. In addition, foreign businesses operating in these sectors seem to attract the most highly qualified workers, at the expense of French enterprises. The transmission channels for these positive spillovers are far from uniform. These various results therefore confirm the hypothesis that technology spillover emanates from the presence of foreign firms. The estimates show that the presence of horizontal spillovers is dependent on the sectors' technological level and degree of concentration. Intra-sectoral spillovers become positive if high or medium technology sectors are involved or if the business attraction effect exerted by foreign capital is overwhelmed by the other positive effects.

The high-tech industries benefit more from foreign labor, whereas medium-technology sectors benefit more from the quality of inputs provided to foreign affiliates.

Moreover, the output of French firms is positively correlated to the increase in the number of foreign-controlled enterprises in the

3 Where k is the number of explanatory variables, including constants. Based on a threshold risk level of 5%, the tabulated or theoretical chi-squared value is equal to 11.07, 12.59 and 14.07 for 5, 6 and 7 degrees of freedom (DOF), respectively.

segment. This result is consistent with the hypothesis according to which technology transfers are more likely to occur through the vertical linkages between foreign affiliates and local firms. The estimates show that an increase in the output, the size of the workforce, and added value of foreign-owned suppliers in France is associated with a growth in the output of domestic firms. These backward vertical spillovers take the form of enhanced quality of inputs, increased productivity on the part of workers in the foreign affiliates, thanks to re-investments of profits earned by the firms. These effects are confirmed by positive and statistically significant coefficients in virtually all regressions for all sectors. Backward vertical spillovers are present in all sectors studied in France.

## 5. CONCLUSION

Several studies have sought to assess the impact of FDI on the growth of output by local firms. These studies rely on different research methods (time series, panel data, micro-economic data, industry data, etc.) and, depending on the evaluation of the size and importance of spillovers, have led to generally controversial results. Indeed, it is conceptually difficult to determine empirically whether FDI is accompanied by technological dissemination. The measurement of labor productivity, which is the variable most often employed, reflects merely a part of a firm's or an industry's output and not output as a whole.

The study of FDI-based technology spillovers in France has never, to our knowledge, been subjected to empirical study, in spite of vast theoretical and empirical literature on attractiveness factors. Furthermore, France ranks as the third destination worldwide in terms of FDI inflows, with a record level of 108 billion euros, in 2007, according to figures published by the Bank of France. The present study, which is based on data involving French-owned and foreign-owned manufacturing firms in France, is intended to bridge that gap. Its aim is to examine the presence and characteristics of technology spillovers inside and outside each French manufacturing sector, excluding the agri-food and energy industries.

Nonetheless, these findings should be interpreted with a degree of caution, bearing in mind, for example, that firms not polled in the LIFI survey are considered to be French-owned affiliates, although they could actually be foreign. We hope that a harmonized survey taking this point into consideration will be conducted by statistical services in order to clear up such ambiguity. Our sample covers a relatively short time span of 3 years, owing to difficulties we experienced in accessing the data. Accordingly, the effect of time frames has not been taken into account. We hope that future research will overcome these limitations and yield more precise results.

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# APPENDIX

**Table A1: Estimates for the clothing and leather goods sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 5.137 (2.86)* | 4.996 (2.83)* | 4.593 (12.79)* | 4.497 (12.13)* | 4.575 (12.58)* | 5.020 (2.88)* | 4.599 (2.86)* | 4.502 (2.85)* | 4.514 (2.90)* |
| Δ Log K | 0.127 (16.15)* | 0.113 (14.44)* | 0.107 (13.85)* | 0.127 (16.15)* | 0.113 (14.44)* | 0.107 (13.85)* | 0.127 (16.15)* | 0.113 (14.44)* | 0.107 (13.85)* |
| Δ Log L | 0.362 (31.18)* | 0.357 (31.28)* | 0.369 (32.56)* | 0.362 (31.18)* | 0.357 (31.28)* | 0.369 (32.56)* | 0.362 (31.18)* | 0.357 (31.28)* | 0.369 (32.56)* |
| Δ Log M | 0.369 (98.65)* | 0.350 (87.00)* | 0.341 (84.17)* | 0.369 (98.65)* | 0.350 (87.00)* | 0.341 (84.17)* | 0.369 (98.65)* | 0.350 (87.00)* | 0.341 (84.17)* |
| Δ Log horizontal | −0.20 (−12.87)* | −0.346 (−5.26)* | −0.112 (−8.86)* | −0.422 (−2.16)** | −0.116 (−7.54)* | −0.366 (−8.61)* | −0.068 (−1.51) | −0.083 (−5.95)* | −0.085 (−22.78)* |
| Δ Log backward | 0.022 (8.57)* | 0.012 (4.88)* | 0.378 (8.30)* | 0.352 (5.05)* | 0.344 (6.50)* | 0.013 (5.37)* | 0.391 (17.26)* | 1.278 (4.22)* | 0.308 (13.29)* |
| Δ Log K_Inc | | 0.039 (12.14)* | 0.035 (11.03)* | | 0.039 (12.14)* | 0.035 (11.03)* | | 0.039 (12.14)* | 0.035 (11.03)* |
| Δ Log TxExp | | | 0.451 (9.95)* | | | 0.451 (9.95)* | | | 0.451 (9.95)* |
| Chi-squared | 1. 99 | 1.98 | 1.98 | 1. 99 | 1.98 | 1.98 | 1. 99 | 1.98 | 1.98 |
| No. Obs. | 4089 | 4089 | 4089 | 4089 | 4089 | 4089 | 40897 | 4089 | 4089 |
| $R^2$ | 0.8677 | 0.8727 | 0.8758 | 0.8677 | 0.8727 | 0.8758 | 0.8677 | 0.8727 | 0.8758 |
| $\overline{R^2}$ | 0.8675 | 0.8725 | 0.8756 | 0.8675 | 0.8725 | 0.8756 | 0.8675 | 0.8725 | 0.8756 |
| Fcalc−fisher | 5356.1 | 4676.8 | 4115.5 | 5356.1 | 4676.8 | 4115.5 | 5356.1 | 4676.8 | 4115.5 |

