Dirk Engel and Vivien Procher

Export, FDI and Productivity

Evidence for French Firms

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Export, FDI and Productivity – Evidence for French Firms

Abstract
The decision of companies to enter international markets, either via exports or foreign direct investment (FDI), has been postulated by the self-sorting model of Helpman, Melitz and Yeaple (HMY, 2004). In the strict sense, the theoretical predictions of HMY only apply to firms that become engaged in market-driven (horizontal) FDI. Hence, in this paper we apply more precise methodologies to test the HMY hypothesis. First, we classify MNEs according to the underlying motives for investing abroad (market-driven vs. resource-driven FDI). Second, we highlight the role of productivity growth in the post-entry period. Our findings suggest that productivity affects the FDI decision considerably whereas expected feedback and learning effects of FDI on productivity are remarkably lower. We further detect that more market-driven MNEs exhibit a higher productivity than comparatively less market-driven MNEs.

JEL Classification: F10, F23, D21, D24

Keywords: Foreign direct investment, horizontal and vertical FDI, multinational enterprises, productivity

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1. Introduction

The conditions under which some firms in the same industry become exporters and others conduct outward foreign direct investment (FDI) have received considerable interest in the theoretical and empirical literature. It is widely recognized that the mode chosen for serving foreign markets depends on the relative size of trading and sunk costs. A firm choosing to export benefits from the concentration of production and can therefore exploit economies of scale but it has to pay trade costs. If the firm is deciding to become a multinational instead, then it can produce closer to each market but has to pay higher sunk and fixed costs, since production capabilities have to be duplicated.

Addressing this trade-off, Helpman, Melitz and Yeaple (HMY 2004) advocate that the mode chosen by firms reflects their productivity level: Only the most productive firms become multinational enterprises (MNEs), whereas firms with intermediate productivity enter foreign markets via exports. The least productive companies produce only for the domestic market. While some empirical papers provide empirical evidence supporting the self-sorting hypothesis of firms for a selected group of manufacturing companies, it is yet unclear, how robust these patterns are across countries and business sectors.

Being precise, the theoretical predictions of HMY only apply to firms that become engaged in market-driven (horizontal) FDI, which refers to horizontal production structures of MNEs that replicate the same product, service or process in another country. Hence, in order to derive a valid empirical test of the HMY model one needs to differentiate between market-driven (horizontal) and resource-driven (vertical) FDI as well as to take the pre-entry level of productivity into account. With respect to the latter, any empirical test of HMY hypothesis might be biased if information about firm productivity in the pre-entry period (i.e. before becoming engaged in FDI) is not

available and if the post-entry change in productivity might matter to a large extent. Regarding the former, previous studies persistently stress the different motives for FDI, but not many scholars have empirically differentiated between them. One reason could be that motives for FDI are usually mixed (see e.g. Yeaple 2003) and hard to disentangle empirically.[1]

Keeping data limitations on the firm level in mind, our literature review suggests that two approaches have the potential to classify firms' foreign investments into resource-driven and market-driven FDI. The first approach, called *host country approach,* was theoretically developed by Head and Ries (2003). Here low productive firms enter only low-wage but not high-wage countries via FDI whereas highly productive firms enter both, low-wage and high-wage countries. The second approach, called *NACE approach*, is based on the idea that a similar industry affiliation of the parent company and its subsidiary fulfil the condition for market-driven FDI, while vertical subsidiaries are active in industries that are upstream (or downstream) from their parent's industry. In contrast to the host country approach, the NACE approach has not been used in the context of the HMY hypothesis before.[2]

The major contribution of this paper to the existing literature is to enhance the precision of an empirical test of the HMY hypothesis. We attempt to do this by testing the suitability of two approaches, namely the NACE and the host country approach, which classify firms according to the relevance of resource-driven and market-driven FDI. Furthermore we provide a simple descriptive analysis to evaluate the importance of the

[1] Görg et al. (2008) use information from the Irish Economy Expenditure Survey to focus on the level of international outsourcing at the firm level, defined as the ratio of imported materials over total wages, and the ratio of imported service inputs over total wages. The higher the ratio the larger will be the incentive for resource-driven FDI.

[2] Alfaro and Charlton (2007) were the first in applying this approach to analyse the FDI pattern between high-wage countries in more detail.

pre-entry level of productivity and the post-entry change in productivity in order to explain the observed productivity difference between exporters and MNEs. Besides this main contribution we are also the first to test the theoretical predictions of Head and Ries (2003) in Europe for a large sample of French companies. By using a rich panel of up to 110,000 French enterprises from all business sectors, including a large range of manufacturing and service sectors, we further strengthen the empirical evidence regarding the basic HMY ranking.

The rest of the paper is organized as follows. Section 2 reviews briefly the main findings of the empirical literature with respect to the theoretical predictions of the HMY model. Section 3 presents the general empirical test methodology and introduces the dataset. In section 4 the empirical findings for the productivity ranking of French companies according to their mode of internationalisation are presented and discussed. Section 5 concludes.

2. Review of empirical literature

Empirical studies mostly focus on an empirical test of the HMY model. In particular, the comparison of productivity differences between MNEs, exporters and domestic firms has received increasing attention in recent years (Greenaway and Kneller 2007). These studies display some remarkable differences in the measurement of productivity and the derivation of empirical tests. Some authors apply total factor productivity (TFP) measures while others use labour productivity. In contrast to labour productivity which measures output per worker, TFP relates output to combined inputs of labour, capital and sometimes intermediate goods (including materials, energy and services). Concerning the derivation of the empirical test, some studies test for an equality of the entire cumulative productivity distribution with a so-called Kolmogorov-Smirnov (KS) test (Kolmogorov 1933; Smirnov 1939), whereas others only test for the equality of

means, i.e. for the first moment of the distribution. Finally, the studies also differ with respect to the selection of firms and the sample size. In Table 1 we briefly summarize the main characteristics, methodological differences and findings of these studies.

[Table 1 about here]

Arnold and Hussinger (2006) and Girma et al. (2005) analyse firms' TFP levels using KS tests which check for the stochastic dominance of an entire distribution over another. The authors find support for the predicted productivity ranking of the HMY model. The approach applied by Girma et. al (2004) and Wagner (2006) differs slightly as they use value-added per worker instead of a TFP measure. Girma et. al (2004) find that MNEs in Ireland are more productive than exporters and domestic firms, but no significant difference is discernible between exporters and local firms. In contrast, Wagner (2006) confirms the HMY productivity ranking. The findings from Wagner (2006) and Arnold and Hussinger (2006) suggest that different productivity measurements do not fundamentally alter the HMY productivity ranking for Germany. Whether this does hold for the case of Ireland remains an open question, though.

