CHAPTER 3

WHY ARE FOREIGN MULTINATIONAL FIRMS MORE PRODUCTIVE THAN DOMESTIC FIRMS?

***KOEN DE BACKER*[1]**

(version August 2001)

Abstract

In analyzing firm productivity and efficiency in Belgium, this paper empirically shows that multinationality is a source of heterogeneity between firms, more than other firm characteristics. Large differences in productivity between MNEs and domestic firms exist even after controlling for other firm characteristics put forward in theoretical models formalizing heterogeneity between firms. Productivity seems to vary between MNEs and domestic firms due to differences in technical efficiency, but not to differences in scale efficiency. Stochastic production frontiers using the translog form indicate that differences in scale efficiency between MNEs and domestic firms are relatively small, notwithstanding the different choice of production technology by both groups of firms. Differences in technical efficiency between foreign MNEs and domestic firms are much larger and significant in most industries. This result is largely consistent with the possession of firm specific advantages by MNEs, and the hypothesis that foreign MNEs have to be very efficient in order to compensate their liability of foreigness.

JEL-codes: F23, L10, M20.
Keywords: Multinational firms, productivity, efficiency

[1] Katholieke Universiteit Leuven; Naamsestraat 69, 3000 Leuven, Belgium

The author benefited from comments by L. Sleuwaegen.

Financial support of DWTC (project SE/01/003) and PBO (project 99B/3/24) are gratefully acknowledged.

1. Introduction

Until recently heterogeneity in firm productivity has largely been disregarded as theoretical and empirical research traditionally started from the presumption of an aggregate production function based on the representative firm. Due to the increased availability of longitudinal micro-level databases and the development of theoretical models formalizing the concept of heterogeneity (Jovanovic (1982), Pakes and Ericson (1987), Jovanovic and Lach (1989), Hopenhayn (1992), Pakes and McGuire (1994), Ericsson and Pakes (1995)), the importance of heterogeneity has however been established in recent empirical work (Roberts and Tybout (1996), Bartelsman and Doms (2000)). This new direction in research stands in sharp contrast with the early and robust evidence on the relative high productivity of MNEs in the international business literature (Dunning (1970), Dunning and Pearce (1977), Haex (1979), Davies and Lyons (1991), Dunning (1993)). Simple comparisons of productivity may then obscure differences in observable firm characteristics between MNEs and domestic firms; this paper empirically analyzes firm productivity in Belgium and controls for other firm characteristics in discussing differences between MNEs and domestic firms.

Size is typically assumed as an important source of productivity differences between foreign MNEs and domestic firms, with foreign MNEs believed to exploit economies of scale more optimally. Productivity differences between foreign MNEs and domestic firms may additionally be explained by differences in technical efficiency between both groups of firms, if firm specific advantages cause foreign MNEs to attain higher output levels for a given input bundle of production factors. A second objective of this paper is to analyze how differences in scale and technical efficiency contribute to differences in productivity between MNEs and domestic firms. The limited empirical evidence reported only for developing countries, points to a higher technical efficiency of MNEs relative to domestic firms (Pitt and Lee (1981) Sleuwaegen and Goedhuys (2000)).

Heterogeneity between firms also affects the traditional literature on growth accounting, as apart from productivity growth on the firm level, reallocation of outputs and inputs between firms affect macro-economic growth. In a last part of this paper the contribution of market share reallocation between continuing firms and reallocation because of entry and exit of firms to aggregate productivity growth in Belgian manufacturing is calculated for the period 1990-1995. Again specific attention is devoted to the differential contribution of MNEs and domestic firms.

2. Heterogeneity in productivity and foreign MNEs

The existence of an aggregate production function based on the representative firm was the traditional presumption underlying the earlier literature on productivity (growth). Differences in productivity between firms were not allowed and productivity growth was assumed to occur through a shift in the production technology common to all firms in the industry. This research focused mainly on growth accounting and the estimation of factor demands using aggregate and/or industry data (see for an overview Nadiri (1970)). More recent research however has increasingly acknowledged the heterogeneity between firms, thereby shifting the unit of analysis towards the level of the individual firm (for an overview see Roberts and Tybout (1996), Bartelsman and Doms (2000))

Different theoretical models of industry dynamics have formalized firm heterogeneity in productivity, thereby linking productivity differentials to observable firm characteristics. By modeling an unknown and time-invariant efficiency level for individual firms, Jovanovic (1982) showed that firm productivity varies initially but eventually settles down to a constant level. As firms only learn about their true efficiency by effectively operating and producing, a process of natural selection arises whereby less efficient firms leave the industry while more efficient firms grow to their optimal size. This selection mechanism results in younger firms being on average smaller, more heterogeneous but less productive than older firms. In contrast to this 'passive learning' by firms, several models starting with Pakes and Ericson (1987) stressed the importance of 'active learning' by firms through investments in productivity enhancement (Jovanovic and Lach (1989), Pakes and McGuire (1994), Ericsson and Pakes (1995)). By endogeneizing efficiency and production costs, these models showed that high productive firms may experience losses in productivity because of the uncertainty of these investments. Hopenhayn (1992) while obtaining similar results for heterogeneity on the firm level, discussed also differences between industries. As such he demonstrated that industries characterized by large and sunk cost investments show larger dispersion in productivity, as higher fixed costs with a sunk cost character act as a barrier to entry and exit while at the same time accommodating more low productive firms in the market.

Another source of heterogeneity has been largely discussed in the international business literature, as several researchers reported MNEs to be more productive than domestic firms (Dunning (1970), Dunning and Pearce (1977), Haex (1979), Davies and Lyons (1991), Dunning (1993)). Given the distinctive characteristics of MNEs relative to domestic firms simple comparisons of the relative productivity of MNEs and domestic firms may however obscure differences in firm characteristics. Globerman et al (1994) found, after controlling for firm characteristics like age, size, capital intensity, no productivity differences between foreign MNEs and Canadian-owned firms in Canada. In contrast, Doms and Jensen (1998) reported a significant residual productivity differential between foreign MNEs and US firms to exist, even after taking into account the same firm characteristics together with industry and location variables. The higher productivity of foreign MNEs supports the possession of firm specific advantages by MNEs; firms do not become multinational unless they are good at something (Caves (1996)).

Aggregate productivity figures for the manufacturing industry in Belgium support the general finding that foreign MNEs show higher average levels of labor productivity[1] than Belgian firms (table 1). Since MNEs typically concentrate in higher productive industries (Howenstine and Zeile (1992, 1994), Dunning (1993), Caves (1996)), industry composition effects may bias these figures and consequently regression analysis was undertaken by pooling the observations over industries and over the years 1990 to 1995, and by including industry and year dummies. The results of regression (1) in table 2 indicate that foreign MNEs (FORMNE) in Belgium are on average 38% more productive than their Belgian owned competitors.

INSERT TABLES 1 AND 2 HERE

According to the aforementioned theoretical models firm characteristics have been included in regression (3). The positive coefficient of firm age (AGE) supports the common prediction of the models of Jovanovic (1982) and Pakes and Ericsson 1987), namely that young firms are on average less productive than older firms are. At the same time this finding contradicts a pure vintage capital model in which new firms embody the latest technology and consequently attain higher productivity levels. Also the positive coefficient of firm size (SIZE)[2] is consistent with the passive and active learning models of Jovanovic (1982) and Pakes and Ericsson (1987), since younger firms are also typically relatively small.

[1] Defined by value added divided by employment (in FTE), where value added figures are expressed in real terms using the price deflator for the whole manufacturing sector. This paper focuses on differences in labor productivity, given the difficulties (measurement error, availability of investment data on the firm level...) in computing total factor productivity (TFP). While TFP is nevertheless theoretically preferable, previous research on productivity showed that the basic insights are not affected by using labor productivity instead of TFP, on the condition that capital intensity is included in the analysis.
[2] The variable SIZE is measured in terms of employment.