The figures appearing in parentheses are student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A2: Estimates for the publishing, printing, copying sector**

| Variables] | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 5.126 (3.50)* | 5.030 (3.58)* | 5.068 (3.62) | 5.586 (5.89)* | 5.645 (6.22)* | 5.696 (6.30)* | 5.996 (3.51)* | 6.157 (3.76)* | 6.204 (3.80)* |
| Δ Log K | 0.033 (4.14)* | 0.031 (3.99)* | 0.030 (3.90)* | 0.033 (4.14)* | 0.031 (3.99)* | 0.030 (3.90)* | 0.033 (4.14)* | 0.031 (3.99)* | 0.030 (3.90)* |
| Δ Log L | 0.757 (54.75* | 0.681 (49.55* | 0.679 (49.53)* | 0.757 (54.75)* | 0.681 (49.55)* | 0.679 (49.53)* | 0.757 (54.75)* | 0.681 (49.55)* | 0.679 (49.53)* |
| Δ Log M | 0.285 (41.61)* | 0.271 (40.97* | 0.265 (40.01)* | 0.285 (41.61)* | 0.271 (40.97)* | 0.265 (40.01)* | 0.285 (41.61)* | 0.271 (40.97)* | 0.265 (40.01)* |
| Δ Log horizontal | −0.390 (−19.04)* | −0.323 (−6.48)* | −0.243 (−4.91)* | −0.503 (−5.56)* | −0.641 (−15.44)* | −0.796 (−4.01)* | −0.355 (−2.35)** | −0.467 (−4.55)* | −0.474 (−4.31)* |
| Δ Log backward | 0.934 (3.32)* | 0.395 (4.53)* | 0.404 (4.65)* | 0.352 (5.05)* | 0.244 (6.87)* | 1.728 (5.31)* | 0.701 (5.16)* | 0.169 (13.56)* | 0.532 (9.73)* |
| Δ Log K_Inc | | 0.070 (20.27* | 0.069 (20.09)* | | 0.070 (20.27)* | 0.069 (20.09)* | | 0.070 (20.27)* | 0.069 (20.09)* |
| Δ Log TxExp | | | 0.512 (6.04)* | | | 0.512 (6.04)* | | | 0.512 (6.04)* |
| Chi-squared | 0.90 | 1.96 | 1.97 | 0.90 | 1.96 | 1.97 | 0.90 | 1.96 | 1.97 |
| No. Obs. | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 |
| $R^2$ | 0.7709 | 0.7896 | 0.7909 | 0.7709 | 0.7896 | 0.7909 | 0.7709 | 0.7896 | 0.7909 |
| $\overline{R^2}$ | 0.7701 | 0.7888 | 0.7899 | 0.7701 | 0.7888 | 0.7899 | 0.7701 | 0.7888 | 0.7899 |
| Fcalc−Fisher | 1084.2 | 1007.6 | 869.7 | 1084.2 | 1007.6 | 869.7 | 1084.2 | 1007.6 | 869.7 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A3: Estimates for the Pharmaceuticals, perfume, beauty products entreti**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 3.250 (2.04)** | 3.280 (2.10)** | 3.331 (6.54)* | 5.758 (2.28)** | 5.883 (2.39)** | 5.848 (2.37)** | 0.463 (0.13) | 3.279 (1.98)** | 3.284 (2.10)** |
| Δ Log K | 0.018 (1.89)*** | 0.131 (13.98)* | 0.121 (12.79)* | 0.018 (1.89)** | 0.131 (13.98)* | 0.121 (12.79)* | 0.018 (1.89)*** | 0.131 (13.98)* | 0.121 (12.79)* |
| Δ Log L | 0.438 (26.83)* | 0.409 (24.95)* | 0.412 (24.69)* | 0.438 (26.83)* | 0.409 (24.95)* | 0.412 (24.69)* | 0.438 (26.83)* | 0.409 (24.95)* | 0.412 (24.69)* |
| Δ Log M | 0.569 (55.43)* | 0.558 (54.97)* | 0.556 (54.17)* | 0.569 (55.43)* | 0.558 (54.97)* | 0.556 (54.17)* | 0.569 (55.43)* | 0.558 (54.97)* | 0.556 (54.17)* |
| Δ Log horizontal | 0.151 (9.14)* | 0.150 (14.73)* | 0.226 (4.20)* | 0.081 (5.37)* | 0.066 (6.25)* | 0.150 (6.14)* | 0.076 (7.02)* | 0.095 (2.09)** | 0.142 (1.61) |
| Δ LogBackward | 0.485 (8.02)* | 0.416 (2.64)* | 0.603 (3.49)* | 0.350 (3.38)* | 0.531 (9.72)* | 0.488 (9.56)* | 0.283 (3.57)* | 0.365 (3.50)* | 0.413 (8.95)* |
| Δ Log K_Inc | | 0.043 (7.89)* | 0.042 (7.84)* | | 0.043 (7.89)* | 0.042 (7.84)* | | 0.043 (7.89)* | 0.042 (7.84)* |
