PRODUCTIVITY SPILLOVERS FROM MULTINATIONAL CORPORATIONS IN PORTUGAL: VULNERABILITY TO DEFICIENT ESTIMATION

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Abstract
Evidence on productivity spillovers from FDI to domestic firms is ambiguous. Incorrect estimation procedures may be one of the sources for the contradictory results obtained in empirical studies on this subject. We observe that inadequacy of the estimation procedures leads to a severe underestimation of the spillover effect. An appropriated econometric methodology is discussed taking into consideration the possible simultaneity of FDI and other explanatory variables and endogeneity related to firm unobserved heterogeneity. Robust inference is also addressed. Our findings for the Portuguese case seem sufficient clear to warn about spillover results obtained with a non-judicious application of the classical panel data methods.

JEL Codes: F21, F23, 052
Keywords: domestic firm productivity; multinational corporations; technological spillovers; panel data; Extended GMM.

1. Introduction

A substantial body of literature has been produced to analyse whether the presence of multinational corporations (MNCs) results in an increase of the productivity of domestic firms in host countries. This is related to the concept of productivity (or technology) spillovers, which embodies the fact that foreign firms own intangible assets such as technological know-how, marketing and managerial skills, international experience or reputation, which can be transmitted to domestic firms and thereby raise their productivity level.

Although theory has been identifying a wide range of possible productivity spillover's channels - they may be knowledge or technologically based and they may occur through demonstration/imitation effects, the labour market via skill enhancement, increased competitive pressure that may spur local firms to operate more efficiently and/or backward and forward linkages between local and foreign firms - robust empirical support for positive productivity spillovers is hard to find, as shown, for instance, in the surveys by Meyer (2003) and Görg and Greenaway (2004).

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Heterogeneity on the spillover result has been associated to the ambiguity as regards the sign of the effect in the case of some spillover channels (Crespo and Fontoura, 2005), in addition to the fact that it may be difficult to distinguish one channel from the other as they are often interdependent (Kinoshita, 2001). Recent literature also stresses that the sign, the magnitude and the existence of productivity spillovers appear to depend on idiosyncrasies of the host country and of the foreign direct investment (FDI) project, such as the macroeconomic policies, competition and FDI laws, educational level, size and market share of domestic firms, size and age of foreign firms, degree of ownership and entry mode of the FDI, technological gap between the foreign and domestic firms, degree of geographical proximity of domestic firms to foreign ones, among others, that require further theoretical and empirical attention (Fan, 2002; Meyer, 2003; Crespo and Fontoura, 2005). However, lack of robustness on the role of foreign presence can also be due to inadequacy of the estimation procedures used. This paper focuses this last aspect by investigating the impact of deficient estimation on the spillover effect, with data at the firm level for the Portuguese manufacturing industry.

Görg and Strobl (2001) and Görg and Greenaway (2004), with a sample of representative papers on the subject, have shown that the results for the spillover effect appear to be affected whether the data used are cross-sectional or panel data. The sign obtained is frequently negative with a panel dataset, in contradiction with the results obtained with many cross-sectional studies. It is well known that the cross-sectional approach may induce significant bias in the estimation of the coefficients if there are unobserved time-invariant firm or specific effects on the relationship between MNCs and productivity that are correlated with the explanatory variables of the model. Together with the fact that the development of domestic firms' productivity should be analysed over a longer period of time and the improvement on panel data estimating techniques, this explains why most recent studies on the subject have opted for panel data models, while in the 1970s and 1980s predominated the cross-sectional data.

Panel data studies, nonetheless, may also not be reliable when they are based, as in the vast majority of studies on this subject, on the classical panel data methods, such as the Pooled OLS (POLS) or the Fixed Effects Estimator (FEE) and the Random Effects Estimator (REE). These methods usually do not take into account features of the data like the existence of unobserved heterogeneity dependent on the regressors (except the FEE), the existence of explanatory variables that are predetermined or even endogenous, thus requiring the use of instrumental variables, and/or statistical properties of the disturbances related to the panel nature of the data that set the need of robust inference. The consequences are inconsistency of the coefficients estimators and/or of the covariance estimators.

In this paper, we investigate whether estimation of the spillover effect with a blind application of the panel data methods suffers from severe bias. For this purpose, these classical estimates are compared with those obtained with the adequate methodology. Our findings point to possible misleading conclusions induced by invalid estimating procedures in most case studies and give directions for a correct approach.

Section 2 introduces the model used in this study to analyse the existence of productivity spillovers. Section 3 discusses the adequate econometric methodology. Section 4 presents the empirical results and section 5 concludes.