Furthermore, the smaller scale of operation may prevent the full exploitation of scale economies resulting in lower productivity. In line with Pakes and Ericsson (1987), the results further suggest that firms are able to enhance their productivity through R&D-investments (DUMRD)[3]. While R&D-investments may not bring the expected increase in productivity for individual firms given the typical uncertain character of these investments, it is expected that on average R&D-investments increase firm productivity. Further on, the importance of capital intensity (PHYSCAP)[4] in explaining productivity differences between MNEs and domestic firms is also clearly demonstrated, in line with previous research showing that MNEs employ more capital intensive methods than their indigenous competitors (see Dunning (1993) for an overview).

While firm characteristics seem to partially explain differences in productivity between firms, the large significant coefficient of FORMNE nevertheless indicate that there remains a residual productivity differential between foreign MNEs and domestic firms. These results are largely consistent with the importance of firm specific advantages (marketing and managerial skills, product differentiation, proprietary technology…) in order for firms to become multinational.

3. *Differences in scale and technical efficiency between MNEs and domestic firms*

3.1 Productivity, average scale, scale efficiency and technical efficiency

The large productivity residual of foreign MNEs after taking into account observable firm characteristics, indicates that scale is not the only reason for the productivity differential between foreign MNEs and domestic firms. Productivity between firms also varies if some firms are able to attain higher levels of outputs from a given input of production factors. This is captured by the concept of technical efficiency that measures to what extent the maximum potential output is realized given the bundle of inputs and the observed scale[5]. While productivity is expressed as the (average) ratio of output over input(s), efficiency compares the observed to the optimal values of production. In order to identify the 'sources' of the productivity differential between foreign MNEs and domestic firms, the technical efficiency of both types of firms has been analyzed in more detail.

[3] The dummy-variable RD indicates that firms are investing in R&D-activities.
[4] The variable PHYSCAP is defined as physical fixed assets over employment.
[5] Debreu (1951) and Farrel (1957) introduced the first measures of technical efficiency, based on the formal definition by Koopmans (1951).

This paper hypothesizes that MNEs since they tend to be larger than their domestic competitors, should be better able to take advantage of potential scale economies. While previous research showed that MNEs are typically active in industries most subject to economies of scale (Horst (1972), Pugel (1981), Dunning (1993), Caves (1996)), no evidence is however found about the scale advantage of MNEs within industries. With regard to technical efficiency, it is expected that foreign MNEs are more efficient than domestic firms, not only because of the existence of firm specific advantages and their transferability within MNEs[6], but especially in order to overcome the competitive disadvantages of operating in a foreign environment. Hampered by this liability of foreigness, foreign MNEs have to compete abroad with domestic firms whether domestically oriented or multinational, stimulating only the most efficient (foreign) firms to become multinational. Though, the reverse argument has also been put forward by some authors starting with Hymer (1970), namely that operating in a foreign environment results in a lower efficiency of foreign MNEs because of additional investments (e.g. in communication facilities) which have no direct 'productive' use.

3.2 The basic model

In order to test the hypothesis regarding scale efficiency and to discriminate between the contrasting hypotheses with respect to technical efficiency, the production frontier has been estimated on the level of individual industries using the stochastic frontier approach[7]. As the industry production frontier measures the maximum attainable output for the different bundles of production factors, scale efficiency is computed on the basis of the output elasticities for the different input factors, while technical efficiency is determined by the deviation of the individual firms from this production frontier. In contrast to the so-called deterministic frontier models (including the technique of Data Envelopment Analysis (DEA)), the stochastic approach is able to discriminate between inefficiency and statistical noise (i.e. due to factors outside the control of firms)[8] but has the disadvantage that it is a parametric technique. In order to prevent mistakes of specifying the wrong parametric production

[6] This argument is also valid for domestic MNEs; firms do not become multinational unless they are good at something (Caves (1996).
[7] Developed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van Den Broeck (1977); see for an overview Fried, Lovell and Schmidt (1993), and Cornwell and Schmidt (1996).
[8] The stochastic technique assumes that the production frontier is determined both by technological factors and random external factors such as bad weather, equipment failures…

function, a translog function has been used for estimating the industry production frontiers (Christensen et al (1973), Kim (1992)). In contrast to other production function like Cobb-Douglas, CES… this form is not restricted to be homothetic and allows for flexible substitution elasticities between input factors[9]. Furthermore the translog function, which can be represented as a second order approximation to any arbitrary production function, allows for returns to scale to vary over the input domain. As such a well behaved pattern of firstly decreasing, constant, and then increasing unit costs can be estimated.

The stochastic frontier relationship for firm i with production factors capital and labor, is then expressed as:

$$\begin{aligned} \ln(VA_{i,t}) = {} & b_0 + b_1\ln(CAP_{i,t}) + b_2\ln(EMPL_{i,t}) + b_3TIME + \\ & b_4(1/2)*[\ln(CAP_{i,t})]^2 + b_5(1/2)*[\ln(EMPL_{i,t})]^2 + b_6\ln(CAP_{i,t})*\ln(EMPL_{i,t}) + \\ & b_7\ln(CAP_{i,t})*TIME + b_8(EMPL_{i,t})*TIME + b_9(1/2)*TIME^2 + \\ & v_{i,t} - u_i \end{aligned} \tag{1}$$

where $VA_{i,t}$ is the deflated value added of firm i in year t, , $CAP_{i,t}$ the deflated capital stock, $EMPL_{i,t}$ employment expressed in FTE, TIME a time trend, $v_{i,t}$ a two sided i.i.d. error representing random factors and u_i being a non-negative one-sided error capturing technical inefficiency of firm i[10].

Assuming a half normal distribution for the non-negative error term u_i capturing technical inefficiency at the firm level, expression (1) has been estimated for 17 individual industries (NACE-2) using firm data for the years 1990-1995. As random panel effects have been estimated, and given the small number of Belgian MNEs in some industries, differences between domestically oriented Belgian firms and Belgian MNEs could not be analyzed.

The significance of the second order terms in all industries except for the office and data machines industry, show that the translog form is appropriate; the less flexible forms like Cobb Douglas and CES production functions typically used in most empirical work may report biased results. While the TIME-variable is traditionally included to capture disembodied technical change, the negative coefficient of this variable for several industries suggests that TIME merely picks up capacity utilization effects. The years 1993 and 1994

[9] Consequently, the optimal capital-labor ratios may differ between large (MNE) firms and small (domestic) firms.

[10] Using panel data in estimating expression (1) guarantees that more precise estimates are obtained for firm technical inefficiency but this at the expense of another assumption, namely that firm efficiency does not vary over time. The relatively short time period considered makes that this assumption is however not too restrictive.

were characterized by a significant slowdown in the demand for manufactured products, resulting in a large capacity staying idle.

INSERT TABLE 3 HERE

In order to compare differences in scale efficiency between foreign MNEs and domestic firms, returns to scale are computed for firm i in year t following Tybout and Westbrook (1995):

$$\text{returns to scale}_{i,t} = b_1 + b_2 + (b_4 + b_6)*\ln(CAP_{i,t}) + (b_5 + b_6)*\ln(EMPL_{i,t}) + (b_7 + b_8)*TIME \qquad (2)$$

This returns to scale index is averaged across years for each individual firm and then averaged again separately for the group of foreign MNEs and domestic firms (table 4). Notwithstanding the observation that the returns to scale index is statistically different from zero in nearly all industries[11], the value of this index and its concentration around 1 indicates that economies of scale are almost fully exploited by MNEs as well as domestic firms. The region of constant returns to scale however is different for foreign MNEs and domestic firms, since the results in table 4 clearly show that foreign MNEs operate on a significantly larger scale than domestic firms. All this suggests that foreign MNEs use a different production technology, which becomes most prominent through the large differences in capital intensity between foreign MNEs and domestic firms.