Based on linear regression models, Castellani and Zanfei (2007) for Italy and Head and Ries (2003) as well as Kimura and Kiyota (2006) for Japan detect that MNEs outperform exporters and firms serving only the domestic market in terms of productivity. Although exporters do not differ from firms which are merely serving the domestic market in the studies of Castellani and Zanfei (2007) and Kimura and Kiyota (2006), it remains unclear whether this finding would be robust when using the KS test methodology. In addition, the findings of Head and Ries (2003) and Kimura and Kiyota (2006) emphasize the role of sample characteristics. Admittedly, the sample of Head

and Ries (2003) is very selective and thus not representative for the Japanese firm population.

The empirical results seem to be fairly robust with respect to different productivity measures. However, the findings might differ with respect to the test methodology. Exporters always outperform domestic firms when applying the KS test methodology whereas exporters do not differ from domestic firms if a linear regression model is applied.

The productivity difference could be driven by the pre-entry level of productivity and by feedback (and learning) effects of FDI on the productivity in the post-entry period. Related to that topic Wagner (2007) reviews in a comprehensive survey study the relationship between exporting and firm productivity. He analyses pre-entry and post-entry productivity levels and finds that more productive firms start exporting while exporting itself does not necessarily increase firms' productivity.

In contrast, empirical evidence regarding post-entry effects of FDI on the home plant performance of MNEs has received less research attention. Becker and Muendler (2008) estimate a negative effect on employment, whereas the employment effect is insignificant in the study of Kleinert and Toubal (2007) for German MNEs. The paper of Navaretti et al. (2006) finds significant positive feedback effects on employment, turnover and productivity on Italian home plants. Hijzen et al. (2007) observe a significant positive effect on home plant TFP in the initial year and positive effects on output and employment in the following three years. The evidence is rather mixed and thus we cannot clearly exclude that the observed productivity gap between exporters and MNEs is driven by both, pre-entry productivity and post-entry changes in the productivity of MNEs.

As pointed out in section 1, Head and Ries (2003) are one of the few scholars that try to explicitly distinguish between resource-driven and market-driven FDI. They argue that firms with a low productivity might have the greatest incentive for resource-driven (vertical) FDI in low-wage countries, since the difference in the cost per unit between the home and host country is largest for the least productive firms. According to the predictions of Head and Ries (2003), firms which have invested in low-wage countries are assumed to have even a lower productivity than exporters. Furthermore, low productive firms might enter only low-wage but not high-wage countries via FDI whereas highly productive firms might enter both, low-wage and high-wage countries.

With respect to the second hypothesis, the authors take 459 firms with export activity and FDI and divide these firms into four quartiles with equal numbered groups based on the approximate total factor productivity (ATFP = ln(Output/Labour) – s ln(Capital/Labour)).[3] They relate the productivity quartiles to the income of the host countries (relative to Japan) for the 2,495 investments of these firms. The authors observe that the host income ratios tend to increase with firm productivity. Hence, more productive internationally engaged firms seem to invest to a larger extent in high-wage countries than less productive internationally engaged firms. Nevertheless, Head and Ries (2003) do not present an explicit empirical test for exporters compared to multinational firms with different composition of resource-driven and market-driven FDI.

[3] The parameter s measures the importance of capital in the production function. It can take values between 0 (i.e. productivity equals labour productivity) and 1 (i.e. productivity equals capital productivity with output/capital).

3. Methodology and data

3.1 Productivity measurement

In general, two broad types of productivity measurement exist, namely partial and total factor productivity (TFP). In the former one factor of production (labour or capital) is related to output (gross output or value-added). The simplest and most frequently encountered single-factor measure is labour productivity which measures output per worker. In contrast, TFP relates output to combined inputs of labour, capital and intermediate goods (e.g. materials, energy, services). In contrast to labour productivity, total factor productivity is not affected by changes in the ratio of capital to labour or the ratio of intermediate goods to labour. Therefore, total factor productivity is often preferred to labour productivity as a measure of efficiency. However, TFP has higher data requirements on capital and intermediate goods.

In order to obtain consistent estimates of firm-level TFP a number of econometric challenges have to be mastered. One of the most prominent issues is the so-called simultaneity problem which was first discussed by Marschak and Andrews (1944). The main difficulty is that part of the TFP will be observed by the firm early enough as to allow the firm to adjust factor input decisions. This implies for the Cobb-Douglas production function that a part of the error term could influence the choice of labour and other inputs. In that case the regressors and the error term are not uncorrelated which renders OLS estimates to be biased and inconsistent.

Several techniques exist to overcome the endogeneity problem of measuring productivity in the production function (Van Biesebroeck 2007). The most apparent solution is to find instrumental variables that are uncorrelated with productivity but finding valid instruments remains a major hurdle. Another remedy to this problem is the

semi-parametric estimator by Olley and Pakes (1996) which uses firm-level investment to proxy unobserved productivity shocks. A major shortcoming of this approach is that observations with zero or negative investment have to be dropped from the data. Especially small and medium-sized firms that may not have strictly positive investments in every year are affected by the truncation bias. Therefore, Levinsohn and Petrin (Levpet 2003, 2004) suggest to use intermediate inputs as a valid proxy rather than investment as firms typically report a positive use of intermediate inputs like materials or electricity. In the international trade literature, the Levpet estimation procedure has become the dominant approach in obtaining consistent estimates of the parameters of the production function (see the Appendix for a technical presentation of the Levpet method).

3.2 Kolmogorov-Smirnov test

The productivity levels of domestic firms, exporter and firms engaged in FDI can be analysed by using the standard mean and median comparison. Nevertheless, the methodological standard in this literature is the Kolmogorov-Smirnov (KS) test (Kolmogorov 1933; Smirnov 1939) which is based on the concept of stochastic dominance of one distribution over another (see the Appendix for a more detailed presentation of the KS test).

In contrast to the mean and median comparison which only evaluates a single moment of the distribution, the KS test exploits the characteristics of the entire productivity distribution. Two- and one-sided KS tests are carried out to test for the stochastic dominance of two cumulative distributions S_N and S_M. Stochastic dominance of N over M implies graphically that the cumulative distribution S_N is situated to right of S_M. The KS test only allows to compare two distributions at a time. Therefore, in a first step domestic-oriented companies (D) are compared to exporters (DX) and in a second step

exporters (DX) are compared to multinational companies (DI). In case that DX stochastically dominates D and DI stochastically dominates DX, then DI also dominates D due to transitivity.

3.3 Data and descriptive analysis

The data used in this study comes from AMADEUS (Analyse Major Databases from European Sources), a pan-European financial database which includes information on the enterprises' financial accounts, ownership structure and affiliated companies. Bureau van Dijk compiles the AMADEUS database from company accounts filed under legal obligations in European countries. The financial data are supplemented with information from company reports and regional information providers. In total, AMADEUS contains financial and ownership data as well as information about domestic and foreign subsidiaries on about 9 million public and private companies in 38 European countries. The AMADEUS database has been recently used by Javorcik (2004) and Helpman, Melitz and Yeaple (HMY 2004).