2. The empirical model

Following the approach adopted in most studies on the subject, we measure the intra-sectoral spillover effect[2] indirectly, by regressing labour productivity of domestic firms (*PROD*) on a number of covariates assumed to have an effect on productivity, including the presence of foreign firms measured at the sectoral level (*FP*).

To specify the equation that estimates the spillover effect, we have chosen a standard model, based on the pioneering work of Caves (1974) and Globerman (1979), with an extension suggested as indispensable by the empirical literature on this topic, including previous results for Portugal. With this simple model, the estimation issues that motivate this paper can be easily generalised to alternative specifications. Table 1 presents the variables used in this study.

Besides the standard explanatory variables (*FP*, *SL*, *CI*, *H*, *SE*), we have also considered the influence of the technological gap between domestic and foreign-owned firms. In contrast with the remaining extensions provided by literature on this topic, the importance of this latter variable emerges as a solid conclusion in most studies on the subject (Crespo and Fontoura, 2005), including the analysis of Flôres et al. (2002) for the Portuguese case. The reasoning is that if the gap in technological capabilities between the two sets of firms is too large, domestic firms may not be able to benefit from the introduction of new technology (like for instance, copying foreign procedures or benefit from the training of local workers) but, on the other hand, if the gap is too small, domestic firms may not have much to learn from the foreign ones.

Table 1: Definition of the variables

Variable	Definition
$PROD_{it}$	domestic productivity – labour productivity of firm i at time t measured by the total added value of the firm divided by the respective number of workers.
FP_{it}	foreign presence – share of equity capital held by foreign firms in the industrial sector of domestic firm i, at time t.
SL_{it}	skilled labour – total remuneration per worker in domestic firm i, at time t.
CI_{it}	capitalistic intensity – total fixed assets of domestic firm i divided by the number of workers, at time t.

[2] Some recent studies also investigate the existence of inter-sectoral spillovers, associated to backward and forward linkages (see, for instance, Harris and Robinson, 2002, Schoors and van der Tol, 2002, and Smarzynska, 2003), but this is not the motivation of this paper.

$H_{it} = \sum_{g\in J}\left(\frac{X_{gt}}{\sum_{g\in J} X_{gt}}\right)^2 \times 100$	degree of concentration – Herfindhal concentration index, where X_{gt} represents the output of firm g, at time t; g is an index for the firms (domestic or foreign) belonging to sector J to which domestic firm i belongs.
SE_{it}	scale economies – the ratio in % of the output of domestic firm i to the average output of the five largest firms (in terms of output) in the industrial sector of firm i, at time t.

To measure the technological gap (TG), we assume, as is usually done in this literature, that higher productivity signals better technology. Therefore, TG_{it} is the ratio of the productivity of domestic firm *i* to the highest productivity level of the foreign firms in the industrial sector of firm *i*. For values below 1, the wider the gap the lower is *TG*. The corresponding model is:

$$PROD_{it} = b_1 FP_{it} D_{it} + b_2 CI_{it} + b_3 SE_{it} + b_4 SL_{it} + b_5 H_{it} + l_t + h_i + e_{it}. \qquad (1)$$
$$i = 1,\ldots,n;\ t = 1,\ldots,T$$

where D_{it} is a dummy variable that takes the value one if TG_{it} is in a specified range and zero otherwise. The choice of an adequate gap is empirically driven. A unit variation of the foreign presence in the sector induces a spillover effect equal to b_1 only if the firm has a technological gap lying in the chosen range.

The error term of this model includes the unobserved heterogeneity of firms, h_i (the permanent effect) and e_{it}, an idiosyncratic random error which may be heteroscedastic and/or autocorrelated (the transitory effect). We include fixed time effects[3], l_t, in order to capture possible common aggregate shocks in production, such as technological progress or other unobserved time-varying (pro-cyclical) influences on productivity.

The unobserved permanent effect, h_i, can be related to a myriad of influences on productivity that are constant over the time period, like those related to the "software" environment for spillovers mentioned by Kokko (1994), managerial skills, environment characteristics, among others. Flôres et al (2002) suggested that, in the case of Portugal, part of this time-invariant influence is related to geographical proximity of firms in the context of agglomeration economies. It is reasonable to assume that the spillover effect of the MNCs on productivity is lagged which would lead us to define a dynamic model if we

[3] Since time effects are fixed, in practice they are parameters to be estimated corresponding to a different intercept for each year.

had more waves in the panel. Nevertheless, we can consider that present values of foreign presence are a proxy of past values given that this variable is highly correlated in time.[4]

3. Discussion of the econometric methodology

As previously mentioned, panel data methods commonly used to estimate the spillover effect may not be adequate because either they lead to inconsistent estimators for the unknown coefficients or, even if they are consistent, inference may be invalid.