| Δ Log TxExp | | | 0.053 (8.26)* | | | 0.053 (8.26)* | | | 0.053 (8.26)* |
| Chi-squared | 0.07 | 1.65 | 1.58 | 0.07 | 1.65 | 1.58 | 0.07 | 1.65 | 1.58 |
| No. Obs. | 1470 | 1470 | 1470 | 1470 | 1470 | 1470 | 1470 | 1470 | 1470 |
| $R^2$ | 0.9133 | 0.9171 | 0.9171 | 0.9133 | 0.9171 | 0.9171 | 0.9133 | 0.9171 | 0.9171 |
| $\overline{R^2}$ | 0.9130 | 0.9167 | 0.9167 | 0.9130 | 0.9167 | 0.9167 | 0.9130 | 0.9167 | 0.9167 |
| Fcalc−fisher | 3085.4 | 2700.5 | 2310.6 | 3085.4 | 2700.5 | 2310.6 | 3085.4 | 2700.5 | 2310.6 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A4: Estimates for the C4−housenold equipment**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 3.234 (2.15)** | 3.309 (2.22)** | 3.321 (2.25)** | 2.962 (2.28)** | 2.912 (2.26)** | 3.067 (2.41)** | 8.500 (2.15)** | 3.021 (2.25)** | 3.321 (2.25)** |
| Δ Log K | 0.073 (13.61)* | 0.067 (12.48)* | 0.062 (11.77)* | 0.073 (13.61)* | 0.067 (12.48)* | 0.062 (11.77)* | 0.073 (13.61)* | 0.067 (12.48)* | 0.062 (11.77)* |
| Δ Log L | 0.430 (47.83)* | 0.421 (47.01)* | 0.420 (47.42)* | 0.430 (47.83)* | 0.421 (47.01)* | 0.420 (47.42)* | 0.430 (47.83)* | 0.421 (47.01)* | 0.420 (47.42)* |
| Δ Log M | 0.487 (90.22)* | 0.479 (88.18)* | 0.478 (88.80)* | 0.487 (90.22)* | 0.479 (88.18)* | 0.478 (88.80)* | 0.487 (90.22)* | 0.479 (88.18)* | 0.478 (88.80)* |
| Δ LogHorizontal | 0.090 (11.75)* | 0.042 (17.55)* | 0.045 (5.09)* | 0.070 (11.75)* | 0.195 (17.56)* | 0.237 (4.75)* | 0.138 (11.74)* | 0.204 (12.43)* | 0.148 (11.16)* |
| Δ LogBackward | 0.586 (5.16) | 0.179 (13.85)* | 0.596 (4.77)* | 0.302 (4.31)* | 0.497 (5.01)* | 0.509 (2.36)** | 0.296 (7.71)* | 0.239 (2.61)* | 0.279 (7.14)* |
| Δ Log K_Inc | | 0.020 (8.31)* | 0.0180 (7.34)* | | 0.020 (8.31)* | 0.0180 (7.34)* | | 0.020 (8.31)* | 0.0180 (7.34)* |
| Δ Log TxExp | | | 0.243 (8.80)* | | | 0.243 (8.80)* | | | 0.243 (8.80)* |
| Chi-squared | 0.96 | 1.25 | 0.93 | 0.96 | 1.25 | 0.93 | 0.96 | 1.25 | 0.93 |
| No. Obs. | 3624 | 3624 | 3624 | 3624 | 3624 | 3624 | 3624 | 3624 | 3624 |
| $R^2$ | 0.9395 | 0.9406 | 0.9419 | 0.9395 | 0.9406 | 0.9419 | 0.9395 | 0.9406 | 0.9419 |
| $\overline{R^2}$ | 0.9394 | 0.9405 | 0.9417 | 0.9394 | 0.9405 | 0.9417 | 0.9394 | 0.9405 | 0.9417 |
| Fcalc−Fisher | 11251.4 | 9558.9 | 8409.8 | 11251.4 | 9558.9 | 8409.8 | 11251.4 | 9558.9 | 8409.8 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A5: Estimates for the automotive sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 5.437 (5.16)* | 5.409 (4.38)* | 5.457 (4.42)* | 5.905 (6.12)* | 6.163 (6.01)* | 5.893 (3.43)* | 3.208 (3.30)* | 5.409 (4.38)* | 3.218 (3.32)* |
| Δ Log K | 0.081 (7.94)* | 0.079 (7.73)* | 0.078 (7.67)* | 0.081 (7.94) | 0.079 (7.73)* | 0.078 (7.67)* | 0.081 (7.94)* | 0.079 (7.73)* | 0.078 (7.67)* |
| Δ Log L | 0.336 (19.15)* | 0.333 (18.89)* | 0.334 (18.91)* | 0.336 (19.15)* | 0.333 (18.89)* | 0.334 (18.91)* | 0.336 (19.15)* | 0.333 (18.89)* | 0.334 (18.91)* |
| Δ Log M | 0.598 (65.62)* | 0.597 (65.48)* | 0.595 (64.54)* | 0.598 (65.62)* | 0.597 (65.48)* | 0.595 (64.54)* | 0.598 (65.62)* | 0.597 (65.48)* | 0.595 (64.54)* |