The analysis in this paper is restricted to French companies and their international status in the years 2002, 2004 and 2005. Three AMADEUS updates (113, 136 and 146) are used to record the FDI status in the respective years which allows to build a repeated cross-section dataset.[4] All firms in a given year are classified into one of three groups depending on their export and FDI status. Domestically oriented companies (D) neither export nor hold any foreign investment assets; domestic exporters (DX) export but do not undertake FDI; and multinational enterprises (DI) engage in foreign direct

[4] Each AMADEUS update allows to observe the internationalization status of companies for the year in which the update was released. Unfortunately, the status in 2003 is not known as no AMADEUS update from this year is available to the authors.

investments.[5] Of course, the majority of multinationals in the DI group is also engaged in export activities. According to the OECD (2008) foreign investment is defined as being direct if a non-resident investor holds 10% or more of the equity of a resident enterprise. These direct investment enterprises will be classified as DI type. An ownership share of at least 10% ascertains an effective voice in the management of the company, implying that the investor is able to decisively influence its course.

Descriptive statistics of our sample are provided in Table 2 and Table 3. We restrict the data to companies that have a complete record on key economic indicators like employees, turnover, intangible assets and material costs. Furthermore, the dataset has been purged from outliers in turnover, material cost, employment cost, intangible and tangible fixed assets by dropping observations belonging to the upper and lower 1st percentile of the entire distribution for any variable. For example, about 435 871 French companies have a complete record for the year 2004. Thus, 46 % of all recorded firms in this year can be used in the empirical analysis. The shares in 2002 and 2005 are remarkably lower. The higher share of complete records in 2004 compared to 2002 may highlight some improvements in the data availability over time. Moreover, the AMADEUS update used for the year 2005 dates two months earlier compared to the update used for 2004 and 2002, which in turn might explain the lower share of companies with complete records.

[Table 2 about here]

The AMADEUS database allows to identify the host country of foreign subsidiaries and their type of business via the industry affiliation (NACE code). Based on this

[5] Abbreviations for the D, DX and DI group follow closely the cited literature.

information we are able to improve the methodology for empirical tests of the HMY hypothesis.

The majority of research conducted in this field has concentrated on manufacturing firms. However, the availability of a large dataset allows to differentiate between major industry sectors. Six industry groups have been defined in order to guarantee a minimum of 50 observations per industry for each internationalisation status. A short overview of the descriptive statistics is given in Table 3. A general observation is that domestically oriented companies (D) constitute always the largest group followed by exporters (DX) and multinational companies (DI). Moreover, exporters (DX) are usually older, have more employees and a higher turnover than domestic companies (D). In turn, the average multinational company (DI) is bigger and older than the average exporter.

[Table 3 about here]

4. Empirical findings

4.1 KS tests based on the traditional approach for the entire economy and major industries

In a first step and for the purpose of comparability with previous studies, the productivity ranking with respect to the internationalisation status is being analyzed by testing for the equality of the TFP means presented in Table 3. According to the standard t-tests the null hypotheses of the equality of means are rejected at the 5% significance level in all but one case, the construction industry.

Following the methodology of the KS test, we test whether the entire cumulative distribution function of DI is to the right of DX (in short notation $DX \prec DI$) and whether

DX is to the right of D (in short $D \prec DX$). If this is the case one can conclude that $D \prec DI$ will also hold by transitivity. The findings for the entire sample are depicted in Table 4.

[Table 4 about here]

According to the two-sided KS tests the null hypothesis of the equality of distribution can be rejected in all years whereas the one-sided tests do not lead to the rejection of the corresponding null hypothesis at the conventional significance levels. The results hold regardless of the productivity measure (labour productivity or TFP) being used. This implies that the HMY ranking $D \prec DX \prec DI$ is confirmed, since the confluence of these two test results indicates stochastic dominance. Figure 1 gives a graphical illustration of the cumulative density function of TFP for D, DX and DI for the year 2004.

[Figure 1 about here]

The KS test results for six main business sectors for the year 2004 are presented in Table 5.[6] The two-sided and one-sided KS tests clearly confirm the productivity ranking of $D \prec DX \prec DI$ for the following industries: manufacturing, wholesale and retail trade, transport & financial intermediation & real estate, IT services and services for companies. Only the construction industry does not exhibit any clear productivity pattern between national companies, exporters and MNEs. The two-sided KS test regarding the equality of distribution between DX and DI and both one-sided tests between nationals and exporters (i.e. testing $D \prec DX$ and $DX \prec D$) do not lead to the null hypothesis being rejected. Two considerations might help to explain these results. The construction and building market is dominated by local players and transport costs play

[6] Similar results are obtained for the labour productivity measure and for the years 2002 and 2005.

a fundamental role because of typically bulk-sized and low-margin products (Handelsblatt 2007: 12). Closeness to the customer is of utmost importance. Hence, transnational expansion in this industry might be governed by different motivations compared to other industries. In addition, temporally project-oriented co-operations with the involvement of a large number of consortium partners are quite common in the construction industry. Here, sunk costs of FDI might be comparatively low so that the difference between exporters and multinational becomes negligible.

[Table 5 about here]

4.2 Explaining the productivity ranking between MNEs and exporters

In section 1 it is argued that productivity difference between MNEs and exporters can be driven by both, differences in the pre-entry level of productivity and the post-entry change in productivity of firms that become engaged in FDI based on feedback and learning effects. One way to detect the existence of both effects is to compare the productivity path of exporters that actually become engaged in FDI (infant MNEs) to continuous exporters and to firms with a long experience in investing abroad (continuous or incumbent MNEs).

Figure 2 presents the mean TFP of firms that are continuous domestic companies, exporters and MNEs across the observed time period and of exporters that become engaged in FDI (DX to DI) i.e. these infant MNEs switch the internationalization status between 2004 and 2005. The graph shows that continuous MNEs achieve on average a TFP of 4.02 in 2004. The mean TFP value of exporters is 3.22 and thus, remarkably lower. Infant MNEs have an average TFP of 3.87 in 2004. Moreover, the findings suggest that infant MNEs already have a much higher productivity in the years before the change compared to continuous exporters which can be calculated by the pre-entry

TFP difference between infant MNEs and continuous exporters that do not invest abroad. In contrast, the post-entry change in the productivity is calculated by the TFP difference between incumbent MNEs and infant MNEs. Based on this calculation we observe that the pre-entry TFP difference is approximately 0.69 whereas the post-entry TFP change amounts only to about 0.10 in the year 2002 and 2004. Maybe, infant MNEs close the productivity gap in the long term and thus we cannot exclude that feedback and learning effects may matter for home plants of MNEs. These effects do not seem to play the major role in explaining the productivity ranking between MNEs and exporters, however.