The reason behind the scale inefficiency of both groups of firms seems to be different between foreign MNEs and domestic firms. In 12 out of the 17 industries the average index for foreign MNEs is larger than 1 suggesting that MNEs could improve their scale efficiency by further increasing their scale of operation. In contrast, domestic firms seem to be too large given their choice of technology; the return to scale index is smaller than 1 in 9 out of 17 industries for this group of firms.

---

[11] Given the large number of observations only coefficients significant on a 0.001 level were considered.

INSERT TABLE 4 HERE

While the differences in scale efficiency between foreign MNEs and domestic firms are relatively small and thus can only partially explain the higher productivity of foreign MNEs relative to domestic firms, both groups of firms seem to differ significantly in terms of technical efficiency. Firm technical inefficiency is computed by averaging the yearly deviations of the firm's output level from the industry production frontier thereby making use of the panel structure of the data (Battese and Coelli (1988)). The results in table 5 show that as hypothesized foreign MNEs are on average more (technically) efficient than domestic firms firms, with in some industries the level of inefficiency for domestic firms almost doubling that for foreign MNEs. In all industries the level of technical inefficiency is lower for foreign MNEs than for domestic firms[12] and in 12 out of the 17 industries this difference is statistically significant. Next to this higher level of technical efficiency, the results also show that the dispersion in inefficiency is significantly smaller among foreign MNEs than among domestic firms. These findings support the hypothesis that foreign MNEs have to be highly efficient in order to overcome their competitive disadvantage of operating in a foreign environment. The results suggest that only the most efficient firms become multinational and that additional investments and costs of operating in a foreign country do not result in a lower efficiency relative to domestic firms.

Another observation is that the case of positive productivity spillovers of foreign direct investment (see for an overview Blomstrom and Kokko (1996)) seems not to be supported by the results in table 5. The uncorrelatedness between the level and dispersion of technical efficiency for domestic firms at the one side, and the foreign multinational presence in industries at the other side contradicts with the already mixed evidence[13] on productivity spillovers of foreign MNEs. This observation may be related to Hopenhayn's (1992) findings as his model shows that industries characterized by high entry/exit (sunk) costs have on average larger dispersion of productivity/efficiency levels. Since high entry/exit barriers are more easily overcome by MNEs (see for an overview of the empirical entry/exit literature Siegfried and Evans (1994), Geroski (1995)), the increased competition of MNEs drives out

[12] In two industries (instruments and other transport) the average technical inefficiency of foreign MNEs was not significantly different from 0; the relatively small number of foreign MNEs in these industries however may explain this observation.
[13] Especially in industrializing countries, empirical evidence of positive effects of foreign direct investment on domestic firm's productivity has been reported (Globerman (1979), Blomstrom (1986), Haddad and Harrison (1993), Aitken and Harrison (1994)).

low productivity firms in these industries. The overall result is dispersion in efficiency figures rather similar across industries, as reported in table 5.

INSERT TABLE 5 HERE

A firm-specific inefficiency model

In order to analyze the specific effect of multinationality on technical efficiency independent of other firm characteristics, a so-called firm-specific efficiency model is estimated. The objective is to identify systematic differences in technical efficiency among heterogeneous groups of firms within industries. Following Reifschneider and Stevenson (1991), the stochastic (base) production frontier of the preceding analysis is enlarged with extra regressors indicating firm characteristics[14]. Hence the inefficiency level u_i is decomposed in systematic influences related to specific firm characteristics ($Z_{i,t}$) and one non-negative random error w_i capturing the residual unexplained firm technical inefficiency:

$$u_i = g(Z_{i,t}, b) + w_i \qquad (3)$$

Assuming that firm characteristics only affect the level of technical efficiency thereby shifting the production frontier up- or downwards, the firm-specific efficiency model becomes:

$$\begin{aligned} \ln(VA_{i,t}) = {} & b_0 + b_1\ln(CAP_{i,t}) + b_2\ln(EMPL_{i,t}) + b_3TIME + \\ & b_4(1/2)*[\ln(CAP_{i,t})]^2 + b_5(1/2)*[\ln(EMPL_{i,t})]^2 + b_6\ln(CAP_{i,t})*\ln(EMPL_{i,t}) + \\ & b_7\ln(CAP_{i,t})*TIME + b_8(EMPL_{i,t})*TIME + b_9(1/2)*TIME^2 + \\ & b_{10}\ln(AGE_{i,t}) + b_{11}DUMRD_i + b_{12}FORMNE_i + \\ & v_{i,t} - w_i \end{aligned} \qquad (4)$$

[14] Another approach, frequently used in the literature, estimates first the technical inefficiency of individual firms, and regress these estimates then on firm characteristics by OLS. This approach however may lead to biased results in the first step (because of omitted variable bias) and in the second step (estimated u_i is one-sided).

The base production frontier is enlarged with the firm characteristics that were also discussed in the analysis of the average labor productivity, except for firm size and capital intensity whose effects are captured in the input factors capital and labor. Following Jovanovic's model (1982) of passive learning and competitive selection, age is hypothesized to shift the production frontier upwards[15]. Since firms only learn about their true efficiency level over time, young and smaller firms are on average less efficient than older firms; the less efficient firms in the successive entry cohorts will exit while the more efficient will survive and grow. According to the active learning model of Pakes and Ericson (1987), the variable DUMRD is also hypothesized to positively affect firm efficiency, as R&D investments are hypothesized to increase the technical efficiency of firms.

If foreign MNEs are highly efficient in order to compensate their liability of foreigness, it is expected that foreign multinationality shifts upwards the firm specific production frontier even after controlling for other firm characteristics. While several studies analyzed the link between MNEs and productivity, the effect of multinationality on efficiency has only received little attention. Pitt and Lee (1981) reported in their analysis of the Indonesian weaving industry that foreign MNEs are more efficient while also Sleuwaegen and Goedhuys (2000) found a positive effect for European firms in the manufacturing industry of Côte d'Ivoire.

The firm specific efficiency model in expression (4) is again estimated for 17 industries, thereby exploiting the panel structure of the firm level data to obtain random effects estimators. While simultaneity problems due to correlation between input levels and firm inefficiency w_i[16] may arise using these estimator, random effects estimation allows to include firm specific time-invariant attributes in the model (like multinationality). Further on, Schmidt and Sickles (1984) pointed out that the random effects model is most suitable for short panels in which the uncorrelatedness assumption has empirical support.

While firm characteristics like age and R&D-investment contribute to the dispersion of technical efficiency between firms, the significance and the size of coefficient of the FORMNE-variable clearly show the importance of (foreign) multinationality in explaining firm-level differences in efficiency (table 6). The firm specific production frontier model largely confirms the significant differences found between the simple comparison of the

[15] Jovanovic's model is originally formulated in terms of a time-invariant cost efficiency parameter; given the absence of input factors and input prices in this model and because of the assumption that efficiency differences between firms exist irrespective of the scale of operation, cost efficiency can be interpreted as technical efficiency.

[16] It can be expected that highly efficient firms are more likely to expand; another source of correlation is measurement error in the explanatory variables.

levels of technical efficiency between foreign MNEs and domestic firm in table 5. Again in 12 out of the 17 industries foreign MNEs are more efficient than domestic firms are even after controlling for other firm characteristics. The results clearly indicate that (foreign) multinationality is an additional source of heterogeneity in efficiency between firms and confirm the central hypothesis of this paper that foreign MNEs have to be highly efficient if they want to compete successfully in a foreign environment.

The results also largely confirm the passive learning hypothesis, as in 11 industries age is reported to have a positive effect on technical efficiency. The negative coefficient of the AGE-variable in the 'rubber and plastics' industry suggests that this industry is better described by a process of creative destruction whereby young firms embody the latest technology and are consequently more efficient than older incumbents (like in a pure capital vintage models). The active learning hypothesis finds somewhat less support as the results for the DUMRD variable show that only in 8 industries doing R&D shifts the production frontier upwards. Furthermore, in two industries 'extraction of minerals' and 'timber and wood', R&D investing firms are reported to less efficient. The downturn of demand in these industries seems to have resulted in a relative worse performance of R&D-investing firms.