| Δ Log horizontal | 0.096 (1.97)** | 0.159 (2.41)** | 0.177 (20.58)* | 0.204 (2.70)* | 0.234 (2.03)** | 0.256 (9.75)* | 0.064 (2.20)** | 0.159 (2.41)** | 0.163 (17.31)* |
| Δ Log backward | 0.178 (10.52)* | 0.192 (2.09)** | 0.207 (20.22)* | 0.158 (10.77)* | 0.175 (2.27)** | 0.276 (18.98)* | 0.120 (2.38)** | 0.092 (2.09)** | 0.209 (18.98)* |
| Δ Log K_Inc | | 0.077 (16.02)* | 0.054 (12.61)* | | 0.077 (16.02)* | 0.054 (12.61)* | | 0.077 (16.02)* | 0.054 (12.61)* |
| Δ Log TxExp | | | 0.612 (18.41)* | | | 0.612 (18.41)* | | | 0.612 (18.41)* |
| Chi-squared | 1.67 | 1.98 | 1.17 | 1.67 | 1.98 | 1.17 | 1.67 | 1.98 | 1.17 |
| No. Obs. | 1413 | 1413 | 1413 | 1413 | 1413 | 1413 | 1413 | 1413 | 1413 |
| $R^2$ | 0.9671 | 0.9406 | 0.9672 | 0.9671 | 0.9406 | 0.9672 | 0.9671 | 0.9406 | 0.9672 |
| $\overline{R}^2$ | 0.9669 | 0.9403 | 0.9670 | 0.9669 | 0.9403 | 0.9670 | 0.9669 | 0.9403 | 0.9670 |
| Fcalc−Fisher | 5759.6 | 3714.8 | 5930.1 | 5759.6 | 3714.8 | 5930.1 | 5759.6 | 3714.8 | 5930.1 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A6: Estimates for the naval, aeronautics railway sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 2.750 (2.65)* | 2.805 (2.66)* | 3.121 (2.59)* | 5.912 (2.32)** | 5.927 (2.32)** | 5.839 (2.30)** | 4.579 (3.20)** | 4.558 (3.19)** | 4.587 (3.22)* |
| Δ Log K | 0.067 (3.55)* | 0.091 (4.62)* | 0.058 (3.01)* | 0.067 (3.55)* | 0.091 (4.62)* | 0.058 (3.01)* | 0.067 (3.55)* | 0.091 (4.62)* | 0.058 (3.01)* |
| Δ Log L | 0.787 (29.71)* | 0.784 (29.52)* | 0.781 (29.55)* | 0.787 (29.71)* | 0.784 (29.52)* | 0.781 (29.55)* | 0.787 (29.71)* | 0.784 (29.52)* | 0.781 (29.55)* |
| Δ Log M | 0.220 (16.69)* | 0.217 (16.41)* | 0.210 (15.69)* | 0.220 (16.69)* | 0.217 (16.41)* | 0.210 (15.69)* | 0.220 (16.69)* | 0.217 (16.41)* | 0.210 (15.69)* |
| Δ Log horizontal | 0.120 (2.31)** | 0.184 (4.97)* | 0.334 (10.77)* | 0.182 (2.39)** | 0.188 (3.19)* | 0.187 (10.59)* | 0.017 (1.76)*** | 0.021 (4.71)* | 0.021 (13.97)* |
| Δ Log backward | 0.033 (2.84)* | 0.127 (4.68)* | 0.168 (11.74)* | 0.079 (4.38)* | 0.250 (6.04)* | 0.258 (27.6)* | 0.021 (2.42)** | 0.147 (6.23)* | 0.148 (15.0)* |
| Δ Log K_Inc | | 0.021 (2.75)* | 0.080 (10.46)* | | 0.021 (2.75)* | 0.080 (10.46)* | | 0.021 (2.75)* | 0.080 (10.4)* |
| Δ Log TxExp | | | 0.284 (3.10)* | | | 0.284 (3.10)* | | | 0.284 (3.10)* |
| Chi-squared | 1.98 | 1.40 | 0.64 | 1.98 | 1.40 | 0.64 | 1.98 | 1.40 | 0.64 |
| No. Obs. | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| $R^2$ | 0.9124 | 0.9126 | 0.9137 | 0.9124 | 0.9126 | 0.9137 | 0.9124 | 0.9126 | 0.9137 |
| $\overline{R}^2$ | 0.9118 | 0.9119 | 0.9129 | 0.9118 | 0.9119 | 0.9129 | 0.9118 | 0.9119 | 0.9129 |
| Fcalc−fisher | 1638.0 | 1366.5 | 1186.6 | 1638.0 | 1366.5 | 1186.6 | 1638.0 | 1366.5 | 1186.6 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A7: Estimates for the mechanical equipment sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 5.364 (6.59)* | 5.372 (6.66)* | 5.465 (6.97)* | 3.519 (2.24)** | 3.619 (2.33)** | 3.966 (2.62)* | 4.752 (14.34)** | 4.779 (14.56)* | 4.970 (15.55)* |
| Δ Log K | 0.046 (11.61)* | 0.041 (10.38)* | 0.030 (7.59)* | 0.046 (11.61)* | 0.041 (10.38)* | 0.030 (7.59)* | 0.046 (11.61)* | 0.041 (10.38)* | 0.030 (7.59)* |