[Figure 2 about here]

4.3 KS tests based on qualified approaches

The availability of firm-specific information about the imports of intermediate goods and the motivations for FDI is necessary in order to correctly distinguish between market-driven and resource-driven FDI. However, with the exception of Görg et al. (2008) this kind of information is usually not available at the firm level. Subsequently, assumptions and approximations are needed to improve the empirical tests of the HMY model.

Head and Ries (2003) look at the host countries chosen by the firms for their investments and classify them into low- and high-wage countries. In the majority of cases information about the host country of the foreign subsidiary are available in the AMADEUS database. In this paper the high-income OECD members (25 countries) (World Bank, 2008) are classified as high-wage countries, whereas the remaining

countries are classified as low-wage countries.[7] Hence, following the *host country approach* by Head and Ries (2003) firms with FDI in both, low- and high-wage countries (DI_{LoHi}) are assumed to have the highest productivity followed by firms that only invest in low-wage countries (DI_{Low}). The main reason behind this ranking is the fact that firms in the DI_{LoHi} group are characterised by a much broader investment strategy, reflecting an outstanding relevance of market-driven FDI with their presence in many different countries.

Interestingly, Head and Ries (2003) further point out that exporters (DX) outperform firms with pure resource-driven FDI (single foreign plants with export back to the home country). One may argue that FDI of firms belonging to the DI_{Low} group is a suitable approximation for resource-driven FDI. However, it cannot be excluded that FDI in low-wage countries is driven by both, market expansion and resource-seeking motives. Based on several data limitations, we group together new (infant) *and* incumbent MNEs with activities in low-wage countries to achieve an acceptable number of observations. Furthermore we cannot exclude that a post-entry productivity change occurs (see e.g. Navaretti et al. 2006 for empirical evidence) which in turn affects the observed productivity difference between exporters and MNEs belonging to the DI_{Low} group. Thus, contrary to Head and Ries (2003) we expect that firms with investments in low-wage countries only must not necessarily perform worse than exporters.

A fourth group of firms, not considered by Head and Ries (2003), is added to the analysis, namely, MNEs that invest only in high-wage countries (DI_{High}). No theoretical predictions exist with respect to the productivity level of the latter. On the one hand, one may expect a higher market potential in well-developed countries compared to less-

[7] A similar classification has been applied by Navaretti et al. (2006).

developed ones. On the other hand, Konings and Murphey (2006) detect significant employment substitution effects between affiliates of European MNEs in the north of the European Union and its parent firms. However, they neither find employment substitution between parent firms and their affiliates in low-wage southern regions of the European Union nor in Central and Eastern Europe. These empirical findings demonstrate that high-wage countries are also target countries for resource-driven FDI. In line with this conclusion, Alfaro and Charlton (2007) detect substantial vertical FDI within developed countries.

Table 6 lists the total number of observations in the respective FDI groups. In fact, firms in the DI_{LoHi} group have on average 8.8 subsidiaries in 6.4 different countries (approx. 60% in high-cost and 40% in low cost countries) whereas firms in the DI_{Low} group have on average only 1.3 subsidiaries in 1.2 low-cost countries. From an empirical point of view, the former is actually characterised by a much broader investment strategy with the presence in many different countries compared to firms in the two remaining FDI groups.

[Table 6 about here]

The KS test results for the TFP comparison of the three FDI types and the exporter group are reported in Table 7. The two-sided tests regarding the equality of distributions between exporters and the three FDI groups lead to rejections of the corresponding null hypothesis (column (1) to (3)). The one-sided tests reveal that firms engaged in FDI, regardless of the type, stochastically dominate exporters in terms of TFP. Since controlling for the actual number of affiliates does not fundamentally alter the KS test results in our study, we conclude that the host country approach has its clear limitation for differentiating accurately between resource-driven and market-driven FDI.

[Table 7 about here]

MNEs with a broader investment strategy (DI_{LoHi}) seem to exhibit a higher productivity than either of the remaining two groups of MNEs (columns (5) and (6)). This finding is clearly in line with Head and Ries (2003) who predict that the most productive firms invest in a wider range of countries.

In column (3) the null hypothesis on the equality of distributions between firms engaged only in low-wage countries and firms engaged only in high-wage countries cannot be rejected. In this case no stochastic dominance ordering with respect to TFP can be established. This finding might be driven by the fact that high-wage countries are also targets of substantial vertical FDI. Albeit applying a different empirical approach, Alfaro and Charlton (2007) reach a similar conclusion. In sum, the findings suggest the following TFP ranking for exporters and the three FDI types: $DX \prec DI_{Low} \approx DI_{High} \prec DI_{LoHi}$.

By following Alfaro and Charlton (2007) we want to explore a second methodology in order to capture the heterogeneity of FDI activities. Alfaro and Charlton use the 2 and 4-digit SIC industry code to distinguish between horizontal and vertical FDI. They classify horizontal subsidiaries as plants that have the same industry code as their parents, while vertical subsidiaries are active in industries that are upstream from their parent's industry. Taking the "same industry" should fulfil the condition for horizontal (market-driven) FDI, i.e. implying horizontal production structures that usually occur when MNEs replicate the same product, service or process in another country.

For the purpose of checking the suitability of this NACE approach we classify French MNEs (almost) identically to Alfaro and Charlton (2007) based on the NACE 2-digit

industry code.[8] In addition, subsidiaries from the wholesale and retail sector (NACE 2-digit code 50, 51, 52) often act as a commercial agency for the mother company, so that a comparatively strong market-driven orientation could be assumed. The group defined as "different" comprises MNEs for which none of the subsidiaries has the same industry code as the mother company[9] and none of the subsidiaries is a trading company. The latter group is considered to be comparatively less market-driven because of a more diverse firm network, as captured by the different NACE codes which might signal a higher vertical value-chain integration and which in turn allows to exploit cost advantages.

Finally, MNEs with subsidiaries in "same and different" industries are characterised by a large industrial footprint. From our point of view, however, the information is not sufficient to evaluate whether the latter are more or less market-driven than MNEs with foreign subsidiaries in the "same" industry only. Table 8 reports the number of observations for the NACE approach. Due to a large number of missing NACE codes, the sample size is much lower than the host country sample.

[Table 8 about here]

[Table 9 about here]

The KS test results for the NACE approach are presented in Table 9. The findings reveal that firms engaged in FDI, regardless of the NACE classification, have a higher productivity than exporters thereby confirming earlier results from the host country

[8] The NACE (**N**omenclature générale des **A**ctivités dans les **C**ommunautes **E**uropéenes) classification is the statistical industrial code for economic activities in the European Union.

[9] A different industry code for the mother company and the subsidiary usually implies that the subsidiary is active in a upstream or downstream industry (within the production and value chain) with respect to the industry of the mother company.

approach (columns (1) to (3)). The two-sided test regarding the equality of distributions indicates no significant productivity differences between MNEs that have subsidiaries solely in the "same" or "different" industries. This finding implies that a FDI typology along the pure lines of the NACE industry code is not refined enough to distinguish between market-driven and resource-driven FDI.[10]

MNEs that have subsidiaries in the "same and different" industry sectors (DI_{SaDi}) stochastically dominate any other group according to the NACE classification (columns (5) and (6)). This finding is robust when controlling for the actual number of foreign affiliates. A broad industrial network could signal higher organisational and managerial capabilities which in turn might be reflected in a higher productivity level.