INSERT TABLE 6 HERE

---

4. Productivity dynamics

The large heterogeneity in firm productivity casts doubt not only on the aggregate production function based on the representative firm, but also on the traditional growth accounting; aggregate productivity growth can no longer be seen as a shift in production technology common to all firms. Recent empirical work has decomposed aggregate productivity growth (on industry or country level) in within-firm productivity growth, reallocations between low- and high productive firms and the effects of entry and exit (Baily et al (1992), Bartelsman and Drymes (1994), Griliches and Regev (1995), Olley and Pakes (1996), Haltiwanger (1997), Foster et al (1998), Levihson and Petrin (1999), Disney et al (2000)). A common finding of this research is that large-scale ongoing reallocation of outputs and inputs across individual firms including the entry and exit of firms, contributes to a large extent to the productivity growth in industries and countries. Further on, this reallocation reflects merely within rather than between industry reallocation.

Following Griliches and Regev (1995), aggregate productivity growth in Belgian manufacturing during the period 1990-1995 is decomposed[17]:

$$
\begin{aligned}
\Delta PROD_t = \; & \Sigma_{FORMNE} \, [\Sigma_{i \text{ in } C} \; \underline{s_i} \, {*}\Delta PROD_{i,t} + \Sigma_{i \text{ in } C} \; (\underline{PROD_i} - \underline{PROD}){*}\Delta s_{i,\,t} + \\
& \Sigma_{i \text{ in } N} \; s_{i,\,t} \, {*}(PROD_{i,t} - \underline{PROD}) \; - \; \Sigma_{i \text{ in } X} \; s_{i,\,t-1} \, {*}(PROD_{i,t-1} - \underline{PROD})] \; + \\
& \Sigma_{DOM} \, [\Sigma_{i \text{ in } C} \; \underline{s_{i,}} \, {*}\Delta PROD_{i,t} + \Sigma_{i \text{ in } C} \; (\underline{PROD_i} - \underline{PROD}){*}\Delta s_{i,\,t} + \\
& \Sigma_{i \text{ in } N} \; s_{i,\,t} \, {*}(PROD_{i,t} - \underline{PROD}) \; - \; \Sigma_{i \text{ in } X} \; s_{i,\,t-1} \, {*}(PROD_{i,t-1} - \underline{PROD})]
\end{aligned}
\qquad (5)
$$

where C, N and X, are respectively the group of continuing firms between t-1 and t, the group of entering firms in t and the group of exiting firms in t-1, $s_{i,\,t}$ the share of firm i in year t in industry employment[18], $PROD_{i,t}$ the labor productivity of firm i in period t, and PROD the productivity of the industry, and underlined variables indicate averages of the variables over t and t-1.

The first term ($\Sigma_{i \text{ in } C} \; \underline{s_{i,\,t}} \, {*}\Delta PROD_{i,t}$) is the so-called 'within'-effect and is based on firm-level changes in productivity, weighted by the average share of the firm in the industry. The second term ($\Sigma_{i \text{ in } C} \; (\underline{PROD_i} - \underline{PROD}){*}\Delta s_{i,\,t}$) represents a 'between' firm component that reflects changing shares, weighted by the average productivity of firm i from the average industry productivity. The last terms ($\Sigma_{i \text{ in } N} \; s_{i,\,t} \, {*}(PROD_{i,t} - \underline{PROD}) \; - \; \Sigma_{i \text{ in } X} \; s_{i,\,t-1} \, {*}(PROD_{i,t-1} - \underline{PROD})$) represent the contribution of respectively entering and exiting plants. The between firm term and the entry and exit terms use the deviation between the firm productivity and the industry productivity, meaning that a continuing firm with an increasing share only contributes to average productivity growth if its average productivity over the period is larger than the average industry productivity. Likewise, entrants (exiters) contribute only if they have higher (lower) productivity than the industry. As such the contribution does not arise because of differences in scale between entering and exiting firms but only because of productivity differences (Haltiwanger (1997)).

[17] Different decompositions have been proposed as in expression (5) the within effect also reflects in part cross/covariance effects and this may hamper the interpretation. However as Foster et al (1998) show, compared to other techniques of decomposition expression (5) is less sensitive to measurement error.
[18] Using value added or sales shares did not alter the results significantly.

As the central focus in this paper is on multinationality as source of heterogeneity, the different effects have been computed for foreign MNEs and domestic firms[19] separately in order to compute the specific contributions of foreign MNEs and domestic firms. In order to compute the contribution to productivity growth in total manufacturing, the individual industry results are aggregated using the average employment share of the industry in total manufacturing. As such only within industries reallocation is taken into account; however, decomposing aggregate productivity growth in manufacturing according to Hill (1987), showed that within industry reallocation was responsible for more than 80% of total productivity growth (8.1% over the period 1990-1995).

INSERT TABLE 7 HERE

The results in table 7 indicate that especially productivity growth at the firm level and the exit of firms that displayed productivity less than the industry average, have contributed to the aggregate productivity growth in manufacturing. Market share reallocations between continuing firms seem to have played only a minor role over the considered period, consistent with results reported for other countries[20] (Baily et al (1992), Foster et al (1997)). Counter-cyclical tendencies explain the importance of the exit-term in expression (5), as recession years (especially the years '93 and '94) result in a shake out in industries whereby the least productive firms exit the industry.

More importantly, the results point to important differences between the different groups of firms, with foreign MNEs having contributed disproportianally to average productivity growth. Within firm productivity growth is almost completely realized within the group of foreign MNEs, indicating that foreign MNEs raised productivity growth at the firm-level stronger than domestic firms. Productivity change in domestic firms contributed only less than 1% to aggregate productivity growth. And despite the smaller number of MNEs that have entered and exited the Belgian manufacturing industry during the period 1990-1995 (De Backer and Sleuwaegen (2001)), also the contribution of net entry by foreign MNEs to aggregate productivity growth is significant. Entry by foreign MNEs happens at a higher productivity level than the industry average, resulting in a positive contribution of foreign

[19] No distinction could be made between Belgian uninationals and Belgian MNEs, as no accurate information was available about the time domestic firms became multinational.

[20] This last result may be due to the length of the period considered, as Disney et al (2000) show that share reallocation between continuing firms but also because of entry and exit are typically smaller the shorter the time period.

entry to aggregate productivity growth. The situation is totally different for domestic firms, with domestic firms entering with below (industry) average productivity thereby negatively contributing to aggregate productivity growth. The exit of domestic firms also typically less productive than the average firm in the industry, contributes additionally strongly to aggregate productivity growth. In contrast, the contribution of foreign exit is much smaller, reflecting the high productivity level at which foreign MNEs exit Belgium (in some industries even higher than the industry average).

Regression analysis of the productivity level, pooled across the years 1990 till 1995 and across industries (table 8), illustrates these findings clearly and shows that foreign MNEs enter (FORENTRY) and exit (FOREXIT) with a significant higher productivity level than domestic firms do (regression (1))[21]. Further on, while the results are in line with previous research by showing that the productivity of entering and existing domestic firms is below that of the average domestic incumbent (regression (2)), no significant differences in productivity is found between foreign entrants/exiters and foreign continuing MNEs (regression (3)). In contrast to domestic firms, foreign entrants do not have to go through the learning process described by Jovanovic (1982), as they have already learnt about their true efficiency in their home country. Only highly efficient firms decide to start business in foreign countries and become multinational (Caves (1996)), the more as they aware they have to compensate their liability of foreigness.

