

research paper series

Globalisation, Productivity and Technology



Research Paper 2008/16

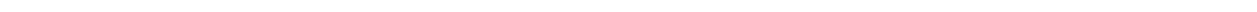
*The Causal Effect of Exporting and Multinational Acquisition on TFP in UK:
An Evaluation Method Approach*

by

Agelos Delis

The Author

Agelos Delis is an Internal Research Fellow in GEP, University of Nottingham.



The Causal Effect of Exporting and Multinational Acquisition on TFP in UK: An Evaluation Method Approach

by

Agelos Delis

Abstract

This paper assesses the effect on total factor productivity (TFP) of a change in the status of a firm from domestic producer to either exporter or subsidiary of a multinational firm. It is an extension of earlier work that looks solely on the effect of exporting on TFP (Girma et al, 2003 and 2004 and Wagner, 2002). In particular, it estimates the differences in TFP between domestic, exporting firms or subsidiaries of multinationals after controlling for the likely presence of endogeneity using the Multiple Treatment Approach (Blundell and Costa Dias, 2000 and Lechner, 2001). Results show that firms that have become exporters experience higher TFP, between 7.8% and 8.8%, with respect to domestic producers. Productivity gains were also experienced for firms acquired by multinationals relative to domestic producers ranging from 11.5% to 13%. Finally, exporters have a lower annual TFP compared to firms acquired by multinationals by around 10 percentage points.

JEL classification: F14, F23

Keywords: Exporting, acquisition, TFP, multinationals, propensity score matching, multiple treatments.

Outline

1. *Introduction*
2. *Theoretical Background*
3. *Econometric Issues*
4. *The Problem of Identification and the Three Causal Effects*
5. *Identification Strategies*
6. *The Curse of Dimensionality and Propensity Score Matching*
7. *Data Description*
8. *Results*
9. *Conclusions*

Non-Technical Summary

Increasing international trade and the emergence of Multinational Enterprises (MNEs) are two of the most significant phenomena the UK economy has experienced the last twenty years. These changes have affected the UK economy in various ways. This paper focuses on the question whether the decision of a British firm to become an exporter or the acquisition of a British firm by a multinational company affects its productivity. Following on the recent theoretical literature on exports versus FDI and productivity and the empirical research on the causal effect of exporting on productivity, I try to assess the causal effect of exporting decision or acquisition by MNEs on the Total Factor Productivity (TFP) growth of British firms. For that reason, I extend the single treatment approach followed by Girma et al (2003, 2004) and Wagner (2002), allowing for an additional treatment. This additional treatment is the possible outcome that a local firm is acquired by a multinational.

The dataset used includes information on an unbalanced panel of more than 14,113 British firms in the manufacturing sector for the period from 1990 to 1996. Firms are divided into three types: pure domestic (non-exporters), exporters and firms acquired by domestic and foreign multinationals. There are between 2,441 and 3,137 firms each year and all of them are observed at least for two consecutive years.

Using a multiple treatments approach based on the literature on evaluation methods, Blundel and Costa Dias (2000), I try to assess the following causal effects on TFP growth for British firms: i) becoming an exporter relative to remaining a domestic producer, ii) being acquired by an MNE relative to remaining domestic producer and iii) becoming an exporter relative to being acquired by an MNE.

The results show that the short-term TFP gains for exporters relative to domestic producers are between 7.79% and 8.79% depending on the number of matches allowed and are all significant at a 5 % level of significance. Identical in sign and again statistically significant at a 5% level, but higher in magnitude are the gains experienced by subsidiaries of multinationals relative to domestic producers, one year after the acquisition. On average firms that were acquired by MNEs had a higher annual productivity growth between 11.55% and 13.09% relative to domestic producers. Finally, the difference in TFP growth, one year after the change in status, between exporters and firms that were acquired by MNEs was negative for almost all the number of matches. Only one was significant at the 6% level with a value of 9.94%. The rest of the estimates were ranging between 8.58% and 9.49% less productivity for exporters, but only significant at the 10% level.

1 Introduction

During the last two decades UK has become one of the most globally integrated economies in the world. There are many aspects of this phenomenon in the UK economy, but two can be considered as the most important. The first is the rapid expansion of UK's international trade with other countries¹. While the second is the growing activities and importance of Multinational Enterprises (*MNEs*) within UK and in particular the increase of Foreign Direct Investment (*FDI*)². The effects of increased trade and *FDI* have raised numerous discussions among the public and the academic community with regard to the benefits and losses for national economies. In this paper the discussion will focus on the UK economy and the question whether the decision of a British firm to become an exporter or the acquisition of a British firm by a multinational company affects its productivity.