Overall, the results from the NACE approach indicate that no unequivocal productivity ranking can be established for MNEs that we classify as relatively more market-driven compared to less market-driven MNEs. These findings have some major implications. We suggest to avoid an approximation of horizontal and vertical FDI by using the NACE approach in empirical studies to analyze effects of horizontal and vertical FDI. The approach has neither a grand ambition to theory nor an empirical confirmation for such a differentiation.

In contrast, the host country approach clearly suggests a productivity ranking between both groups. Investments of MNEs with affiliates in a wide range of low and high-wage countries are more driven by market motives than investments of MNEs with affiliates in low- or high-wage countries only. Clearly, no approach can fully substitute the need

[10] A more detailed typology based on the NACE 4-digit level may reduce the problem of miss-classification (see Alfaro and Charlton 2007 for empirical findings). Overall, taking the NACE 4-digit level instead of the NACE 2-digit level results in very similar findings. Results are available from the authors upon request.

for precise information about FDI motives at the firm level, but given our type of data, the host country approach seems to be more suitable than the NACE approach to differentiate between resource-driven and market-driven FDI.

5. Conclusion

In this paper we investigated the self-sorting hypothesis of the Helpman, Melitz and Yeaple (HMY 2004) model based on a large panel data set of 110,000 French firms. In line with many other studies, the productivity ranking as postulated by the HMY model was confirmed for the French sample with MNEs exhibiting the highest productivity level followed by exporters and domestic companies, respectively. With the exception of the construction industry, the results were endorsed for five major industry sectors. Interestingly, labour productivity measure instead of total factor productivity did not alter the results. This suggests that measurement issues of this kind may not remarkably hamper the cross-country comparison of results. Further findings clearly suggest that pre-entry productivity differences play a major role in explaining the observed productivity ranking. Feedback and learning effects of FDI on productivity may matter, but these effects seem to be remarkably lower compared to the pre-entry productivity difference.

Since the HMY model is only valid for market-driven FDI, we applied the *host country approach* suggested by Head and Ries (2003) to obtain more accurate empirical test results. In line with the theoretical predictions of Head and Ries (2003) we detected that firms with investments in both, low-wage and high-wage countries were more productive than MNEs with investments in low-wage countries only. In other words, more market-driven MNEs exhibit a higher productivity than comparatively less market-driven MNEs. We further observe that MNEs with investments in high-wage countries do not outperform MNEs with investments in low-wage countries. This

evidence is in line with recent findings of Konings and Murphey (2006) and Alfaro and Charlton (2007) suggesting that high-wage countries are also targets of substantial vertical FDI.

Furthermore, we made an alternative attempt to distinguish between resource-driven and market-driven FDI by comparing the industry codes of the mother companies and their subsidiaries in the so-called *NACE approach*. This approach, however, did not provide a fundamental advancement in capturing the heterogeneity of FDI motives and thus, researcher should not solely build on this approach when analyzing the effects of horizontal and vertical FDI on economic decisions.

Keeping data limitations in mind, a central finding of this paper is that the host country approach seems to constitute an appropriate methodology to classify MNEs according to the underlying market and resource motives for investing abroad even if information about FDI motives, imports and intermediate goods are not available.

Appendix: Estimation of firm-level TFP and the KS test

Estimation of firm-level TFP[11]

Following the production estimation of Levinsohn and Petrin (2003) the production function is assumed to be Cobb-Douglas

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \eta_{it} \quad (1)$$

where y_{it} is the logarithm of output (in this paper, gross revenue), k_{it} is the logarithm of the state variable for the capital stock, l_{it} and m_{it} are the logarithms of freely variable labour and intermediate inputs (e.g. materials), and the subscripts i and t denote the firm and time. The error term is comprised of two components, the firm's productivity ω_{it} that enters the firms' decision-making process and an error term η_{it} that does not affect input choices.[12]

The endogeneity problem arises if labour l_{it} responds to productivity ω_{it} so that a variable input choice is positively correlated with ω_{it} in period t, leading to an upward bias in the estimate for the elasticity of output with respect to labour. Similarly, the capital coefficient can be subject to endogeneity since capital and labour levels are correlated so that a bias in one coefficient can translate into a bias in the other coefficient since both coefficients are estimated simultaneously.

Levinsohn and Petrin (2003) propose a two-step procedure to achieve efficient and consistent estimates for the input variables. For that reason the Levpet procedure

[11] The following explanation is closed to Levinsohn et al. (2004).

[12] According to Levinsohn and Petrin (2003) the decision-making process of firms involve the following steps: At the beginning of each period t firms choose their investment level. After having done so firms observe their productivity level ω_{it}. Then, given the capital stock k_{it}, the productivity ω_{it} and the output and input prices, firms choose the level of the variable inputs for labour l_{it} and intermediate inputs m_{it} which maximizes their profit function.

involves the following identification restrictions: First, demand for intermediate input m_{it} depends on the firm's capital stock k_{it} and productivity ω_{it}:

$$m_{it} = m_{it}(k_{it}, \omega_{it}) \ . \tag{2}$$

Levinsohn and Petrin (2003) show that this demand function is monotonically increasing in ω_{it}. Therefore, equation (2) can be inverted to express unobserved productivity ω_{it} as a function of two observable factors, capital k_{it} and intermediate inputs m_{it}:

$$\omega_{it} = h_{it}(k_{it}, m_{it}) . \tag{3}$$

The inversion is important as it allows to control for productivity ω_{it}. A second identification restriction assumes that productivity ω_{it} follows a first-order Markov process which implies that knowing productivity realization in period t generates a distribution known to the firm for the possible values of productivity realization in period t+1:

$$\omega_{it} = E[\omega_{it} \mid \omega_{it-1}] + \xi_{it} \ . \tag{4}$$

where $\xi_{i,t}$ is the innovation in $\omega_{i,t}$ which is uncorrelated with $k_{i,t}$ but can be correlated with $l_{i,t}$ (one source of the endogeneity problem).