| Δ Log L | 0.768 (109.8)* | 0.750 (106.4)* | 0.745 (108.0)* | 0.768 (109.8)* | 0.750 (106.4)* | 0.745 (108.0)* | 0.768 (109.8)* | 0.750 (106.4)* | 0.745 (108.0)* |
| Δ Log M | 0.264 (77.57)* | 0.255 (74.30)* | 0.244 (72.42)* | 0.264 (77.57)* | 0.255 (74.30)* | 0.244 (72.42)* | 0.264 (77.57)* | 0.255 (74.30)* | 0.244 (72.42)* |
| Δ Log horizontal | | 0.133 (3.01)* | 0.220 (8.10)* | 0.112 (1.63) | 0.152 (0.89) | 0.255 (12.83)* | 0.138 (1.79)*** | 0.144 (2.55)** | 0.148 (7.26)* |
| Δ Log backward | 0.182 (1.68)*** | 0.021 (2.32)** | 0.423 (33.29)* | 0.174 (1.74)*** | 0.122 (3.12)* | 0.190 (4.58)* | 0.068 (1.86)*** | 0.024 (3.86)* | 0.104 (5.51)* |
| Δ Log K_Inc | | 0.024 (13.21)* | 0.019 (10.74)* | | 0.024 (13.21)* | 0.019 (10.74)* | | 0.024 (13.21)* | 0.019 (10.74)* |
| Δ Log TxExp | | | 0.495 (22.31)* | | | 0.495 (22.31)* | | | 0.495 (22.31)* |
| Chi-squared | 1.62 | 1.90 | 2.02 | 1.62 | 1.90 | 2.02 | 1.62 | 1.90 | 2.02 |
| No. Obs. | 9117 | 9117 | 9117 | 9117 | 9117 | 9117 | 9117 | 9117 | 9117 |
| $R^2$ | 0.8930 | 0.8952 | 0.8988 | 0.8930 | 0.8952 | 0.8988 | 0.8930 | 0.8952 | 0.8988 |
| $\overline{R^2}$ | 0.8931 | 0.8951 | 0.8987 | 0.8931 | 0.8951 | 0.8987 | 0.8931 | 0.8951 | 0.8987 |
| Fcalc−Fisher | 15268.3 | 12973.9 | 11567.5 | 15268.3 | 12973.9 | 11567.5 | 15268.3 | 12973.9 | 11567.5 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A8: Estimates for the electrical and electronic equipment sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 4.140 (2.17)** | 4.339 (2.30)** | 4.528 (2.47)** | 5.127 (5.02)** | 5.090 (5.05)* | 5.109 (5.22)* | 5.810 (2.63)** | 5.590 (2.57)** | 5.497 (2.60)* |
| Δ Log K | 0.076 (9.26)* | 0.066 (8.10)* | 0.042 (5.18)* | 0.076 (9.26)* | 0.066 (8.10)* | 0.042 (5.18)* | 0.076 (9.26)* | 0.066 (8.10)* | 0.042 (5.18)* |
| Δ Log L | 0.732 (55.43)* | 0.712 (53.64)* | 0.729 (56.31)* | 0.732 (55.43)* | 0.712 (53.64)* | 0.729 (56.31)* | 0.732 (55.43)* | 0.712 (53.64)* | 0.729 (56.31)* |
| Δ Log M | 0.286 (45.18)* | 0.280 (44.36)* | 0.269 (43.51)* | 0.286 (45.18)* | 0.280 (44.36)* | 0.269 (43.51)* | 0.286 (45.18)* | 0.280 (44.36)* | 0.269 (43.51)* |
| Δ Log horizontal | 0.156 (1.85)*** | 0.154 (10.04)* | 0.278 (58.47)* | 0.028 (1.99)** | 0.178 (5.73)* | 0.206 (34.6)* | 0.012 (1.91)*** | 0.016 (3.87)* | 0.026 (3.84)* |
| Δ Log backward | 4.140 (2.17)** | 0.552 (2.96)* | 0.572 (12.31)* | 0.531 (2.02)** | 0.531 (2.07)** | 0.583 (49.0)* | 0.429 (1.94)*** | 0.370 (3.39)* | 0.529 (3.25)* |
| Δ Log K_Inc | | 0.030 (8.56)* | 0.023 (6.79)* | | 0.030 (8.56)* | 0.023 (6.79)* | | 0.030 (8.56)* | 0.023 (6.79)* |
| Δ Log TxExp | | | 0.534 (13.04)* | | | 0.534 (13.04)* | | | 0.534 (13.04)* |
| Chi-squared | 2.01 | 2.01 | 2.11 | 2.01 | 2.01 | 2.11 | 2.01 | 2.01 | 2.11 |
| No. Obs. | 2943 | 2943 | 2943 | 2943 | 2943 | 2943 | 2943 | 2943 | 2943 |
| $R^2$ | 0.9253 | 0.9272 | 0.9314 | 0.9253 | 0.9272 | 0.9314 | 0.9253 | 0.9272 | 0.9314 |
| $\overline{R^2}$ | 0.9251 | 0.9270 | 0.9312 | 0.9251 | 0.9270 | 0.9312 | 0.9251 | 0.9270 | 0.9312 |
| Fcalc−fisher | 7276.0 | 6232.4 | 5692.7 | 7276.0 | 6232.4 | 5692.7 | 7276.0 | 6232.4 | 5692.7 |