There is already a vast literature that tries to assess the exporting decision versus productivity question, see for example Clerides, Lach and Tybout (1998), Bernard and Jensen (1999) and Girma, Greenaway and Kneller (2004). The main question that is addressed in this body of literature is whether the decision of a firm to export leads to better performance. In particular there are two main hypotheses under investigation: i) the learning by exporting (LBE) hypothesis and ii) the self selection hypothesis. The first suggests that when a firm enters the export market becomes more productive due to higher competition and by accumulating knowledge from a potentially more advanced market. While, the second claims that future exporters experience an increase in their productivity some time before exporting takes place, since they have to be able to cover sunk costs in order to enter the foreign market.

From an econometric point of view, it is clear that there is a problem of causality. Do exporters become more productive or is it that more productive firms enter foreign markets? Many different approaches have been implemented in order to tackle the causality problem and different results were obtained. For example, Clerides et al (1998) used full information maximum likelihood and generalised method of moments estimators on a panel of Colombian, Mexican and Moroccan firms and found that there is no learning by exporting³ and that exporters self select. Similar results were obtained by Bernard and Jensen (1999) on a much larger unbalanced panel of US plants, but without looking for causal effects. On the other hand, Girma et al (2004) implemented a difference in difference approach in an unbalanced panel of matched UK firms and found that both self selection

¹2.64% annual increase for total trade in constant prices for the period 1960-2003 (OECD, Historical International Trade by Commodities, 1961-1990, 1991-2003.)

²\$28 billion of inward FDI inflow on average per year over the period 1981-2004 (OECD, International Direct Investment Statistics Yearbook, 2005).

³with the exception of Moroccan firms.

and learning by exporting exist.

Similar to the literature on the decision to export and productivity, the research on the topic of the theory of *FDI* is voluminous and dates back at least three decades⁴. One of the first attempts was by Dunning (1977, 1981)⁵, who stated that a multinational firm should be superior to local firms in order to enter the domestic market due to costs of entry. Dunning specified this superiority in three advantages a multinational should possess in order to be able to undertake *FDI*. These are: i) an ownership advantage, ii) a location advantage and iii) an internalisation advantage. The ownership advantage refers to exclusive product or production practices like patents or R&D. The location advantage is related to trade restrictions, such as tariffs and quotas, transportation cost and lower labour cost at the host country. The internalisation advantage refers to the fact that firm specific practices and technologies are better transferred within the same company rather than by licensing⁶. Hence, the ability of the *MNE* to transfer its advanced technology to its subsidiary could lead to better performance in terms of total factor productivity for the newly acquired firm.

Recently, a new stream of the literature has tried to integrate the two existing theoretical frameworks discussed above by formulating a model where a firm can choose the mode of entry in a foreign market, either by exporting or undertaking *FDI* and the importance of firm productivity differences. Helpman et al (2004) construct a model in which firms can serve a market abroad by exporting or horizontal *FDI*, similar to the proximity-concentration literature (see Krugman, 1983, Horstmann and Markusen, 1992, Brainard, 1993, and Markusen and Venables, 2000), that allows for firm heterogeneity in productivity. Firms choose to undertake *FDI*, if trade costs are higher than the cost of acquiring or building and maintaining a plant abroad. Helpman et al show that there is a clear partition of firms with respect to their productivity and the mode of serving a foreign market. The most productive firms will engage into *FDI*, while the next most productive firms will export and the least productive firms will just sell in the domestic market. This result seems to be consistent with empirical evidence in the case of UK (Girma et al, 2005) and for the case of Japan (Head and Ries, 2003).

In this paper, following on the recent theoretical literature on exports versus *FDI* and productivity and the empirical research on the causal effect of exporting on productivity, I try to assess the causal effect of exporting decision or acquisition by *MNEs* on the Total Factor Productivity (*TFP*) growth of British firms for the period 1990-1996. For that

⁴for early studies see Kindleberger (1969) and Hymer (1976).

⁵see Markusen 1995 for a summary.

⁶For a discussion on internalisation see Williamson, 1975 and 1981, Teece, 1977, Mansfield and Romeo, 1980, and Rugman, 1986

reason, I extend the single treatment approach followed by Girma et al (2004) and Wagner (2002), allowing for an additional treatment. This additional treatment is the possible outcome that a local firm is acquired by a multinational. More specifically, using a multiple treatments approach based on the literature on evaluation methods, Blundel and Costa Dias (2000), Frolich (2002), Lechner (2001) and (2002) and Heckman and Navarro-Lozano (2003), I will try to assess the following causal effects on *TFP* for British firms for the period 1990-1996 : i) becoming an exporter relative to remaining a domestic producer, ii) being acquired by an *MNE* relative to remaining domestic producer and iii) becoming an exporter relative to being acquired by an *MNE*.