Consistency in POLS and REE fail if the permanent effect (unobserved heterogeneity) is related to the regressors. We expect this situation to arise in productivity spillovers' models at the firm level, since the unobserved factors explaining firm heterogeneity in what concerns productivity (some were identified in the last section) depend in great deal from the characteristics of the firm itself.

The usual alternative approach defines a transformation of the variables, like the deviations from mean (FEE) or the first differences, in order to wipe out the permanent effect of the model. The consistency of FEE estimators depends on the strict exogeneity of the regressors whereas economic variables are usually predetermined. The estimation of the model for the first differenced variables is less demanding than FEE on the type of exogeneity required and instruments can be easily found to guarantee consistency with predetermined variables. On the other hand, in presence of heteroscedasticity, autocorrelation and strictly exogenous regressors, the GMM estimator in the first-differenced variables model (DGMME), with appropriately chosen instruments, is asymptotically more efficient than the FEE with a robust estimator for the covariance matrix for panels with few observations in time (see Arellano, 2003).

Even if POLS is consistent, inference is invalid unless a robust estimator of the covariance matrix appropriated to the pattern of autocorrelation induced by the permanent effect is used (Wooldridge, 2002).[5] REE specifically addresses this type of autocorrelation by Feasible Generalised Least Squares (FGLS) estimation, traditionally assuming homoscedasticity. However if the transitory effect is heteroscedastic, which frequently happens with micro data, and/or displays autocorrelation, its consistency is questionable unless FGLS is tailored to accommodate the particular patterns of the covariance matrix of the error term.

When some of the explanatory variables suffer from endogeneity due to simultaneity, instrumental variable estimation has to be performed. It is well known that high productivity sectors or firms may attract the location of MNCs in the same sector, yielding a positive relationship even without spillovers taking place, as emphasised by

[4] This is a common shortcoming as most studies use either the contemporaneous level of foreign presence or relatively short lags, usually one year (Görg and Greenaway, 2004).

[5] The popular Newey-West estimator is not adequate because it assumes that autocorrelation fades away with time, which is not the pattern of autocorrelation induced by the permanent effect. Most softwares use a robust block covariance estimator that is consistent to autocorrelation and heteroscedasticity of unknown type for panels that are short in time.

Aitken and Harrison (1999). Furthermore, it is highly plausible that workers' remuneration, the proxy for skilled labour, may also depend on productivity itself. Even when additional variables are not available in the data, finding suitable instruments for first-differenced variables is straightforward if observations in levels, conveniently lagged, are correlated with observations in first differences.

With dynamic models extra care has to be taken because of the properties enhanced by the presence of the lagged dependent among the regressors and instrumental variables estimation has to be performed even when the other regressors are strictly exogenous.[6] Bond (2002) addresses specifically dynamic panel data models when the number of observations in time is small.

Recently, Blundell and Bond (2000) introduced the Extended GMM Estimator (EGMME) as an alternative to the DGMME that has shown to produce better estimates for panels with small to moderate number of periods, as it is the case of the example we will consider in the next section.[7] It consists on performing GMM estimation on the set of equations for the differenced variables together with equations for the variables in levels given by model (1).

4. An empirical example

In this paper, we consider data at firm level for the Portuguese manufacturing industry, in the period 1996-1998.

Portugal became an important recipient of foreign direct investment inflows after joining the European Union (EU) in 1986. Foreign direct investment as a percentage of GDP rose from less than 1% before 1986 to 5% in 1990 and, although this ratio decreased between 1991 and 1994, another positive trend was to be noted in the second half of the 1990s, reaching a peak of 11.4% in 1998. A significant share of this inflow has been increasingly directed to the manufacturing sector (47.4% of total FDI inflow in 1995-99). It should, however, be pointed out that, if foreign direct divestment is taken into account, the previous picture is altered to more modest values from the beginning of the 1990s onwards. In fact, for this decade, inward FDI net of divestment amounts to an average of only 2% of GDP, while the 1998 peak is reduced to 2.54%.