**Table A9: Estimates for the mineral products sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 3.128 (2.21)** | 3.321 (2.37)** | 3.436 (2.47)** | 4.164 (1.89)*** | 4.072 (1.87)*** | 3.913 (1.81)*** | 4.313 (6.12)* | 4.328 (6.22)* | 4.261 (6.16)* |
| Δ Log K | 0.267 (48.69)* | 0.256 (46.14)* | 0.254 (45.93)* | 0.267 (48.69)* | 0.256 (46.14)* | 0.254 (45.93)* | 0.267 (48.69)* | 0.256 (46.14)* | 0.254 (45.93)* |
| Δ Log L | 0.403 (42.89)* | 0.391 (41.66)* | 0.410 (41.72)* | 0.403 (42.89)* | 0.391 (41.66)* | 0.410 (41.72)* | 0.403 (42.89)* | 0.391 (41.66)* | 0.410 (41.72)* |
| Δ Log M | 0.305 (98.65)* | 0.299 (56.38)* | 0.295 (55.62)* | 0.305 (98.65)* | 0.299 (56.38)* | 0.295 (55.62)* | 0.305 (98.65)* | 0.299 (56.38)* | 0.295 (55.62)* |
| Δ Log horizontal | 0.080 (2.41)** | 0.093 (7.65)* | 0.126 (2.67)* | 0.065 (2.53)** | 0.090 (4.08)* | 0.168 (2.39)** | 0.141 (5.93)* | 0.063 (3.04)* | 0.082 (2.16)** |
| Δ Log backward | 0.026 (3.27)* | 0.112 (2.08)** | 0.185 (2.37)** | 0.054 (5.22)* | 0.080 (13.1)* | 0.174 (2.77)* | 0.061 (3.19)* | 0.121 (2.41)** | 0.137 (3.47)* |
| Δ Log K_Inc | | 0.023 (9.27)* | 0.023 (9.17)* | | 0.023 (9.27)* | 0.023 (9.17)* | | 0.023 (9.27)* | 0.023 (9.17)* |
| Δ Log TxExp | | | 0.235 (6.26)* | | | 0.235 (6.26)* | | | 0.235 (6.26)* |
| Chi-squared | 2.04 | 2.03 | 2.02 | 2.04 | 2.03 | 2.02 | 2.04 | 2.03 | 2.02 |
| No. Obs. | 3255 | 3255 | 3255 | 3255 | 3255 | 3255 | 3255 | 3255 | 3255 |
| $R^2$ | 0.9241 | 0.9261 | 0.9270 | 0.9241 | 0.9261 | 0.9270 | 0.9241 | 0.9261 | 0.9270 |
| $\overline{R^2}$ | 0.92398 | 0.9259 | 0.9268 | 0.92398 | 0.9259 | 0.9268 | 0.92398 | 0.9259 | 0.9268 |
| Fcalc-fisher | 7911.4 | 6784.0 | 5890.0 | 7911.4 | 6784.0 | 5890.0 | 7911.4 | 6784.0 | 5890.0 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A10: Estimates for the textiles sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 4.508 (4.33)* | 4.605 (4.47)* | 4.712 (4.67)* | 4.298 (5.36)* | 4.373 (5.52)* | 4.529 (5.83)* | 4.368 (4.02)* | 4.453 (4.15)* | 4.622 (4.39)* |
| Δ Log K | 0.072 (10.78)* | 0.067 (10.05)* | 0.059 (9.02)* | 0.072 (10.78)* | 0.067 (10.05)* | 0.059 (9.02)* | 0.072 (10.78)* | 0.067 (10.05)* | 0.059 (9.02)* |
| Δ Log L | 0.342 (31.57)* | 0.324 (29.87)* | 0.339 (31.61)* | 0.342 (31.57)* | 0.324 (29.87)* | 0.339 (31.61)* | 0.342 (31.57)* | 0.324 (29.87)* | 0.339 (31.6)* |
| Δ Log M | 0.448 (96.58)* | 0.434 (90.21)* | 0.416 (83.93)* | 0.448 (96.58)* | 0.434 (90.21)* | 0.416 (83.93)* | 0.448 (96.58)* | 0.434 (90.21)* | 0.416 (83.9)* |
| Δ Log horizontal | −0.066 (−2.52)** | −0.109 (−1.87)*** | −0.152 (−1.96)** | −0.014 (−2.82)* | −0.057 (−3.19)* | −0.149 (−3.03)* | −0.058 (−4.35)* | −0.039 (−3.90)* | −0.001 (−1.96)** |
| Δ Log backward | 0.061 (4.84)* | 0.057 (1.84)*** | 0.077 (4.09)* | 0.057 (1.73)*** | 0.041 (2.54)** | 0.068 (2.79)* | 0.026 (1.95)*** | 0.047 (3.19)* | 0.080 (2.85)* |
| Δ Log K_Inc | | 0.032 (9.65) | 0.030 (9.18)* | | 0.032 (9.65)* | 0.030 (9.18)* | | 0.032 (9.65)* | 0.030 (9.18)* |
| Δ Log TxExp | | | 0.477 (12.27)* | | | 0.477 (12.27)* | | | 0.477 (12.27)* |
| Chi-squared | 2.01 | 2.05 | 1.54 | 2.01 | 2.05 | 1.54 | 2.01 | 2.05 | 1.54 |
| No. Obs. | 3834 | 3834 | 3834 | 3834 | 3834 | 3834 | 3834 | 3834 | 3834 |
| $R^2$ | 0.8602 | 0.8636 | 0.8689 | 0.8602 | 0.8636 | 0.8689 | 0.8602 | 0.8636 | 0.8689 |
| $\overline{R^2}$ | 0.8600 | 0.8633 | 0.8686 | 0.8600 | 0.8633 | 0.8686 | 0.8600 | 0.8633 | 0.8686 |
| Fcalc−Fisher | 4710.8 | 4038.3 | 3622.3 | 4710.8 | 4038.3 | 3622.3 | 4710.8 | 4038.3 | 3622.3 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A11: Estimates for the timber paper, paperboard sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 2.386 (0.88) | 2.443 (0.90) | 2.897 (1.10) | 4.105 (2.16)** | 4.049 (2.13)** | 4.369 (2.36)** | 3.369 (8.97)* | 3.382 (9.03)* | 3.555 (9.71)* |
| Δ Log K | 0.130 (22.86)* | 0.128 (22.43)* | 0.120 (21.37)* | 0.130 (22.86)* | 0.128 (22.43)* | 0.120 (21.3)* | 0.130 (22.86)* | 0.128 (22.43)* | 0.120 (21.37)* |
| Δ Log L | 0.378 (39.87)* | 0.373 (39.02)* | 0.374 (40.07)* | 0.378 (39.87)* | 0.373 (39.02)* | 0.374 (40.0)* | 0.378 (39.87)* | 0.373 (39.02)* | 0.374 (40.07)* |
| Δ Log M | 0.478 (83.74)* | 0.475 (82.21)* | 0.466 (81.85)* | 0.478 (83.74)* | 0.475 (82.21)* | 0.466 (81.8)* | 0.478 (83.74)* | 0.475 (82.21)* | 0.466 (81.85)* |
| Δ Log horizontal | −0.046 (−3.14)* | −0.078 (−4.22)* | −0.156 (−2.00)** | −0.114 (−1.84)*** | −0.179 (−2.52)** | −0.185 (−3.40)* | −0.078 (−2.79)* | −0.065 (−2.72)* | −0.038 (−3.22)* |