I find that British exporters are more productive than British firms selling only domestically. Exporters appear to be more productive relative to domestic producers by 7.79% to 8.79% one year after they became exporters. This finding is similar with the results obtained in other studies, see for example Girma et al (2004) for the UK, Alvarez and Lopez (2005) for Chile and Wagner (2002) for Germany. I also find that British firms acquired by *MNEs* experience higher *TFP* growth one year after acquisition than domestic sellers. They gain between eleven to thirteen percentage points more *TFP* when compared with domestic producers. This result is similar in terms of sign and magnitude as the one obtained in Conyon et al (2002) with the solely difference that they look on labour productivity for British firms. Girma and Gorg (2007) also found a positive causal effect, but very small in magnitude in their work for two sectors in British manufacturing. While Harris and Robinson (2002) found that British subsidiaries experience lower *TFP* growth relative to domestic producers a year after acquisition. Finally, there is evidence that British exporters are less productive when compared to British firms acquired by *MNEs*. New British exporters have a smaller productivity growth of 8.6 to 9.95 percent one year after they begin to export. This result seems to be in agreement with the argument of Dunning (1977) that *MNEs* have a superior technology and are able to transfer it to their subsidiaries.

The rest of this paper is organised as follows. In Section 2 I briefly discuss a simple theoretical framework as a way to motivate the empirical question. Sections 3 and 4 describe econometric issues that arise because of the simultaneity problem and the three causal effects that can be estimated. The control for confounding approach that is used and the necessary conditions in order to identify the counterfactual are discussed in Section 5. While Section 6 describes the advantages of pair-matching on the propensity score estimator that is implemented to get the causal effect for the following three cases; a) exporting vs domestic production, b) exporting vs becoming subsidiary of *MNEs* and c) being acquired by *MNEs* vs domestic producers. In addition, it discusses the extensions of the propensity score matching estimator that permit for bias correction when not exact

matching is present and allow heteroscedastic variances for treatments. Section 7 offers a detailed description of the original data and the steps followed to construct the final sample. In Section 8, I present and discuss the results for the Multinomial Logit and the three Average Treatment Effect for the Treated estimates obtained when the condition of Common Support is imposed and for the whole sample, respectively. Furthermore, the validity of the Irrelevant Independence Alternatives assumption and the Common Support condition are tested and discussed. Finally, Section 9 offers a detailed conclusion of the results and discuss their implications.

2 Theoretical Background

A theoretical framework similar to the type of proximity-concentration trade-off model is needed in order to describe the setup of my research question. In particular, I assume that firms operate within a dynamic monopolistic competition environment, are initially producing and selling only into the domestic market and then have the possibility to choose between three different alternative states. They can decide to: i) remain domestic producers, ii) become exporters or iii) become subsidiaries of *MNEs*. The difference of this setup with other theoretical models, like Helpman et al (2004), lays on the fact that I look at the case where a firm is the recipient of *FDI* rather than being the investor. As in all similar models there are benefits and costs related to the three decisions of the firm. A profit maximising firm will choose one of the three alternatives, only if its current and future discounted revenues from such a choice are higher than the cost.

First, consider the decision of a firm to export compared to a situation where it sells only at home. The cost of such a decision consists mainly of trade restrictions (tariffs), transportation cost and sunk costs of exporting (product alteration). While the revenues arise from increased sales or the presence of economies of scale. Hence, a firm will decide to export if the expected discounted gains from exporting are greater than the cost of entry into the foreign market, as in the model of Roberts and Tybout (1997).

Second, a firm faces the choice to accept the offer of a *MNE* to become its subsidiary relative to remaining a domestic producer. The gains associated with such a decision are mainly financial and more specifically the amount offered by the *MNE* for the acquisition. While the cost is the loss of ownership and is related to the market value of firm plus the present value of any future revenues. In addition assume that the domestic firm faces uncertainty in the market that operates, which affects its future profits. Hence, the local firm will choose to become a subsidiary of a multinational if the monetary reward is higher

than its present market value and future profits (adjusted for uncertainty)⁷. Similarly, the decision of the domestic firm between exporting and being a subsidiary of a *MNE* will depend on the net gains from exporting compared to the net gains of becoming affiliated to a multinational. If the former is higher than the latter then the firm decides to export and vice versa.

In an environment like this, an increase in the fixed cost of exporting will lead to a situation in which there are less exporters and more of domestic producers and firms acquired by *MNEs*. While a fall in uncertainty will result in less companies to be acquired by *MNEs* and more companies exporting and selling domestically. This is a rather simple theoretical background, it is definitely not a model and its main purpose is to motivate the empirical question and discussion.

3 Econometric Issues

The research question of this paper tries to assess the effect of a change in the status of British firms on their total factor productivity growth. In particular, the focus lays on the estimation of the causal differences on the *TFP* growth for a British firm that is producing only for the domestic market and is becoming either an exporter or is acquired by a multinational company. As it was discussed earlier, the direction of causality between the decision of a firm to change status and its observed productivity is not clear. More specifically there is a simultaneity problem. Exporters might increase their productivity because they learn from the new market (learning by exporting), but equally exporters might need to experience an increase to their productivity before exporting to the foreign market in order to cover the fixed cost of entry. Similar arguments apply for the case of the acquisition of domestic firms by *MNEs*. A British firm that becomes the subsidiary of a *MNE* could gain in terms of productivity through the superior technology and management of the multinational. While, *MNEs* might target highly productive British firms for acquisition (cherry picking).