INSERT TABLE 8 HERE

Notwithstanding the contribution of foreign MNEs to aggregate productivity growth is only measured in an accounting sense[22], the results in table 8 show the profound impact of foreign MNEs on the economic structure of Belgium. Just like they have significantly speed up the industrialization of Belgium in the 1960s and 1970s by their greenfield investments, foreign MNEs have been important actors in the desindustrialization of the Belgian economy in recent years. While Baily et al (1994) show that in the US rising labor productivity is accompanied by reductions in labor input at the aggregate manufacturing level but not necessarily at the firm level, most foreign MNEs in Belgium have strongly decreased

[21] The omitted group of firms is the continuing domestic firms so the coefficients have to be interpreted accordingly.
[22] The impact of foreign MNEs on the productivity (growth) of domestic firms through e.g. increasing competition is not taken into account.

employment in order to stay and/or become more productive. Consequently, while productivity has risen significantly within foreign MNEs, industrial employment in foreign MNEs in Belgium has fallen by 44240 units over the period 1990-1995 especially through downsizing and exit. Job losses due to downsizing were much larger than the job creation in expanding (in terms of employment) foreign MNEs (figure1), resulting in a disproportional large share of foreign MNEs in falling industrial employment in Belgium. .

INSERT FIGURE 1 HERE

5. Conclusion

In analyzing firm productivity and efficiency in Belgium, this paper empirically shows that multinationality is a source of heterogeneity between firms, relatively more than other firm characteristics. Large differences in productivity between foreign MNEs and domestic firms exist even after controlling for other firm characteristics put forward by theoretical models formalizing heterogeneity between firms.

Productivity seems to vary between foreign MNEs and domestic firms due to differences in technical efficiency, but not to differences in scale efficiency. Stochastic production frontiers using the translog form indicate that differences in scale efficiency between MNEs and domestic firms are relatively small, notwithstanding the different choice of production technology by both groups of firms. Differences in technical efficiency between foreign MNEs and domestic firms are much larger and significant in most industries. This result is largely consistent with the possession of firm specific advantages by MNEs, and the hypothesis that foreign MNEs have to be very efficient in order to compensate their liability of foreigness.

While this paper relates productivity differences to differences in efficiency and specific firm characteristics, more research is needed in order to identify the exact sources of these efficiency differences between MNEs and domestic firms. Analyzing how and why MNEs are able to create firm specific advantages is the future direction of research in further discussing the differences between MNEs and domestic firms.

Table 1: Differences in labor productivity[23], foreign MNEs and domestic firms

	Foreign MNEs	***Domestic firms***
1990	2 350	1 739
1991	2 246	1 643
1992	2 464	1 742
1993	2 374	1 696
1994	2 628	1 793
1995	2 707	1 808

[23] In millions BEF.

Table 2: Differences in productivity between MNEs and domestic firms, OLS results[24]

N = 100002	***PROD***[25] ***(1)***	***PROD (2)***
CONSTANT	7.284 (0.029)	5.807 (0.028)
FORMNE	0.383 (0.008)	0.161 (0.009)
SIZE		0.046 (0.001)
PHYSCAP		0.194 (0.001)
AGE		0.023 (0.002)
RD		0.059 (0.009)
INDUSTRYDUMMIES		Yes
YEARDUMMIES	Yes	Yes
	Yes	
R^2	0.081	0.262

All coefficients are different from zero at the 10^{-9} significance level

[24] Productivity (PROD), size (SIZE), capital intensity (PHYSCAP) and age (AGE) are all expressed in logarithmic form.
[25] The reference group is the whole of domestic firms (all Belgian owned firms).

Table 3: Regression results (Maximum likelihood) for the base production frontier

(number of firms)	***CONSTANT***	***CAP***	***EMPL***	***TIME***	***CAP²***	***EMPL²***	***CAP*EMPL***	***TIME²***	***TIME*CAP***	***TIME*EMPL***	Log Likeli-Hood
Iron and steel (162)	1.333*	0.215*	0.618*	-0.128*	0.091*	0.186*	-0.115*	0.058*	0.022**	-0.021	-527
Extraction of minerals (189)	1.661*	0.311*	0.564*	0.090	0.050*	0.116	-0.068	0.180	0.016	-0.037**	-768
Non-metallic minerals (1254)	1.250*	0.190*	0.680*	-0.017	0.032*	0.091*	-0.040*	0.005	0.007*	0.003	-3296
Chemicals (740)	1.692*	0.241*	0.558*	0.007	0.066*	0.184*	-0.098*	0.002	0.006*	-0.001	-2396
Metal Articles (3756)	1.685*	0.173*	0.803*	-0.024*	0.019*	0.484*	-0.054*	0.012*	0.003*	-0.001	-12087
Mechanical Engineering (1210)	1.251*	0.128*	0.750*	-0.035*	0.016*	0.065*	-0.024*	0.016*	0.007*	-0.003	-3047
Office- data machinery (135)	1.292*	0.193*	0.829*	-0.076	0.006	0.048	0.009	0.012	-0.017	0.021	-408
Electrical engineering (955)	1.183*	0.181*	0.680*	-0.004	0.038*	0.108*	-0.051*	0.004	-0.003	0.012*	-2495
Motor vehicles (332)	1.014*	0.206*	0.713*	-0.004	0.056*	0.128*	-0.082*	0.010	0.018*	-0.013	-851
Other transport (210)	0.932*	0.192*	0.840*	-0.017	0.054*	0.162*	-0.101*	0.011	0.009	-0.005	-670
Instruments (453)	1.622*	0.178*	0.446*	-0.001	0.023*	0.136*	-0.033*	-0.002*	0.001	0.018**	-1392
Food, drink, tobacco (3664)	1.006*	0.182*	0.654*	0.146	0.056*	0.081*	-0.032*	-0.003	0.005*	0.001	-9462
Textiles (1239)	1.017*	0.201*	0.736*	0.029	0.068*	0.048*	-0.053*	-0.002	0.010*	-0.013*	-3548
Leather and footwear (1527)	0.980*	0.243*	0.621*	0.014	0.046*	0.076*	-0.046*	-0.009	0.009*	0.001	-4230
Timber and wood (2371)	0.967*	0.263*	0.624*	0.006	0.068*	0.126*	-0.079*	-0.002	0.004**	0.001	-5817
Paper, printing, publish. (3658)	1.199*	0.292*	0.761*	0.002*	0.066*	0.136*	-0.104*	0.004*	0.001*	0.008*	-31818
Rubber and plastics (786)	1.178*	0.254*	0.813*	0.122*	0.044*	0.086*	-0.072*	0.004*	0.004*	0.003*	-7961

*: $p < 0.001$; **: $p < 0.01$

Table 4: Scale efficiency and operation of scale, foreign MNEs and domestic firms

	RETURNS TO SCALE			SCALE OF OPERATION			
				CAPITAL[26]		LABOR	
	foreign MNEs	domestic firms		foreign MNEs	domestic firms	foreign MNEs	domestic firms
Iron and steel	1.068*	0.957*	Δ	1806	391	657	195
Extraction of minerals	1.006	0.949*		199	54	88	20
Non-metallic minerals	1.089*	0.972*	Δ	519	26	251	18
Chemicals	1.042*	0.912*	Δ	1129	142	327	49
Metal Articles	2.005*	1.012	Δ	219	13	165	16
Mechanical Engineering	1.048*	0.968*	Δ	208	14	215	20
Office- data machinery	1.022	1.022		39	9	60	9
Electrical engineering	1.094*	0.969*	Δ	351	12	450	18
Motor vehicles	1.087*	1.019*	Δ	981	23	923	31
Other transport	0.969	1.012		440	57	568	54
Instruments	1.085*	0.749*	Δ	203	5	225	7
Food, drink, tobacco	1.199*	0.975	Δ	454	30	233	18
Textiles	0.993	0.956*	Δ	189	41	201	37
Leather and footwear	1.017	0.951*	Δ	94	8	184	19
Timber and wood	1.041*	0.960*	Δ	67	13	78	14
Paper, printing, publish.	1.065*	1.083*	Δ	410	17	151	12
Rubber and plastics	1.015*	1.062*	Δ	294	28	190	20

*: index different from 1 on the 0.001 significance level;
Δ: difference between foreign MNEs and domestic firms different from 0 on the 0.001 significance level