Levinsohn and Petrin's two-step estimator starts with an estimation of β_l. The estimator is obtained by substituting (3) into (1) which gives

$$\begin{aligned} y_{it} &= \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + h_{it}(k_{it}, m_{it}) + \eta_{it} \\ &= \beta_l l_{it} + \phi_{it}(k_{it}, m_{it}) + \eta_{it} \end{aligned} \tag{5}$$

where the function ϕ_{it} is defined as

$$\phi_{it}(k_{it}, m_{it}) = \beta_0 + \beta_k k_{it} + \beta_m m_{it} + h_{it}(k_{it}, m_{it}) . \tag{6}$$

From (6), the impact of capital on output (via β_k) is not separately identified from the impact of capital on intermediate inputs as capital also enters the proxy function h_{it}. In line with Olley and Pakes (1996) Levinsohn and Petrin (2003) also use a third-order polynomial expansion in capital k_{it} and intermediate inputs m_{it} for $\phi_{it}(k_{it}, m_{it})$ in order to consistently estimate the labour coefficient β_l:

$$y_{it} = \delta_0 + \beta_l l_{it} + \sum_{s=0}^{3} \sum_{j=0}^{3-s} \delta_{sj} k_{it}^{s} m_{it}^{j} + \eta_{it} \quad . \tag{7}$$

In the second step the estimators for β_k and β_m are calculated simultaneously. To begin with, $\hat{\phi}_{it}$ is being obtained from

$$\hat{\phi}_{it} = \hat{y}_{it} - \hat{\beta}_l l_{it} - \eta_{it} \tag{8}$$

Next some values for β_k* and β_m* between 0.01 and 0.99 are chosen, in order to get a prediction of ω_{it} for all periods t using

$$\hat{\omega}_{it} = \hat{\phi}_{it} - \beta_k^* k_{it} - \beta_m^* m_{it} \,. \tag{9}$$

Taking the ω_{it} for all periods t and considering equation (4), Levinsohn and Petrin (2003) estimate an approximation to $E[\omega_{it} \mid \omega_{it-1}]$ by predicting the values from the regression

$$\hat{\omega}_{it} = \gamma_0 + \gamma_1 \omega_{it-1} + \gamma_2 \omega_{it-1}^2 + \gamma_3 \omega_{it-1}^3 + \varepsilon_{it} \,. \tag{10}$$

Then given $\hat{\beta}_l$, β_k^*, β_m^* and $\hat{E}[\omega_{it} \mid \omega_{it-1}]$, the residuals of the production function can be expressed as

$$\widehat{(\eta_{it} + \xi_{it})} = y_{it} - \hat{\beta}_l l_{it} - \beta_k^* k_{it} - \beta_m^* m_{it} - \hat{E}[\omega_{it} \mid \omega_{it-1}]. \tag{11}$$

with the moment condition that capital stock is uncorrelated to ξ_{it} as long as previous period's investment decision determine period *t*'s capital stock. With the additional assumption that the previous period's level of intermediate inputs is uncorrelated with the current innovation in productivity ξ_{it}, one is able to identify estimates for β_k and β_m separately by using a grid search to minimize the GMM criterion function

$$\min_{\beta_k^*,\beta_m^*} \sum_t \widehat{\left[(\eta_{it}+\xi_{it})\, k_{it}\right]}^2 + \sum_t \widehat{\left[(\eta_{it}+\xi_{it})\, m_{it}\right]}^2 . \qquad (12)$$

Based on the three estimates for β_L, β_k and β_m the total factor productivity (in logarithms) of firm *i* is then given by

$$\hat{TFP}_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_m m_{it} \ . \qquad (13)$$

Kolmogorov-Smirnov test

Originally the Kolomogorov-Smirnov test (KS test) is a goodness-of-fit test developed in the 1930s which evaluates whether a given distribution is significantly different from a given benchmark distribution. In addition, the test is also used to test whether two data samples are compatible with the hypothesis of being random samples of the same, unknown distribution. In our case we use the KS test for the latter purpose to compare the productivity distribution of various companies with respect to their internationalisation strategy. Even though various goodness-of-fit tests have been developed in recent years (D'Agostino and Stephens 1986) which display higher statistical power than the KS test, it remains one of the best known and most widely used goodness-of-fit tests because of its simplicity.

Given two empirical cumulative distributions $S_M(x)$ containing M observations and $S_N(x)$ containing N observations, two-sided and one-sided KS tests are employed to test

for stochastic dominance. The corresponding null hypotheses and test statistics (D statistics), are given below.

Two-sided KS test:

$$H_0 : S_M(x) - S_N(x) = 0 \qquad \text{and} \qquad H_1 : S_M(x) - S_N(x) \neq 0 \quad \text{for some } x \in \Re$$

$$D = \sqrt{(MN/(M+N)}\, \max |S_M(x) - S_N(x)| \quad \text{over all } x \in \Re$$

One-sided KS test:

$$H_0 : S_M(x) - S_N(x) \leq 0 \qquad \text{and} \qquad H_1 : S_M(x) - S_N(x) > 0 \quad \text{for some } x \in \Re$$

$$D = \sqrt{(MN/(M+N)}\, \max\{S_M(x) - S_N(x)\} \quad \text{over all } x \in \Re$$

For $S_N(x)$ to be stochastically dominated by $S_M(x)$, one must reject the null hypothesis of the two-sided KS test on the equality of distributions and fail to reject the null hypothesis of the one-sided KS test.

The KS test has the advantage of making no assumptions about the distribution of the data i.e. it is a non-parametric and distribution free test. Moreover, it can detect differences in the distributions, even if the two samples do not differ in their mean. Nevertheless, a mere look at the *D* statistic can be misleading, as it only reports the maximum vertical distance between the two curves, thereby not taking into account any irregularities of the distributions, e.g. the crossing of the curves. Here, a graphical presentation is helpful for detecting those irregularities.

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Tables and figures

Table 1: Productivity ranking in empirical studies on the internationalisation of firms

Author(s)	Data source	Data description	Method	Results
Arnold and Hussinger (2006)	Micro Database Direct Investment (MiDi) from the German Bundesbank	Germany, manufacturing firms with more than 5 employees, 1996-2002, 60-115 firms engaged in FDI.	KS test; TFP	$D \prec DX \prec DI$
Castellani and Zanfei (2007)	Second Community Innovation survey (CIS), ELIOS (European Linkages and Ownership Structure) based on "Who owns Whom" and "Amadeus"	Italy, manufacturing firms, 1994-1996, 164 MNEs which control only non-manufacturing firms abroad and 123 MNEs which control at least one foreign manufacturing firm.	OLS with dummy variables; TFP	$D \approx DX \prec DI$
Girma et al. (2004)	ABSEI (Annual Business Survey of Economic Impact)	Ireland, manufacturing firms with more than 10 employees, 2004, 246 firms engaged in FDI.	KS test; Turnover, value added, profit per employee	$D \approx DX \prec DI$
Girma et al. (2005)	OneSource, "Who owns Whom" and "Acquisition Monthly" for 1996	UK, manufacturing firms (public limited companies) with more than 50 employees, 1990-1996, 116-185 firms engaged in FDI.	KS test; TFP	$D \prec DX \prec DI$
Head and Ries (2003)	Stock market data, overseas affiliates based on another survey conducted in 1991	Japan, 1,070 manufacturing firms (publicly listed), 459 firms engaged in export and FDI and further 44 firms engaged in FDI but without export activity.	Mean test and OLS; TFP and other measures	$D \prec DX \prec DI$ with $DI \approx DI+exports$
Kimura and Kiyota (2006)	Kigyou Katsudou Kihon Chousa Houkokusho (survey data)	Japan, manufacturing firms with more than 50 employees and at least ¥30 million in capital, 1994 and 2000, 2,765 firms engaged in FDI.	OLS with dummy variables; TFP	$D \approx DX \prec DI$
Wagner (2006)	Hannover Firm Panel (HFP), personnel interviews for random sample	Lower Saxony (Germany), manufacturing firms with more than 5 employees, 1995, 70 firms engaged in FDI.	KS test; value-added per worker	$D \prec DX \prec DI$

Notes: D: companies who serve the domestic market only, DX: exporters, DI: firms investing abroad. $D \prec DX$ implies that exporters tend to display a higher productivity than companies that only serve the domestic market; etc.