The estimation technique that is followed, multiple treatment matching, in this paper is trying to address this simultaneity problem embedded on the research question. A simple comparison of the productivities between firms that chose different alternatives, for example an exporter versus a domestic producer, will suffer from estimation bias. The reason is that firms that chose a particular status might have certain characteristics that would have

⁷The multinational that desires to acquire the local firm is willing to pay more than the present market value plus discounted future profits, because it might be cheaper to serve the domestic market this way rather than exporting.

allowed them to experience an increase in *TFP*, even without a change in their status. The simultaneity problem would have ceased to exist if there was available information about the potential *TFP* of those that chose a particular status had they chosen another. For example, the *TFP* growth that an exporting firm would have experienced had it decided to remain a domestic producer. This is a counterfactual and it is not possible to be observed. But with the use of matching techniques and some assumptions it is possible to identify these causal effects.

There are studies of Girma et al (2003) and (2004) and Wagner (2002) that estimate the differences in *TFP* growth for exporters and non-exporters in UK and Germany, respectively. Both studies control for the possible endogeneity problem of selection for exporters using matching techniques. Here, I am extending this approach, allowing for an extra "treatment", the possibility that a firm is acquired by a multinational firm. Hence, I follow a multiple treatments approach based on the recent literature on evaluation methods, Blundel and Costa Dias (2000) for example.

4 The Problem of Identification and the Three Causal Effects

4.1 Counterfactual and the Stable Unit Treatment Assumption

In the current setup a treatment is defined as the status that a firm has been through from time t to time $t + 1$. Hence, there are three possible treatments. Either becoming an exporter or being acquired by a *MNE* or remaining a domestic producer. Let $i = 1, \dots, n$ indicate a firm, let $j = DP, EX, AM$ denotes a treatment, where *DP* indicates a domestic producer, *EX* an exporter and *AM* indicates a subsidiary of a multinational. I assume that a firm is a domestic producer, if it produces and sells its product only in the domestic market. An exporter is defined as a firm that produces and sells domestically, but some of its output is also exported. Both domestic producers and exporters are owned by British firms that are not engaged in multinational activities. While a subsidiary of a *MNE* produces and sells for the domestic market, but it is owned by a multinational firm.

The treatments should be mutually exhaustive and exclusive. Each firm can have just one of the three statuses at one point in time. This restricts the sample, because we should drop all firms that are subsidiaries of multinationals and exporters at the same time. In addition, only firms that were domestic producers before treatment are considered⁸.

⁸The reason is that we are interested of estimating the causal effect on *TFP* growth of either becoming an exporter or a subsidiary of a *MNE* relative to remaining a domestic producer. In order to do so we

Let Y_{it}^j indicate a vector of potential outcomes on a set of performance measures, TFP , for each firm i and treatment j at time t . There are three such potential outcomes; Y_{it}^{DP} , Y_{it}^{EX} and Y_{it}^{AM} . The first, Y_{it}^{DP} , is the outcome that will be observed had the ith firm remained a domestic producer at time t , the second, Y_{it}^{EX} , is the outcome that will be observed if firm i had become an exporter at t and finally the last one, Y_{it}^{AM} , is the outcome that will be observed if firm i had been acquired by a multinational company.

Before participating in any treatment, at time $t - 1$, all these potential outcomes are latent and are only observed had the firm gone through the treatment. After participation, at time t , only one of this three potential outcomes is observed, because the firm either remained a domestic producer, or became an exporter or was acquired by a multinational. The rest of the potential outcomes are counterfactual and are not observed. But using statistical techniques that require some assumptions will enable us to identify these counterfactual and then estimate the causal effects of treatments.

The first such assumption that needs to be satisfied is the Stable Unit Treatment Value assumption, Rubin (1980), which states that the potential outcomes of a firm should not be influenced by the treatment followed by other firms. Let ϕ_{it} be a ternary indicator of the treatment that firm i followed at time t

$$\phi_{it} = \begin{cases} 0, & \text{if domestic producer (DP)} \\ 1, & \text{if exporter (EX)} \\ 2, & \text{if acquired by MNE (AM)} \end{cases} \quad (1)$$