Previous results obtained for Portugal on this topic are similar to the mixed results found in the literature in general. Santos (1991) did not find a significant influence of FDI on the productivity level of domestic firms in a sectoral analysis for the period 1977-82. However, Farinha and Mata (1996), using a micro data at the firm level and covering the period 1986-92, found a positive effect. Undertaking a study at the sectoral level for 1992-95, Flôres et al. (2002) concluded that the relationship between the productivity of domestic firms and the foreign presence is positive only if there exists a genuine technology differential between foreign and domestic producers and the sectoral

[6] See Arellano (2003) for details on this question.

[7] See Harris and Robinson (2002) for an application of this method to a productivity spillovers' model.

characteristics are favourable. Santos (1991) and Flôres et al. (2002) were estimated with the OLS methodology, while Farinha and Mata (1996) used a random effects model.

To analyse the spillover effect in the Portuguese case, we use data compiled from the Dun & Bradstreet database for the period 1996-98 except for the foreign presence proxy, *FP*. The latter was collected from the Ministry of Employment.

The database comprises observations for 2133 firms (of which 1957 are domestic firms and 176 are foreign firms, i.e. MNCs) for each of the three years of our study. We had to reduce the number of domestic firms to 1604, due to the need to exclude sectors without any foreign presence in the whole period to obtain some of the variables we use. Sectoral disaggregation was carried out at the three digit-level of the NACE Nomenclature (Eurostat), which corresponds to 103 sectors, of which only 62 report the existence of foreign firms.

A crucial premise of this kind of study is that MNCs are technologically more advanced than domestic firms. A preliminary investigation of our data indicates the existence of statistically significant differences between the labour productivity of domestic and foreign firms. For the three-year period analysed, the latter are on average 2.13 times more productive than the former (Table 2).

Table 2: Labour productivity, capitalistic intensity and skilled labour of domestic and foreign firms, Portugal, 1996-98

	[1] Domestic firms	[2] Foreign firms	[3] Total	[4] = [2]/[1]
Labour productivity	4539.94	9653.06	5041.00	2.13
Capitalistic intensity *	1703.51	4872.29	2016.83	2.86
Skilled labour**	2442.71	4230.92	2619.52	1.73

* Total fixed assets divided by the number of workers. ** Total remuneration per worker

A disaggregation at the sectoral level (to the two-digit level of the NACE, as presented in the Annex), reveals that only in four sectors (19, 23, 27 and 33) are domestic firms more productive than their foreign counterparts (Table 1-A in the Annex). Sector 23 is worth highlighting, as here domestic firms are four times more productive, but this may be explained by the exceptionally good performance of one firm (Petrogal SA). In sectors 16, 30 and 37, there is no foreign presence, according to our database. Table 2 shows that, in the period analysed, the capitalistic intensity of foreign firms, as measured by total fixed assets divided by the number of workers, is, on average, almost three times higher than it is for domestic firms, while skilled labour intensity, proxied by the wage level of the firm, is almost twice as high. Together, these results point to the possibility of there being benefits for the host country in terms of positive spillovers from FDI.

Results for the model we propose were obtained with TSP 4.5. Since we observe 1604 firms belonging to many different economic sectors and having dissimilar characteristics, we expect heteroscedasticity in the error term. Therefore, when possible (i.e., in all estimators but the REE), estimated standard deviations are heteroscedasticity robust. TSP considers for GMM optimal weighting matrices, ensuring asymptotic efficiency and the validity of the Sargan test. In order to estimate our model, we first need to find an adequate range for *TG*.[8]

In view of this, we analyse the correlation coefficient between *PROD* and *FP* within several arbitrarily predefined ranges for *TG*. The choice of the range was based on two criteria: the above mentioned correlation is high and it includes a relevant number of observed firms. In the case of our database, the range between 0.3 and 0.95 appears to be the most adequate, as it displays one of the highest correlations and it includes around 50 % of the observed firms. Table 3 reports the results obtained when the model was estimated considering this range for *TG*.

Table 3: Estimation results for the spillover effect (0.3 < *TG* < 0.95)