Table 2: Sample size (number of firms)

		2002 (update 113)		2004 (update 136)		2005 (update 146)	
D:	No FDI, no export	168 137		354 629		223 047	
DX:	No FDI, export	53 830		78 749		50 585	
DI:	FDI	1 991		2 493		1 738	
Sub-total (% of total)		*223 958*	*(25.2%)*	*435 871*	*(46.1%)*	*275 370*	*(28.7%)*
Missing information on export status or key variables (% of total)		666 040	(74.8%)	509 227	(53.9%)	685 616	(71.3%)
Total		*889 998*	*(100%)*	*945 098*	*(100%)*	*960 986*	*(100%)*

Table 3: Descriptive statistics

	Number of firms	(in %)	Employees (mean)	Turnover (mean)	TFP (mean)	Age (mean)
ALL industries						
D	354.629	*(81,4%)*	11	1.809	2,67	13
DX	78.749	*(18,1%)*	87	19.914	3,16	19
DI	2.493	*(0,6%)*	451	175.221	3,97	25
Manufacturing						
D	49.294	*(63,1%)*	13	1.959	3,00	14
DX	27.500	*(35,2%)*	63	14.701	3,39	21
DI	1.362	*(1,7%)*	560	243.460	4,02	32
Construction						
D	73.435	*(96,3%)*	10	1.285	2,19	11
DX	2.722	*(3,6%)*	104	17.401	2,18	16
DI	77	*(0,1%)*	446	90.911	2,27	26
Wholesale & trade						
D	116.997	*(77,2%)*	9	2.448	1,96	13
DX	34.074	*(22,5%)*	23	8.986	2,37	17
DI	555	*(0,4%)*	327	119.482	2,89	25
Transport, communication, financial intermediation, real estate and renting						
D	15.001	*(75,9%)*	19	3.929	4,61	14
DX	4.652	*(23,5%)*	179	29.265	5,13	19
DI	119	*(0,6%)*	428	163.946	5,87	25
IT services						
D	4.268	*(67,3%)*	13	1.490	3,96	8
DX	1.979	*(31,2%)*	47	6.507	4,17	10
DI	98	*(1,5%)*	252	37.037	4,35	13
Services for companies						
D	16.274	*(79,3%)*	22	1.550	4,54	10
DX	4.106	*(20,0%)*	43	5.280	5,00	12
DI	135	*(0,7%)*	133	26.653	5,69	18

Note: Company data for year 2004

Table 4: KS tests on TFP and labour productivity (all industries)

	Two-sided KS tests				One-sided KS tests			
	H_0: DX – D ≈ 0		H_0: DI – DX ≈ 0		H_0*: D – DX ≺ 0		H_0*: DX – DI ≺ 0	
Year	TFP	Labour productivity	TFP	Labour productivity	TFP	Labour productivity	TFP	Labour productivity
2002	0.2068	0.2495	0.2325	0.1461	-0.0023	0.0000	-0.0239	-0.0015
	(0.000)	(0.000)	(0.000)	(0.000)	(0.656)	(1.000)	(0.112)	(0.992)
2004	0.2080	0.2513	0.2376	0.1502	-0.0006	0.0000	-0.0174	-0.0006
	(0.000)	(0.000)	(0.000)	(0.000)	(0.949)	(1.000)	(0.233)	(0.998)
2005	0.2130	0.2480	0.2302	0.1406	-0.0017	0.0000	-0.0204	-0.0003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.792)	(1.000)	(0.247)	(1.000)

Note: The Hypotheses need to be interpreted as follows, for example, H_0*: D – DX ≺ 0 means that the TFP (or labour productivity) distribution of domestic firms is stochastically dominated by the TFP (or labour productivity) distribution of exporters, which according to the KS test implies that S(D) – S(DX) > 0, where S(D) and S(DX) are the cumulative distribution function of the TFP (or labour productivity) distribution for domestic firms and exporters, respectively. The P-values are given in parentheses.

Table 5: KS tests on TFP for selected industries in 2004

		Two-sided KS tests		One-sided KS tests	
Industry	Nace Codes	H_0: DX–D≈0	H_0: DI–DX≈0	H_0*: D–DX ≺ 0	H_0*: DX–DI ≺ 0
Manufacturing	15-37	0.1628 (0.000)	0.2431 (0.000)	-0.0005 (0.991)	0.000 (1.000)
Construction	45	0.0664 (0.000)	0.0854 (0.592)	-0.0664 (0.000)	*
Wholesale & retail trade	50-52	0.3485 (0.000)	0.4349 (0.000)	-0.0001 (1.000)	0.0000 (1.000)
Transport, communication, financial intermediation, real estate & renting	60-71	0.3287 (0.000)	0.4729 (0.000)	-0.0026 (0.951)	-0.0233 (0.881)
IT services	72	0.1477 (0.000)	0.1577 (0.014)	-0.0005 (0.999)	-0.0061 (0.993)
Services for companies	74	0.2929 (0.000)	0.3936 (0.000)	-0.0002 (1.000)	-0.0015 (0.999)

Note: The D-statistic is reported with the P-value given in parentheses. If the two-sided KS test on the equality of distributions does not lead to the null hypothesis being rejected, no one-sided test is carried out (marked with *). The Hypothesis need to be interpreted as follows, for example, H_0*: D – DX ≺ 0 means that the TFP distribution of domestic firms is stochastically dominated by the TFP distribution of exporters, which according to the KS test implies that S(D) – S(DX) > 0, where S(D) and S(DX) are the cumulative distribution function of the TFP distribution for domestic firms and exporters, respectively.

Table 6: MNE statistics according to the host country approach (2004)

	No. Of firms		No. of subsidiaries per MNE (mean)	No. of foreign countries covered (mean)
Low-wage country (DI_{Low})	463	(19%)	1.3	1.2
High-wage country (DI_{High})	1 610	(65%)	1.7	1.5
Low and High wage country (DI_{LoHi})	395	(16%)	8.8	6.4
Total	*2 468*			

Note: The total number of observations for the FDI sample reported in Table 5 is lower than in Table 2 due to missing information on the host country in some cases.