ϕ_{it} is equal to zero indicates that firm i is a domestic producer at time t , when ϕ_{it} is equal to one the firm is an exporter and a value of two for ϕ_{it} indicates that the firm is a subsidiary of a *MNE*. Let Φ be an $n \times 1$ vector that contains each firm's indicator ϕ_{it} . Y denotes the observed outcome vector for all firms and $Y(\Phi)$ the potential outcome that will prevail if all firms had followed their treatment according to their indicator ϕ_{it} . Let $Y_i(\Phi)$ be the potential outcome of the ith firm. Assume that there are two possible treatment allocations for every firm Φ and Φ' respectively. Then, the Stable Unit Treatment Value assumption states that

$$Y_i(\Phi) = Y_i(\Phi') \quad \text{if} \quad \phi_i = \phi'_i \quad (2)$$

which means that the observed outcome for the ith firm depends only on its treatment and not on the treatment followed by other firms. This is a strong assumption, since it rules out any interaction between firms, like spillovers and other externalities. In the presence of such interactions, it is possible that the outcome variable might also be affected. For

exclude from the analysis firms that have been either exporters or subsidiaries in the past.

example, if there are spillovers between firms then the *TFP* of domestic firms might change due to a change in the *TFP* of exporters or firms that were acquired by multinationals. But the magnitude of these kind of effects will be small as long as the participants in the corresponding treatments are small relative to the population of the firms. There are studies in the labour market programmes evaluation literature, Blanchard and Diamond (1989) and (1990) for example, that try to estimate the effects in the case that the Stable Unit Treatment Value assumption is not fully satisfied. But such a task is not easy and generates other difficulties for the estimation of the causal effects⁹.

4.2 The Three Causal Effects and a Naive Estimator

There are three possible effects that can be estimated:

- a) the Average Treatment Effect (ATE)

$$E [Y^k - Y^l] \tag{3}$$

defined as the difference between the outcome expected after following treatment k and the outcome expected after following treatment l for a random firm from the entire population,

- b) the Average Treatment on the Treated (ATET)

$$E [Y^k - Y^l \mid \Phi = k] \tag{4}$$

is similar to the previous but with the difference that now the firm is selected from the subpopulation of the participants in treatment k , and

- c) the Average Treatment Effect on the Non-Treated (ATENT)

$$E [Y^k - Y^l \mid \Phi = l] \tag{5}$$

which is the difference in the expected outcome between the participants in treatment k and l , for a firm drawn from the subpopulation of those that participated in treatment l .

The estimate with the most interest is the Average Treatment Effect on the Treated, because it provides information about the causal effect on the outcome for those firms that have gone through a particular treatment had they decided to follow another one, instead. For example, the Average Treatment Effect on the Treated for exporters relative to domestic producers, $E [Y^{EX} - Y^{DP} \mid \Phi = EX]$, tell us what the gain or loss on *TFP* exporters experienced had they chosen to remain domestic producers. On the other hand,

⁹For more details see Frolich (2002).

the Average Treatment Effect would have provided an estimate of the causal effect of becoming an exporter relative to remaining domestic producer for the whole population of firms. Hence, the ATE would have included in the estimation and those firms that remained either domestic producers or were acquired by *MNEs*. The interest of this paper lays on the causal effect on *TFP* growth for those firms that became either exporters or subsidiaries of *MNEs* and for that reason the ATET is the appropriate causal effect to consider.

In order to highlight the presence of bias on the estimation if simultaneity is not taken in consideration, we consider the case of a naive estimator as it is termed in Blundell, Dearden and Sianesi (2004). This naive estimator involves the difference in expected outcomes between two firms that have followed treatments k and l respectively:

$$E [Y^k | \Phi = k] - E [Y^l | \Phi = l] = E [Y^k - Y^l | \Phi = k] + \{E [Y^l | \Phi = k] - E [Y^l | \Phi = l]\} \quad (6)$$

where the first term on the right hand side is the the Average Treatment Effect on the Treated (ATET) and the second term is the bias¹⁰ that arises from such a naive estimator. The reason is that the decisions made by firms to change status are systematic and consequently the sample of firms that take a decision is not random. Failing to take this into consideration and comparing firms that took a specific decision with those that they took a different one will result in biased estimates.

Hence, by comparing the observed outcomes of exporters and pure domestic firms is not an unbiased estimator of the causal effect of becoming an exporter, since exporters might self-select themselves into to foreign markets. A firm that is to become an exporter might have already¹¹ experienced an improvement in its *TFP*. If this is not taken into consideration and a naive estimator is calculated then an increase in the *TFP* of the new exporter might be wrongly attributed to the change of firm status.

As it was discussed above the correct estimation requires information about the expected outcomes of a firm had it followed both of the treatments. For example, the causal effect on *TFP* growth for a firm that has become an exporter would require information about the *TFP* of this firm had it remained a domestic producer, $E [Y^{DP} | \Phi = EX]$. But after treatment, only one of the potential outcomes is observed and the other is a counterfactual. There are methods that try to identify this counterfactual by imposing some structure and assumptions in the analysis and are discussed in the next section.

¹⁰Heckman and Robb (1985) and Manski (1991) had termed it selection bias.

¹¹Before the change in its status.