| Δ Log backward | 0.023 (2.01)** | 0. 030 (1.88)*** | 0.174 (4.99)* | 0.143 (2.08)** | 0.121 (2.40)** | 0.245 (2.37)** | 0.095 (1.77)*** | 0.118 (2.58)* | 0.137 (4.44)* |
| Δ Log K_Inc | | 0.009 (4.10)* | 0.009 (3.92)* | | 0.009 (4.10)* | 0.009 (3.92)* | | 0.009 (4.10)* | 0.009 (3.92)* |
| Δ Log TxExp | | | 0.349 (12.10)* | | | 0.349 (12.10)* | | | 0.349 (12.10)* |
| Chi-squared | 2.01 | 2.01 | 2.00 | 2.01 | 2.01 | 2.00 | 2.01 | 2.01 | 2.00 |
| No. Obs. | 3141 | 3141 | 3141 | 3141 | 3141 | 3141 | 3141 | 3141 | 3141 |
| $R^2$ | 0.9496 | 0.9498 | 0.9521 | 0.9496 | 0.9498 | 0.9521 | 0.9496 | 0.9498 | 0.9521 |
| $\overline{R^2}$ | 0.9495 | 0.9497 | 0.9519 | 0.9495 | 0.9497 | 0.9519 | 0.9495 | 0.9497 | 0.9519 |
| Fcalc−Fisher | 11813.8 | 9883.2 | 8895.8 | 11813.8 | 9883.2 | 8895.8 | 11813.8 | 9883.2 | 8895.8 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A12: Estimates for the chemicals, rubber, plastics sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 2.811 (2.66)* | 2.819 (2.67)* | 2.861 (2.72)* | 5.449 (0.83) | 5.306 (0.81) | 5.087 (0.78) | 2.784 (2.99)* | 2.814 (3.03)* | 2.895 (3.13)* |
| Δ Log K | 0.095 (25.13)* | 0.093 (24.18)* | 0.089 (23.06)* | 0.095 (25.13)* | 0.093 (24.1)* | 0.089 (23.06)* | 0.095 (25.13)* | 0.093 (24.18)* | 0.089 (23.0)* |
| Δ Log L | 0.400 (59.59)* | 0.397 (57.69)* | 0.399 (58.13)* | 0.400 (59.59)* | 0.397 (57.6)* | 0.399 (58.13)* | 0.400 (59.59)* | 0.397 (57.69)* | 0.399 (58.1)* |
| Δ Log M | 0.527 (117.3)* | 0.527 (117.1)* | 0.523 (115.9)* | 0.527 (117.3)* | 0.527 (117.1)* | 0.523 (115.9)* | 0.527 (117.3)* | 0.527 (117.1)* | 0.523 (115.9)* |
| Δ Log horizontal | 0.119 (2.16)** | 0.272 (2.77)* | 0.172 (2.63)* | 0.367 (1.73)*** | 0.363 (2.50)** | 0.566 (2.74)* | 0.001 (1.38) | 0.007 (2.38)** | 0.024 (3.61)* |
| Δ Log backward | 0.110 (2.43)** | 0.346 (4.59)* | 0.457 (4.22)* | 0.109 (3.14)* | 0.175 (2.69)* | 0.375 (2.63)* | 0.250 (1.97)** | 0.285 (3.84)* | 0.280 (3.69)* |
| Δ Log K_Inc | | 0.044 (2.18)** | 0.033 (16.5)* | | 0.044 (2.18)** | 0.033 (16.5)* | | 0.044 (2.18)** | 0.033 (16.5)* |
| Δ Log TxExp | | | 0.176 (6.80)* | | | 0.176 (6.80)* | | | 0.176 (6.80)* |
| Chi-squared | 1. 96 | 1.96 | 2.00 | 1. 96 | 1.96 | 2.00 | 1. 96 | 1.96 | 2.00 |
| No. Obs. | 5553 | 5553 | 5553 | 5553 | 5553 | 5553 | 5553 | 5553 | 5553 |
| $R^2$ | 0.9421 | 0.9421 | 0.9426 | 0.9421 | 0.9421 | 0.9426 | 0.9421 | 0.9421 | 0.9426 |
| $\overline{R^2}$ | 0.9420 | 0.9420 | 0.9425 | 0.9420 | 0.9420 | 0.9425 | 0.9420 | 0.9420 | 0.9425 |
| Fcalc−fisher | 18051.3 | 15039.7 | 13003.5 | 18051.3 | 15039.7 | 13003.5 | 18051.3 | 15039.7 | 13003.5 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A13: Estimates for the metals and metal products sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 3.905 (13.70)* | 3.928 (13.84)* | 3.976 (14.04)* | 3.269 (1.67)*** | 3.273 (1.68)*** | 3.362 (1.73)*** | 3.925 (10.16)* | 3.947 (10.26)* | 4.001 (10.4)* |
| Δ Log K | 0.127 (34.10)* | 0.122 (32.32)* | 0.119 (31.41)* | 0.127 (34.10)* | 0.122 (32.32)* | 0.119 (31.41)* | 0.127 (34.10)* | 0.122 (32.32)* | 0.119 (31.4)* |
| Δ Log L | 0.546 (85.84)* | 0.536 (83.27)* | 0.535 (83.31)* | 0.546 (85.84)* | 0.536 (83.27)* | 0.535 (83.31)* | 0.546 (85.84)* | 0.536 (83.27)* | 0.535 (83.3)* |
| Δ Log M | 0.320 (98.65)* | 0.319 (107.5)* | 0.315 (104.5)* | 0.320 (98.65)* | 0.319 (107.5)* | 0.315 (104.5)* | 0.320 (98.6)* | 0.319 (107.5)* | 0.315 (104.5)* |
| Δ Log Horizontal | 0.005 (2.67)* | 0.009 (2.69)* | 0.065 (2.89)* | 0.113 (3.54)* | 0.196 (3.59)* | 0.192 (4.14)* | 0.104 (6.67)* | 0.107 (2.45)** | 0.118 (3.71)* |
| Δ Log Backward | 0.127 (3.11)* | 0.152 (4.13)* | 0.261 (4.08)* | 0.171 (2.65)* | 0.220 (1.78)*** | 0.204 (2.83)* | 0.081 (2.71)* | 0.146 (2.53)** | 0.190 (2.16)** |
| Δ Log K_Inc | | 0.014 (8.64)* | 0.014 (8.57)* | | 0.014 (8.64)* | 0.014 (8.57)* | | 0.014 (8.64)* | 0.014 (8.57)* |
| Δ Log TxExp | | | 0.162 (7.28)* | | | 0.162 (7.28)* | | | 0.162 (7.28)* |
| Chi-squared | 1.97 | 1.99 | 1.99 | 1.97 | 1.99 | 1.99 | 1.97 | 1.99 | 1.99 |
| No. Obs. | 9954 | 9954 | 9954 | 9954 | 9954 | 9954 | 9954 | 9954 | 9954 |
| $R^2$ | 0.9202 | 0.9208 | 0.9212 | 0.9202 | 0.9208 | 0.9212 | 0.9202 | 0.9208 | 0.9212 |
| | 0.9101 | 0.9207 | 0.9211 | 0.9101 | 0.9207 | 0.9211 | 0.9101 | 0.9207 | 0.9211 |
| Fcalc−Fisher | 20389.9 | 20131.2 | 18227.1 | 20389.9 | 20131.2 | 18227.1 | 20389.9 | 20131.2 | 18227.1 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels

**Table A14: Estimates for the electrical and electronic equipment sector**

| Variables | Family 1: Spillovers measured in terms of output Y | | | Family 2: Spillovers measured in terms of employment (workforce) L | | | Family 3: Spillovers measured in terms of added value VA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1.1 | Model 1.2 | Model 1.3 | Model 2.1 | Model 2.2 | Model 2.3 | Model 3.1 | Model 3.2 | Model 3.3 |
| Constant | 2.989 (1.61)*** | 3.084 (1.68)*** | 3.143 (1.73)*** | 3.641 (3.18)* | 3.817 (3.36)* | 3.959 (3.52)* | 4.105 (2.47)** | 4.282 (2.60)* | 4.445 (2.72)* |
| Δ Log K | 0.071 (9.72)* | 0.063 (8.61)* | 0.055 (7.42)* | 0.071 (9.72)* | 0.063 (8.61)* | 0.055 (7.42)* | 0.071 (9.72)* | 0.063 (8.61)* | 0.055 (7.42)* |
| Δ Log L | 0.562 (47.37)* | 0.552 (46.42)* | 0.563 (47.44)* | 0.562 (47.37)* | 0.552 (46.42)* | 0.563 (47.44)* | 0.562 (47.37)* | 0.552 (46.42)* | 0.563 (47.4)* |
| Δ Log M | 0.377 (51.71)* | 0.367 (49.29)* | 0.358 (47.81)* | 0.377 (51.71)* | 0.367 (49.29)* | 0.358 (47.81)* | 0.377 (51.71)* | 0.367 (49.29)* | 0.358 (47.8)* |
| Δ Log horizontal | 0.037 (2.86)* | 0.058 (3.89)* | 0.098 (2.41)* | 0.102 (4.57)* | 0.190 (6.50)* | 0.363 (2.28)** | 0.103 (4.48)* | 0.260 (3.57)* | 0.216 (3.25)* |
| Δ Log backward | 0.171 (2.65)* | 0.197 (4.01)* | 0.255 (2.43)** | 0.246 (2.81)* | 0.281 (2.84)* | 0.284 (3.97)* | 0.161 (2.81)* | 0.152 (2.67)* | 0.216 (8.98)* |
| Δ Log K_Inc | | 0.023 (5.82)* | 0.021 (5.52)* | | 0.023 (5.82)* | 0.021 (5.52)* | | 0.023 (5.82)* | 0.021 (5.52)* |
| Δ Log TxExp | | | 0.298 (7.10)* | | | 0.298 (7.10)* | | | 0.298 (7.10)* |
| Chi-squared | 1.54 | 2.00 | 2.02 | 1.54 | 2.00 | 2.02 | 1.54 | 2.00 | 2.02 |
| No. Obs. | 2328 | 2328 | 2328 | 2328 | 2328 | 2328 | 2328 | 2328 | 2328 |
| $R^2$ | 0.9440 | 0.9446 | 0.9456 | 0.9440 | 0.9446 | 0.9456 | 0.9440 | 0.9446 | 0.9456 |
| | 0.9438 | 0.9444 | 0.0454 | 0.9438 | 0.9444 | 0.0454 | 0.9438 | 0.9444 | 0.0454 |
| Fcalc−Fisher | 10863.0 | 6595.7 | 5761.0 | 10863.0 | 6595.7 | 5761.0 | 10863.0 | 6595.7 | 5761.0 |

The figures appearing in parentheses are Student's t distribution values (*), (**), (***): Coefficients are significant at 1%, 5%. and 10% levels