Independent Variables	POLS	Fixed Effects	Random Effects	Ext. GMM (endogeneity of SL)	Ext. GMM (endogeneity of SL and FPxD)
C	108.78 (1.34)		242.36 (14.00)	110.82 (2.52)	176.24 (3.73)
FPxD	1.00 (0.07)	8.16 (1.88)	5.74 (1.36)	9.61 (2.68)	75.70 (2.37)
CI	0.88 (1.47)	-0.25 (-1.30)	-0.23 (-3.23)	12.12 (1.81)	7.62 (1.19)
SL	9.02 (4.04)	-0.02 -(0.01)	3.05 (13.75)	8.34 (7.69)	6.73 (6.50)
SE	3.10 (2.09)	5.25 (4.47)	4.15 (13.63)	1.68 (2.00)	1.95 (2.11)
H	8.08 (1.30)	1.78 (0.58)	8.13 (7.43)	1.61 (0.93)	-4.90 (-1.44)
δ96	-28.79 (-2.38)	-72.48 (-7.78)	-61.76 (-8.60)		
δ97	-18.41 (-2.06)	-29.27 (-4.26)	-25.47 (-3.58)	-7.78 (-1.30)	-3.23 (-0.46)
Sargan Test				20.22 (df =9) [P-value=.02]	12.98 (df=8) [P-value=.11]
Diff. Sargan Test					7.24 (df=1) [P-value=.01]

t-statistics (between brackets) with robust standard deviations estimates in POLS, FE and GMM estimates. Sample: 1604 firms; 4812 observations

[8] See Flôres et al. (2002) for a similar exercise.

Evidence of positive spillovers follows from the estimation with FEE, though only at 7% level, and from EGMME. The difference Sargan test detects simultaneity of the foreign presence. Only the estimator from the last column is consistent and, in this case, the estimate of the coefficient of *FP* (significant at 2% level) is, in fact, substantially bigger (75.7 against 9.61 from EGMME with *FP* considered exogenous or 8.16 from FEE). Therefore, we may conclude that ignoring endogeneity of foreign presence severely underestimates the spillover effect. Our findings seem sufficient clear to warn about spillover results obtained with a non-judicious application of the classical panel data methods. First, we argue that the possible endogeneity of some explanatory variables should be considered and, consequently, tested, for instance with a differenced Sargan test, to ensure that estimates are not significantly biased due to inconsistent estimation. Second, as expected, POLS and REE - which estimate directly models which keep the unobserved heterogeneity of firms depicted in the permanent effect - give systematically erroneously estimates for the spillover effect, and should not be used. Finally, we detect that the FEE may also severely distort the results, which may be explained by inconsistency due to endogeneity of FP and/or violation of strict exogeneity. In fact, in Table 3, not only the spillover effect comes out clearly undervalued but also distortions are obvious in the case of the remaining explanatory variables.

5. Final remarks

This paper alerts that the traditional panel data techniques commonly used in the literature to identify productivity spillovers from FDI may be invalid. This fact suggests that incorrect estimation procedures may be one of the explanations for the ambiguous results on the evaluation of these spillovers found by the literature on the subject.

We remarked that unobserved heterogeneity has to be properly managed in order that consistency in estimation is attained. We also focussed the need to consider the possible simultaneity of some explanatory variables (namely the foreign presence, as it is natural to expect that foreign investors might prefer to acquire shares in sectors with better firms), and to do appropriated hypothesis tests which may eventually lead to the estimation with instrumental variables. In this latter case, or with pre-determined regressors, the differenced model is preferable to the fixed effects transformation given that, when there are more than two waves in the panel, it is possible to easily find instruments suitable in most of the situations. Robust estimation of covariance matrices is also indicated to ensure valid inferences. In contrast to the classical panel data methods, GMM allows to deal with these topics as in most packages it easily implements both instrumental variables and robust covariance matrix estimation. When the panel is short in time, the Extended GMM of Blundell and Bond (2000) is specially advised.

The validity of the conclusions of existent empirical studies on this subject are, therefore, conditional upon whether the econometric methodology used controls the special issues we discuss in this paper. In the case of our empirical example, with statistical information for Portugal, we detected a severe underestimation of the spillover effect with the classical panel data methods.

References

Aitken, B. and A. Harrison (1999), "Do Domestic Firms Benefit From Direct Foreign Investment? Evidence From Venezuela", *American Economic Review*, 89, pp. 605-618.
Arellano, M. (2003), *Panel Data Econometrics*, New York, Oxford University Press.

Blundell, R. and S. Bond (2000), "GMM Estimation With Persistent Panel Data: An Application to Production Functions", *Econometric Reviews*, 19(3), pp. 312-340.

Bond, S. (2002), "Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice" *Portuguese Economic Journal*, 1, pp. 141-162.

Caves, R. (1974), "Multinational Firms, Competition and Productivity in Host-Country Markets", *Economica*, 41, pp. 176-193.

Crespo, N. and M. Fontoura (2005), "Determinant Factors of FDI Spillovers – What Do We Really Know?" Working Paper 06/2005, Department of Economics, Technical University of Lisbon.