5 Identification Strategies

One way to solve the identification problem of the counterfactual is usually¹² to design and implement a randomised experiment. This would mean that firms are assigned randomly into the three different potential treatments. More formally, this would imply that the potential outcomes, Y^j , are statistically independent of the treatment Φ . Hence, in a randomised experiment the decision to go through a particular treatment is random and does not affect the potential outcome.

A randomised experiment ensures that any differences between firms that followed different treatments are random and not systematic. Hence, in such a setup the observed outcome for those that participated in treatment k has the same expected value as the potential outcome for those that participated in programme l ; $E[Y^k | \Phi = k] = E[Y^k | \Phi = l] = E[Y^k]$. As a consequence, under randomisation the naive estimator is applicable because there is no any selection bias. But randomisation in the context of the choice of the status of a firm is very difficult if not applicable at all.

For this reason this paper focuses on other approaches that have been suggested in order to tackle the problem of identification. The control for confounding variables approach, Rubin (1974), is one of them and is used here with some modifications. The control for confounding variables approach tries to reproduce the structure of a randomised experiment by constructing comparable groups with similar features. Assume there are two firms with very similar characteristics, then their potential outcomes should be very close. If these two firms differ only on the treatment that they have been through, then any difference in their observed outcomes should be attributed to the different treatment followed. If it is possible to find a lot of pairs similar to this, then the causal effect of treatment k relative to treatment l can be estimated. But for consistent estimation it is necessary that within each pair, firms have the same or very similar confounding variables X . The confounding variables X are variables that affect the decision to participate in a treatment and also affect the potential outcomes.

The use of the control for confounding variables approach allows the identification of the counterfactual outcome and consequently the estimation of all the three causal effects mentioned. But it requires that the Conditional Independence Assumption (CIA) for multiple treatments, Imbens (2000) and Lechner (2001), to be satisfied:

$$Y^{DP}, Y^{EX}, Y^{MA} \perp \Phi | X \tag{7}$$

(7) states that conditional on the confounding variables X , the treatment assignment in-

¹²Heckman and Smith (1995) discuss the potential bias that may arise in the case of random experiments.

indicator Φ is independent of the potential outcomes Y^j , $j = DP, EX, MA$. This means, that given all the confounding variables X , knowledge of the treatment followed by a firm does not provide any additional information about its potential outcome. It should be noted as Lechner (2002) points out that the Conditional Independence Assumption is not the minimal assumption that allows identification. The minimal assumption is conditional mean independence, which as Lechner (2002) says, empirically usually implies CIA.

The second necessary condition for identification in the case of multiple treatments is the common support requirement. Let $S^j = \{x : P(\Phi = j | X = x) > 0\}$ denote the support of X for the participants in treatment j , where $P(\Phi = j | X = x)$ is the probability of firm i with characteristics x follows treatment j . The support of X for treatment j , S^j , defines a subsample where all firms with characteristics x have a positive probability of following treatment j . The common support condition requires that for the identification of ATET, $E[Y^k - Y^l | \Phi = k]$, it is necessary that $S^k \subseteq S^l$. This means that any firm with characteristics x and positive probability of following treatment k should also belong to the support for the participants in treatment l . In other words, in order to be able to identify the ATET, $E[Y^k - Y^l | \Phi = k]$, those firms that had treatment k and those that had treatment l should share the same (common) support.

For the identification of ATE, $E[Y^k - Y^l]$, the common support condition requires a stronger assumption. That is $S^k = S^l = S$, where S is the union of all treatment supports, $S \cup S^j$. This implies that the support for the population and the two sub-populations should be the same, so that the probability for any observed firm with characteristics x is positive and very similar to the probability that any firm with characteristics x is following any of the treatments, either k or l .

Under the Conditional Independence Assumption and the common support requirement the following is true

$$E[Y^k | X, \Phi = k] = E[Y^k | X, \Phi = l] = E[Y^k | X] \quad (8)$$

which states that conditional on X the observed outcome Y^k for the firms that have followed treatment k has the same expected value as the potential outcome Y^k for those that followed treatment l . Consequently, all the three effects can now be identified. In particular, by following the law of iterated expectations the Average Treatment Effect can

be expressed in the following way:

$$\begin{aligned}
E [Y^k - Y^l] &= E [Y^k] - E [Y^l] & (9) \\
&= E_X [E [Y^k | X] - E [Y^l | X]] \\
&= \int \{E [Y^k | X, \Phi = k] - E [Y^l | X, \Phi = l]\} f_x dx
\end{aligned}$$

where f_x is the population probability density function of X and both $E [Y^k | X, \Phi = k]$ and $E [Y^l | X, \Phi = l]$ are identified and can be estimated from the data. Hence, the Average Treatment Effect is the difference of the expected outcomes given X of both treatment groups weighted by the population probability density function of X .