[26] In million BEF

Table 5:Technical efficiency, foreign MNEs and domestic firms

	LEVEL OF TECHNICAL INEFFICIENCY foreign MNEs	domestic firms		***DISPERSION OF TECHNICAL INEFFICIENCY*** foreign MNEs	domestic firms		***Presence[27] of foreign MNEs***
Iron and steel	0.514*	0.737*		0.601	0.559		0.51
Extraction of minerals	0.655*	0.937*	Δ	0.266	0.592	Δ	0.31
Non-metallic minerals	0.594*	0.741*	Δ	0.451	0.517		0.49
Chemicals	0.576*	1.257*	Δ	0.401	0.690	Δ	0.66
Metal Articles	0.898*	0.906*		0.507	0.556		0.28
Mechanical Engineering	0.442*	0.663*	Δ	0.391	0.529	Δ	0.58
Office- data machinery	0.729*	0.728*		0.386	0.557		0.35
Electrical engineering	0.432*	0.718*	Δ	0.269	0.530	Δ	0.77
Motor vehicles	0.409*	0.668*	Δ	0.252	0.523	Δ	0.81
Other transport	0.611	0.807*		0.563	0.594		0.45
Instruments	0.484	1.157*	Δ	0.227	0.693	Δ	0.59
Food, drink, tobacco	0.541*	0.725*	Δ	0.382	0.509	Δ	0.38
Textiles	0.525*	0.684*		0.418	0.525		0.20
Leather and footwear	0.394*	0.701*	Δ	0.260	0.525	Δ	0.11
Timber and wood	0.409*	0.634*	Δ	0.262	0.500	Δ	0.05
Paper, printing, publish.	0.709*	0.919*	Δ	0.440	0.555	Δ	0.29
Rubber and plastics	0.695*	0.843*	Δ	0.350	0.480	Δ	0.57

*: level different from 0 on the 0.001 significance level;
Δ: difference between foreign MNEs and domestic firms different from 0 on the 0.001 significance level

[27] In terms of employment

Table 6: Regression results (Maximum likelihood) for the firm specific production frontier

(number of firms)	***CONSTANT***	***CAP***	***EMPL***	***TIME***	***CAP²***	***EMPL²***	***CAP*EMPL***	***TIME²***	***TIME*CAP***	***TIME*EMPL***	***AGE***	***DUMRD***	***FORMNE***	Log Likeli-Hood
Iron and steel (162)	1.289*	0.234*	0.599*	-0.109**	0.091*	0.188*	-0.126*	0.056*	0.020**	-0.027	0.008	0.020	0.296**	-523
Extraction of minerals (189)	2.556*	0.180*	0.497*	-0.008**	0.038*	0.074*	-0.046	0.012*	0.017*	-0.002	0.138*	-0.252**	0.108*	-4512
Non-metallic minerals (1254)	1.153*	0.195*	0.701*	-0.022	0.032*	0.068*	-0.042*	0.003	0.006*	0.002	0.044*	0.325*	0.343*	-3260
Chemicals (740)	1.332*	0.195*	0.676*	0.021	0.058*	0.123*	-0.080*	0.002	0.014*	-0.001*	0.008	0.157*	0.476*	-2149
Metal Articles (3756)	1.117*	0.229*	0.634*	-0.037*	0.042*	0.106*	-0.064*	0.011*	0.005*	0.002	0.048*	0.094*	0.360*	-8114
Mechanical Engineering (1210)	1.201*	0.130*	0.741*	-0.038**	0.015*	0.056*	-0.026*	0.008*	0.007*	-0.003	0.031**	0.066	0.360*	-3012
Office- data machinery (135)	1.278*	0.187*	0.800*	-0.059	0.005	0.015	-0.003	0.008	-0.017	0.013	0.019	-0.084	-0.139	-404
Electrical engineering (955)	1.026*	0.176*	0.676*	-0.001	0.038*	0.096*	-0.051*	0.002	-0.002	0.003	0.099*	0.240*	0.130	-2467
Motor vehicles (332)	0.871*	0.253*	0.695*	0.020**	0.051*	0.108*	-0.078*	0.013	0.015	-0.013	0.052**	0.145*	0.260**	-851
Other transport (210)	0.824*	0.178*	0.843*	0.025	0.054*	0.094*	-0.081*	0.007	0.010	-0.007	0.027	-0.127	0.646*	-655
Instruments (453)	1.356*	0.157*	0.524*	-0.019	0.014	0.072	-0.010	-0.010	0.001	0.003	0.134*	0.402*	0.099	-1386
Food, drink, tobacco (3664)	0.832*	0.181*	0.644*	-0.002	0.054*	0.068*	-0.033*	-0.003	0.005*	0.002	0.117*	0.070*	0.521*	-9272
Textiles (1239)	0.984*	0.202*	0.740*	0.027	0.068*	0.043*	-0.053*	-0.002	0.010*	-0.013*	0.013	-0.024	0.162**	-3545
Leather and footwear (1527)	0.912*	0.247*	0.629*	0.011	0.045*	0.069*	-0.049*	-0.009	0.009*	0.001	0.032*	0.130	0.535*	-4211
Timber and wood (2371)	0.879*	0.262*	0.610*	-0.002	0.067*	0.125*	-0.078*	-0.001	0.004**	0.002	0.059*	-0.339*	0.093	-5825
Paper, printing, publish. (3658)	1.152*	0.262*	0.531*	-0.005	0.065*	0.172*	-0.094*	0.001	0.002	0.008*	0.074*	0.067	0.654*	-9528
Rubber and plastics (786)	1.340*	0.250*	0.833*	0.020*	0.040*	0.066*	-0.072*	0.003*	0.005*	0.003*	-0.005*	0.156*	0.223*	-6010

*: $p < 0.001$; **: $p < 0.01$

Table 7: Decomposition of aggregate productivity growth

	TOTAL				***FOREIGN MNEs***				***DOMESTIC FIRMS***			
	Within Firm	***between firm***	***entry***	***-exit***	***within firm***	***between firm***	***entry***	***-exit***	***within firm***	***between firm***	***entry***	***-exit***
Iron and steel	0.005	0.015	0	0.006	-0.022	0.017	0.004	0.010	0.028	-0.002	-0.004	-0.004
Extraction of minerals	0.052	0.030	-0.004	0.031	0.045	0.024	0	0	0.007	0.006	-0.004	0.031
Non-metallic minerals	0.022	0.016	-0.001	0.005	0.004	0.016	0.003	0.008	0.018	0	-0.004	-0.003
Chemicals	0.106	-0.009	0.002	0.026	0.086	-0.008	0.014	0.006	0.020	-0.001	-0.012	0.020
Metal Articles	0.050	-0.039	0.002	0.025	0.064	-0.050	0.014	0.002	-0.014	0.011	-0.012	0.023
Mechanical Engineering	0.029	-0.003	0.003	0.023	0.041	-0.002	0.002	0.009	-0.012	-0.001	0.001	0.014
Office- data machinery	0.045	0.013	-0.059	-0.034	0.048	0.029	-0.025	-0.005	-0.003	-0.016	-0.034	-0.029
Electrical engineering	0.080	0.018	-0.037	0.036	0.070	0.025	-0.017	0.018	0.010	-0.008	-0.020	0.018
Motor vehicles	0.024	0.007	-0.015	0.014	0.025	0.015	-0.007	0.001	-0.001	-0.008	-0.008	0.013
Other transport	-0.047	0.033	-0.038	0.015	-0.023	0.039	0	0.010	-0.024	-0.006	-0.038	0.005
Instruments	0.145	0.004	-0.046	0.047	0.138	0.008	0	0.010	0.008	-0.004	-0.046	0.037
Food, drink, tobacco	0.102	-0.017	-0.017	0.036	0.043	-0.012	0.019	-0.002	0.059	-0.005	-0.036	0.038
Textiles	-0.051	0.046	0.020	0.042	-0.003	0.016	0.006	0.010	-0.048	0.030	0.026	0.032
Leather and footwear	-0.033	0.076	0.001	0.074	0.010	0.046	0	0.001	-0.043	0.031	0.001	0.073
Timber and wood	-0.046	0.009	-0.009	0.026	0.002	0	0	0	-0.048	0.009	-0.009	0.026
Paper, printing, publish.	0.049	0.006	-0.001	0.036	0.020	-0.004	0.014	0.001	0.029	0.010	-0.015	0.035
Rubber and plastics	0.028	0.026	-0.013	0.018	0.043	0.010	0.001	0.004	-0.015	0.016	-0.014	0.014
Total manufacturing	*0.043*	*0.005*	*-0.006*	*0.029*	*0.039*	*0*	*0.007*	*0.006*	*0.004*	*0.005*	*-0.013*	*0.023*