Table 7: KS tests for TFP according to the host country approach (2004)

Two-sided KS test

(1)	(2)	(3)	(4)	(5)	(6)
H_0: DI_{Low}–DX≈0	H_0: DI_{High}–DX≈0	H_0: DI_{LoHi}–DX≈0	H_0: DI_{High}–DI_{Low}≈0	H_0: DI_{LoHi}–DI_{High}≈0	H_0: DI_{LoHi}–DI_{Low}≈0
0.2233 (0.000)	0.2374 (0.000)	0.3059 (0.000)	0.0481 (0.351)	0.1488 (0.000)	0.1824 (0.000)

One-sided KS test

H_0*: DX–DI_{Low} ≺ 0	H_0*: DX–DI_{High} ≺ 0	H_0*: DX–DI_{LoHi} ≺ 0	H_0*: DI_{low}– DI_{High} ≺ 0	H_0*: DI_{High}– DI_{LoHi} ≺ 0	H_0*: DI_{low}– DI_{LoHi} ≺ 0
0.0081 (0.942)	0.0156 (0.465)	0.0413 (0.261)	*	-0.0352 (0.455)	-0.0363 (0.571)

Note: The D-statistic is reported with the P-value given in parentheses. If the two-sided KS test on the equality of distributions does not lead to the null hypothesis being rejected at the 5% significance level , no one-sided test is carried out (marked with *). The Hypotheses need to be interpreted as follows, for example, H_0*: $DI_{Low} - DI_{High} \prec 0$ means that the TFP distribution of MNEs with foreign investments in low-wage countries is stochastically dominated by the TFP distribution of MNEs with foreign divestments in high-wage countries, which according to the KS test implies that $S(DI_{Low}) - S(DI_{High}) > 0$, where $S(DI_{Low})$ and $S(DI_{High})$ are the cumulative distribution function of the TFP distribution for MNEs that invest in low-wage and high-wage countries, respectively.

Table 8: Number of MNEs according to the NACE approach (2004)

Different NACE (DI_{Diff})	268	(28%)
Same NACE (DI_{Same})	494	(52%)
Same and different NACE (DI_{SaDi})	195	(20%)
Total	*957*	

Table 9: KS tests for TFP according to the NACE approach (2004)

Two-sided KS test					
(1)	(2)	(3)	(4)	(5)	(6)
H_0: DI_{Diff}–DX≈0	H_0: DI_{Same}–DX≈0	H_0: DI_{SaDi}–DX≈0	H_0: DI_{Same}–DI_{Diff} ≈0	H_0: DI_{SaDi}–DI_{Same}≈0	H_0: DI_{SaDi}–DI_{Diff}≈0
0.2457	0.1978	0.3352	0.0923	0.2055	0.1756
(0.000)	(0.000)	(0.000)	(0.088)	(0.000)	(0.001)
One-sided KS test					
H_0*: DX–DI_{Diff} ≺ 0	H_0*: DX–DI_{Same} ≺ 0	H_0*: DX–DI_{SaDi} ≺ 0	H_0*: DI_{Diff}– DI_{Same} ≺ 0	H_0*: DI_{Same}– DI_{SaDi} ≺ 0	H_0*: DI_{Diff}– DI_{SaDi} ≺ 0
0.0069	0.0083	0.0326	*	-0.0278	-0.0298
(0.975)	(0.935)	(0.661)		(0.806)	(0.818)

Note: The D-statistic is reported with the P-value given in parentheses. If the two-sided KS test on the equality of distributions does not lead to the null hypothesis being rejected at the 5% significance level , no one-sided test is carried out (marked with *). The Hypotheses need to be interpreted as follows, for example, H_0*: DI_{Same} – DI_{Diff} ≺ 0 means that the TFP distribution of MNEs with horizontal subsidiaries (i.e. the mother firm and subsidiary have the same NACE code) is stochastically dominated by the TFP distribution of MNEs with vertical subsidiaries (i.e. the mother firm and subsidiary have different NACE codes), which according to the KS test implies that $S(DI_{Same})$ – $S(DI_{Diff}) > 0$, where $S(DI_{Same})$ and $S(DI_{Diff})$ are the cumulative distribution function of the TFP distribution for MNEs that have horizontal and vertical subsidiaries, respectively.

Figure 1: Cumulative density function of TFP for D, DX and DI (all industries, 2004)

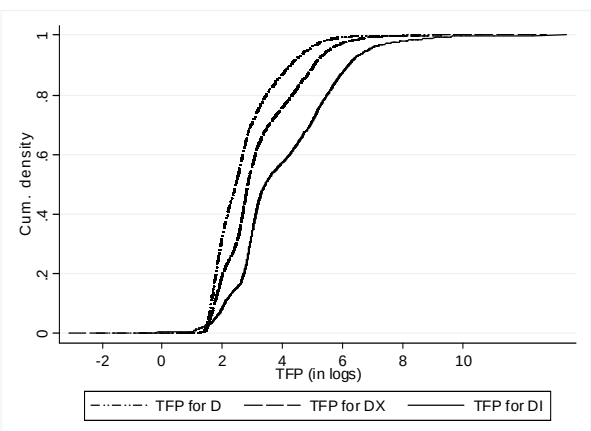
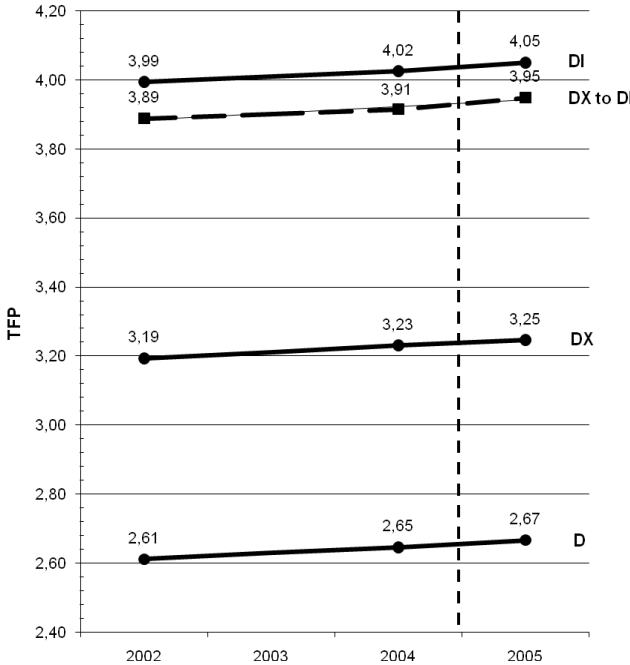


Figure 2: TFP path of domestic companies, exporters and MNEs



Note: The „DX to DI“ group includes exporters that become engaged in FDI between 2004 and 2005. The exact figure for 2003 is not known.