The Average Treatment Effect on the Treated is written as:

$$\begin{aligned}
E [Y^k - Y^l | X, \Phi = k] &= E [Y^k | X, \Phi = k] - E [Y^l | X, \Phi = k] & (10) \\
&= E [Y^k | X, \Phi = k] - E_X [E [Y^l | X, \Phi = k] | \Phi = k] \\
&= E [Y^k | X, \Phi = k] - \int \{E [Y^l | X, \Phi = l]\} f_{(x|\Phi=k)} dx
\end{aligned}$$

where $f_{(x|\Phi=k)}$ is the probability density function of X among the participants in programme k . The first part of the left hand side, $E [Y^k | X, \Phi = k]$, is identified and can be estimated directly from the data, while the second part, $\int \{E [Y^l | X, \Phi = l]\} f_{(x|\Phi=k)} dx$, needs to be estimated non-parametrically. The estimation of the second part proceeds by adjusting the expected outcome of participating in treatment l for the distribution of firm characteristics X for the participants in treatment k .

Similarly, the Average Treatment Effect on the Non-Treated (ATENT) is:

$$\begin{aligned}
E [Y^l - Y^k | X, \Phi = l] &= E [Y^l | X, \Phi = l] - E [Y^k | X, \Phi = l] & (11) \\
&= E [Y^l | X, \Phi = l] - E_X [E [Y^k | X, \Phi = l] | \Phi = l] \\
&= E [Y^l | X, \Phi = l] - \int \{E [Y^k | X, \Phi = k]\} f_{(x|\Phi=l)} dx
\end{aligned}$$

where $f_{(x|\Phi=l)}$ is the probability density function of X among the participants in programme l . The Average Treatment Effect on the Non-Treated is the difference on the potential outcomes between treatments k and l averaged over the probability density function of the participants in the l th treatment.

6 The Curse of Dimensionality and Propensity Score Matching

The matching estimator for the ATET, $E [Y^k - Y^l | X, \Phi = k]$, tries to find for each firm that participated in treatment k at least one firm that participated in treatment l with identical or very similar confounding variables X . If many pairs like this can be found then the causal effect on Y of following treatment k relative to l is obtained by averaging the difference between the observed outcomes of the matched pairs. Hence, the matching estimator needs to condition on a usually high dimensional vector of X . This creates computational difficulties because the estimation of $\int \{E [Y^l | X, \Phi = l]\} f_{(x|\Phi=k)} dx$ is non-parametric and results on the so called curse of dimensionality. Rosenbaum and Rubin (1983) have shown that conditioning instead on a scalar function of X , the propensity score¹³, is sufficient for identification in the case of a single treatment. Furthermore, propensity score matching implies that the subsamples of the treated and non-treated groups should have very similar distributions for variables X (Balancing Property) and as a consequence the quality of "matching" is improved. For multiple treatments Lechner (2001) showed that conditional independence on X implies conditional independence on the propensity score $p^{k|kl}(x)$ and consequently the CIA can be re-written as:

$$Y^l \perp \Phi | p^{k|kl}(x), \Phi \in \{k, l\} \quad (12)$$

where $p^{k|kl}(x) = \frac{p^k(x)}{p^k(x)+p^l(x)}$ is the probability of being a participant of the k th treatment instead of participating on treatment l and $p^j(x) = P(\Phi = j | X)$ is the marginal probability of participating in treatment j given characteristics X . (12) states that conditional on the propensity score $p^{k|kl}(x)$ the choice of treatment is independent of the potential outcome Y^l . So both (9), (10) and (11) can be estimated but with the difference that in this case we need to average over the distribution of the propensity score $p^{k|kl}(x)$ and not the probability density function of X . For example, in the case of ATET (10) the second part of the left hand side is going to be

$$\begin{aligned} E [Y^l | X, \Phi = k] &= E_X [E [Y^l | p^{k|kl}(x), \Phi = l] | \Phi = k] \\ &= \int \{E [Y^l | p^{k|kl}(x), \Phi = l]\} f_{(p^{k|kl}|\Phi=k)}(p^{k|kl}) dp^{k|kl} \end{aligned} \quad (13)$$

¹³The propensity score in the case of a single treatment is defined as the probability of participating in the treatment.

where $f_{(p^{k|kl}|\Phi=k)}$ is the density of the probability to participate in treatment k instead of participating in treatment l in the subpopulation of k .

There are several estimators that are suggested and can be summarised in the following generalised matching estimator (GME) for the ATET, as discussed in Frolich (2002):

$$GME = \frac{1}{n_k} \sum_{i=1}^{n_k} \hat{\theta}_l(p^{k|kl}(x_i)) \quad (14)$$

where n_k is the number of participants in treatment k and $\hat{\theta}_l(x)$ is an estimate of the expected outcome of participating in treatment l for those that actually participated in l , conditional on the propensity score of the firms that followed treatment k , $\theta_l(x) = E[Y^l | p^{k|kl}(x_i), \Phi = l]$. GME is implemented by adjusting the estimate of the conditional expectation $\hat{\theta}_l(x)$ for the distribution of $p^{k|kl}(x_i)$ on the subpopulation k and then averaging $\hat{\theta}_l(x)$ for the values of $p^{k|kl}(x_i)$.