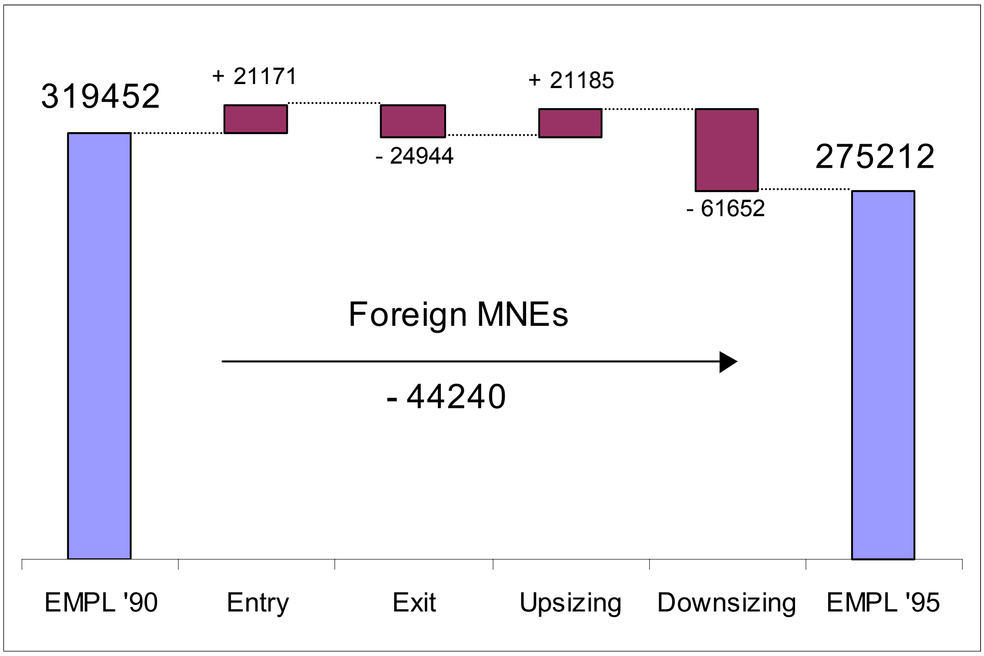
Table 8: Productivity differences, entering, continuing and exiting firms, OLS results[28]

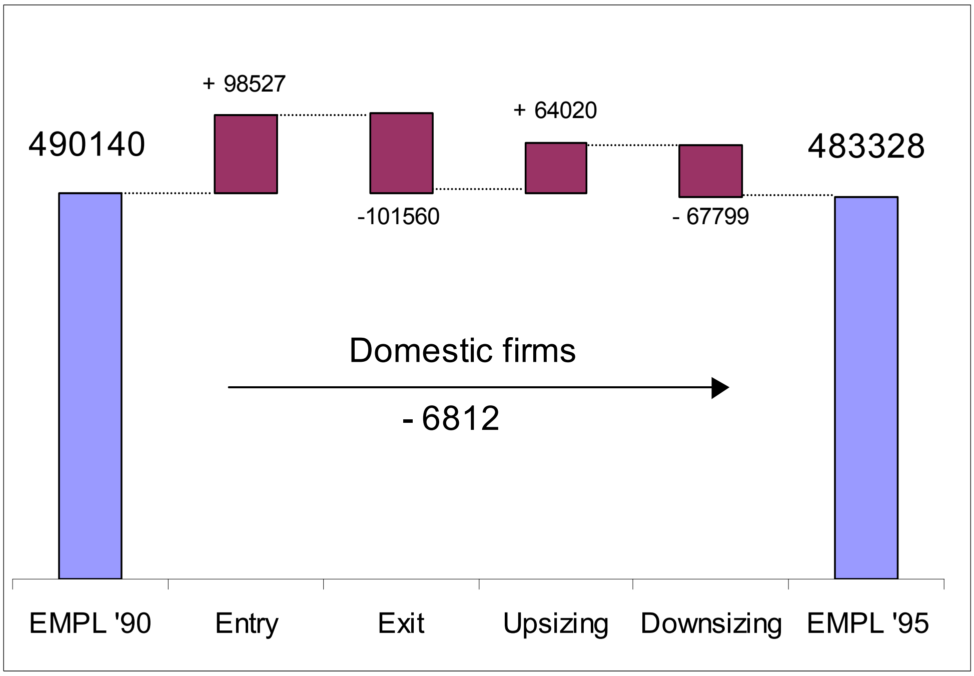
	PROD[29] ***(1)*** ***n = 82710***	***PROD***[30] ***(2)*** ***n = 4643***	***PROD***[31] ***(3)*** ***n = 78066***
CONSTANT	7.313* (0.031)	7.594* (0.061)	7.320* (0.036)
DOMENTRY	-0.153* (0.007)		-0.153* (0.007)
DOMEXIT	-0.290* (0.009)		-0.289* (0.008)
FORENTRY	0.295* (0.048)	-0.035 (0.063)	
FOREXIT	0.197* (0.050)	-0.129** (0.046)	
FORINC	0.341* (0.010)		
INDUSTRYDUMMIES	Yes	Yes	Yes
YEARDUMMIES	Yes	Yes	Yes
R^2	0.099	0.105	0.075

*: p < 0.0001; **: p < 0.01

[28] Labor productivity (PROD) expressed in logarithmic form.
[29] The reference group is the whole of all continuing domestic firms.
[30] The reference group is the whole of all continuing foreign MNEs.
[31] The reference group is the whole of all continuing domestic firms.

Table 8: Job creation and destruction, foreign MNEs and domestic firms





REFERENCES

AIGNER D., LOVELL C.A.K. and P. SCHMIDT (1977), Formulation and Estimation of Stochastic Frontier Production Function Models, *Journal of Econometrics,* 6, pp. 21-37.

AITKEN B. and A. HARRISON (1994), Do Domestic Firms Benefit from Foreign Direct Investment? Evidence from Panel Data, *Policy Research Working paper*, No 1248, World Bank, Washington.

BAILY M.N., BARTELSMAN E.J. and J. HALTIWANGER (1994), Downsizing and Productivity Growth: Myth or Reality?, *NBER Working Paper,* No 4741.

BAILY M.N, C. HULTEN and D. CAMPBELL (1992), Productivity Dynamics in Manufacturing Plants*, Brookings Papers on Economic Activity: Mircroeconomics*, pp. 187-249.

BARTELSMAN E.J. and M. DOMS (2000), Understanding Productivity: Lessons from Longitudinal Microdata, *Journal of Economic Perspectives,* 38, pp. 569-594.

BARTELSMAN E.J. and P.J. DRYMES (1994), Productivity Dynamics: US Manufacturing Plants, 1972-1986, *Board of Governors of the Federal Reserve Board, Finance and Economics Discussion Series*, No 94-1.

BATTESE G.E. and T.J. COELLI (1988), Prediction of Firm-Level Technical Efficiencies with a Generalized Frontier Production Function and Panel Data, *Journal of Econometrics*, 38, pp. 387-399.

BLOMSTROM M. (1986), Foreign Investment and Productive Efficiency: the Case of Mexico, *Journal of Industrial Economics,* 35, pp. 97-122.