Fan, E. (2002), "Technological Spillovers From Foreign Direct Investment - A Survey", ERD Working Paper 33, Asian Development Bank.

Farinha, L. and J. Mata (1996), "The Impact of Foreign Direct Investment in the Portuguese Economy", Working Paper 16/96, Bank of Portugal.

Flôres, R., M. Fontoura and R. Santos (2002), "Foreign Direct Investment Spillovers: Additional Lessons From a Country Study", Ensaios Económicos da EPGE 455, Fundação Getúlio Vargas, Rio de Janeiro.

Globerman, S. (1979), "Foreign Direct Investment and Spillover Efficiency Benefits in Canadian Manufacturing Industries", *Canadian Journal of Economics*, 12, pp. 42-56.

Görg, H. and E. Strobl (2001), "Multinational Companies and Productivity Spillovers: A Meta-Analysis" *The Economic Journal*, 111, pp. 723-739.

Görg, H. and D. Greenaway (2004), "Much Ado About Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?" *The World Bank Research Observer*, 19(2), pp. 171-197.

Harris, R. and C. Robinson (2002), "Spillovers From Foreign Ownership in the United Kingdom-Estimates For UK Manufacturing Using the ARD", Paper Presented at the RES 2002 Conference.

Kinoshita, Y. (2001), "R&D and Technology Spillovers Through FDI: Innovation and Absorptive Capacity", CEPR Discussion Paper 2775, Centre for Economic Policy Research, London.

Kokko, A. (1994), "Technology, Market Characteristics and Spillovers", *Journal of Development Economics*, 43, pp. 279-293.

Meyer, K. (2003), "FDI Spillovers in Emerging Markets: A Literature Review and New Perspectives", DRC Working Papers - Foreign Investment in Emerging Markets, 15.

Santos, V. (1991), "Investimento Estrangeiro e a Eficiência da Indústria Portuguesa", *Estudos de Economia*, 11(2), pp. 407-25.

Schoors, K. and B. van der Tol (2002), "Foreign Direct Investment Spillovers Within and Between Sectors: Evidence from Hungarian Data", Working Paper 2002/157, University of Gent.

Smarzynska, B. (2003), "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages", William Davidson Working Paper, 548.

Wooldridge, J. (2002), Econometric Analysis of Cross Section and Panel Data, Cambridge, MA, MIT Press.

Annex. Table 1 – A: Labour productivity of domestic and foreign firms, Portugal, 1996-98, sectoral level*

Sector	[1] Domestic firms	[2] Foreign firms	[3]=[1]/[2]
15	5171.44	11629.99	.44
17	3393.71	4212.40	.81
18	2901.85	6072.81	.48
19	3153.31	2371.29	1.29
20	4578.91	9014.35	.51
21	6309.86	8086.89	.78
22	6532.75	8481.98	.77
23	80969.89	20959.32	3.86
24	6625.64	16886.46	.39
25	5686.92	7533.21	.75
26	5036.37	7139.03	.71
27	4419.67	3508.32	1.23
28	3918.76	5696.74	.69
29	4454.82	6133.85	.73
31	5877.13	6463.00	.91
32	6554.35	7905.23	.83
33	6941.16	3601.57	1.93
34	6115.36	6255.20	.98
35	2695.36	7068.80	.38
36	3208.56	7562.10	.42

* Two-digit level of the NACE

NACE nomenclature : 15 – Manufacture of food products and beverages. 16 – Manufacture of tobacco products. 17 – Manufacture of textiles. 18 – Manufacture of wearing apparel; dressing and dyeing of fur.19 – Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear. 20 – Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials.21 – Manufacture of pulp, paper and paper products. 22 – Publishing, printing and reproduction of recorded media.23 – Manufacture of coke, refined petroleum and nuclear fuel.24 – Manufacture of chemicals and chemical products.25 – Manufacture of rubber and plastic products.26 – Manufacture of other non-metallic mineral products.27 – Manufacture of basic metals.28 – Manufacture of fabricated metal products, except machinery and equipment.29 – Manufacture of machinery and equipment n.e.c. 30 – Manufacture of office machinery and computers.31 – Manufacture of electrical machinery and apparatus n.e.c.32 – Manufacture of radio, television and communication equipment and apparatus.33 – Manufacture of medical, precision and optical instruments, watches and clocks.34 – Manufacture of motor vehicles, trailers and semi-trailers.35 – Manufacture of other transport equipment.36 – Manufacture of furniture; manufacturing n.e.c. 37 – Recycling