BLOMSTROM M. and A. KOKKO (1996), Multinational Corporations and Spillovers, CEPR Discussion Paper, No 1365.

CAVES R.E. (1998), Industrial Organization and New Findings on the Turnover and Mobility of Firms, *Journal of Economic Literature*, Vol. 36, pp. 1947-1982.

CAVES R.E. (1996), *Multinational Enterprise and Economic Analysis*, Second Edition, New York, U.S.A, Cambridge University Press.

CHRISTENSEN L.R., JORGENSON D.W. and L.J.LAU (1973), Transcendental Logarithmic Production Frontiers, *Review of Economics and Statistcis*, 55, pp 28-45.

CORNWELL C. and P. SCHMIDT (1996), Production Frontiers and Efficiency Measurement in Matyas L. and P. Sevestre (eds) *The Econometrics of Panel Data*, Dordrecht.

DAVIES S.W. and B.R. LYONS (1991), *Characterizing Relative Performance: The Productivity Advantages of Foreign Owned Firms in the U.K.*, Oxford Economic Papers, 43, pp. 584-595.

DE BACKER K. and L. SLEUWAEGEN (2000), Does Foreign Direct Investment Crowd Out Domestic Entrepreneurship*, DTEW Working Paper*, Katholieke Universiteit Leuven.

DEBREU G. (1951), The Coefficient of Resource Utilization, *Econometrica*, 19, pp. 273-292.

DISNEY R. HASKEL J. and Y. HEDEN (2000), Restructuring and Productivity Growth in UK Manufacturing, *CEPR Discussion Paper*, No 2463.

DOMS M.E. and J.B. JENSEN (1998), Comparing Wages, Skills, and Productivity Between Domestic and Foreign Owned Manufacturing Establishments in the United States, in Baldwin R., Lipsey, R. and J. Richardson (eds) *Geography and Ownership as Bases for Economic Accounting*, pp. 235-255.

DUNNING J. (1993), *Multinational Enterprises and the Global Political Economy*, Reading, U.K., Addison-Wesley.

DUNNING J. (1970), *Studies in International Investment*, London: Allen and Irwin.

DUNNING J. and R.D. Pearce (1977), *US Industry in Britain*, Boulder: Westview Press.

ERICSON R. and A. PAKES (1995), Markov Perfect Industry Dynamics: A Framework for Empirical Work, *Review of Economic Studies,* 62, pp. 53-82.

FARREL M.J. (1957), The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society*, 120, pp. 253-281.

FOSTER L, HALTIWANGER J. and C.J. KRIZAN (1998), Aggregate Productivity Growth: Lessons from Microeconomic Evidence, *NBER Working Paper*, No 6803.

FRIED H., LOVELL K. and P. SCHMIDT (1993), *The Measurement of Productive Efficiency-Techniques and Applications*, Oxford University Press.

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

GLOBERMAN S., RIES J. and I. VERTINSKY (1994), The Economic Performance of Foreign Affiliates in Canada, *Canadian Journal of Economics,* 27, pp. 143-156.

GRILICHES Z. and H. REGEV (1995), Productivity and Firm Turnover in Israeli Industry: 1979-1988, *Journal of Econometrics*, 65, pp. 175-203.

HADDAD M. and A. HARRISON (1993), Are there Positive Spillovers from Direct Foreign Investment? Evidence from Panel Data for Marocco, *Journal Of Development Economics*, 42, pp. 51-74.

HAEX F., HALSBERGHE E. and D. VAN DEN BULCKE (1979), *Buitenlandse en Belgische Ondernemingen in de Nationale Industrie,* Gent.

HALTIWANGER J. (1997), Measuring and Analyzing Aggregate Fluctuations: The Importance of Building from Microeconomic Evidence, *Federal Reserve Bank of St Louis Economic Review*, January-February.

HAY D.A. and G.S. LIU (1997), The Efficiency of Firms: What Difference does Competition Make?, *The Economic Journal*, 107, 597-617.

HILL H. (1987), Factor Proportions and Multinationals, Choice of Technique or Choice of Industry?*, Economics Letters*, 25, pp. 279-282.

HOPENHAYN H. (1992), Entry, Exit and Firm Dynamics in Long-Run Equilibrium, *Econometrica,* 60, pp. 1127-1150.

HORST T. (1972), The Industrial Composition of US exports and Subsidiary Sales to the Canadian Market, *American Economic Review,* 62, pp. 37-45.

HOWENSTINE N. and W. ZEILE (1992), Characteristics of Foreign-Owned US Manufacturing Establishments, *Survey of Current Business,* 74, pp. 34-59.

HOWENSTINE N. and W. ZEILE (1992), Foreign Direct Investment in the United States: Establishment Data for 1987, *Survey of Current Business,* 72, pp. 44-78.

HYMER S.H. (1970), The Efficiency Contradictions of Multinational Corporations, *American Economic Review,* 60, pp. 441-448.

JOVANOVIC B. (1982), Selection and Evolution of Industry, *Econometrica*, 50, pp. 25-43.

JOVANOVIC B. and S. LACH (1989), Entry, Exit and Diffusion with Learning by Doing, *American Economic Review,* 79, pp. 690-699.

KIM H.Y. (1992), The Translog Production Function and Variable Returns to Scale, *Review of Economics and Statistics*, 1992, pp. 546-552.

KOOPMANS T.C. (1951), An Analysis of Production as an Efficient Combination of Activities, in T.C Koopmans (ed) *Activity Analysis of Production and Allocation*, New York.

LEVINSOHN J. and A. PETRIN (1999), When Industries Become more Productive, Do Firms? Investigating Productivity Dynamics, *NBER Working Paper*, No 6893.

MEEUSEN W. and J. VAN DEN BROECK (1977), Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error, *International Economic Review,* 18, pp. 435-444.

NADIRI I. (1970), Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey, *Journal Of Economic Literature,* 8, pp. 1137-1177.

OLLEY G.S. and A. PAKES (1996), The Dynamics of Productivity in the Telecommunications Equipment Industry*, Econometrica*, 64, pp. 1263-1297.

PAKES A. and R. ERICSON (1998), Empirical Implications of Alternative Models of Firm Dynamics, *Journal of Economic Theory*, Vol. 79, pp. 1-45.

PAKES A. and R. ERICSON (1987), Empirical Implications of Alternative Models of Firm Dynamics, *SSRI Working Paper*, University of Wisconsin, Madison.

PAKES A. and P. McGUIRE (1994), Computing Markov-Perfect Nash Equilibria: Numerical Implications of a Dynamic Product-Differentiated Model, *Rand Journal of Economics,* 25, pp. 555-589.

PITT M. and L.F. LEE (1981), The Measurement of Sources of Technical Inefficiency in the Indonesian Weaving Industry, *Journal of Development Economics,* 9, pp.43-64.

PUGEL T.A. (1981), The Determinants of Foreign Direct Investment: An Analysis of US Manufacturing Industries, *Managerial and Decision Economics*, 2, pp. 220-228.

REIFSCHNEIDER D. and R. STEVENSON (1991), Systematic Departures from the Frontier: A Framework for the Analysis of Firm Inefficiency, *International Economic Review*, 32, pp. 715-723.

ROBERTS M.J. and J.R. TYBOUT (1996), *Industrial Evolution in Developing Countries, Micro patterns of Turnover, Productivity and Market Structure,* Oxford University Press.

SCHMIDT P. and R.C. SICKLES (1984), Production Frontiers and Panel Data, *Journal Of Business and Economic Studies*, 2, pp. 367-374.

SLEUWAEGEN L. and M. GOEDHUYS (2000), Technical Efficiency and Firm Market Shares: Evidence from Cote d' Ivoire, *DTEW Working paper,* Katholieke Universiteit Leuven.

TYBOUT J.R. and M.D. WESTBROOK (1995), Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries, *Journal of International Economics*, 39, pp. 53-78.