One of the most frequently used estimator is the pair-matching estimator, Rubin (1974), and is implemented here with some modifications. It advances by finding, "matching", for every observation in the treated (target) group an observation in the non-treated (control) group with the same or very similar propensity score. Hence, the observations from the control group that are used as "matches" are forced to follow the distribution of the propensity score from the target group as (13) indicates. Pair-matching finds only one "match", the most similar in terms of propensity score, for every observation in the treated sub-sample. It ignores all other observations in the control group that might have slightly more distant values of propensity score. The only exception occurs, when there are more than one observations in the non-treated sub-sample with propensity scores that are equally distanced from the propensity score of an observation in the treated sub-sample. In this case, the average outcome of these non-treated observations is used for the estimation of the counterfactual.

In the analysis of this paper I use pair-matching with replacement on the propensity score. This implies that each observation from the control group can be used more than once as a "match". For example, when three "matches" are allowed, the same observation from the non-treated group can be used as a "match" for observations in the treated group for a maximum of three times. This results to a higher variance for the estimates, but improves the quality of matches and has been suggested as a way to eliminate any bias that arises from non exact matching¹⁴.

The problem of bias in the case of not exact matching can also be dealt with the use of

¹⁴Abadie and Imbens, "Simple and Bias-Corrected Matching Estimators for Average Treatment Effects", NBER, WP 283, 2002.

bias-corrected matching estimators, see Abadie, Drukker, Herr and Imbens (2004). These estimators adjust the difference on the outcomes between the "matched" observation and the "match" by including the difference on their propensity score. Another issue regarding the matching estimator is that usually the conditional variance of outcome j for firm i given its propensity score, $var(Y_i^j | p^{k|kl}(x_i))$, is assumed to be constant across different propensity scores ($p^{k|kl}(x_i)$) and treatments j . Here I implement estimators that take into consideration both potential problems and correct for the possible bias from a "poor" quality matching and also allow the conditional variance of outcome to be heteroscedastic.

Furthermore, I check whether the Balancing Property of propensity score matching is satisfied by performing a formal test proposed by Smith and Todd (2005). Finally, since the Conditional Independence Assumption does not hold in the sample I follow Lechner (2002) and I carry out matching on a new restricted sample, in which the Conditional Independence Assumption is imposed.

7 Data Description

The dataset that is used is primarily extracted from the OneSource database¹⁵ for the UK from 1990 to 1996. It is an unbalanced longitudinal set that includes all public and private limited companies that employ more than fifty employees. There are 110,000 companies in total and any of them that were in the process of liquidation or dissolved have been excluded from the sample. Due to the fact that only firms with fifty or more employees are included in the database, it is very likely that the sample is biased towards larger firms. But this should not create problems within the context of the analysis that is implemented. Exporters and multinational subsidiaries are generally employing more than fifty employees and matching them with domestic producers of the same size in order to form comparable groups seems to be validated.

Additionally, OneSource contains information among other variables on employment, physical capital, output, sales, exports, ownership status and the age of firms. Although the database provides information of foreign ownership for the latest year, this is not sufficient in order to observe the time that a British firm was acquired by a foreign multinational company. For that reason, our sample was matched to a list of British subsidiaries of foreign multinational companies that it was provided by the Office of National Statistics. In addition, OneSource does not offer any information on whether British firms are acquired by British *MNEs*. In order to identify these subsidiaries of domestic *MNEs* our sample was once again matched with the European Linkages and International Ownership Structure

¹⁵OneSource CD-ROM, "UK companies, vol. 1", October 2000.

(ELIOS) database¹⁶.

The analysis concentrates on the manufacturing sector only. Furthermore, any firms that had an annual employment or output growth higher than 100% are dropped from the sample¹⁷, on the ground that such observations tend not to be reliable. In order to get the final sample I divide the original one into two years subsamples 90-91, 91-92, 92-93, 93-94, 94-95 and 95-96. Within each two years subsample, all firms that are either exporters or subsidiaries of multinationals at the earlier year are excluded. I do so because I am interested on the causal effect of a firm's status change on its *TFP* growth. If a firm has already gone through "treatment" in the earliest time period that is observed, then it does not provide any useful information for the analysis. For each subsample the same firms are observed in either year. All firms are domestic producers in the earliest year of every subsample and in the next year some of them switch (becoming exporters or subsidiaries of *MNEs*) while others remain domestic producers.

The final sample is constructed by merging all two years subsamples and amounts to 34,752 observations. It includes information on an unbalanced panel of more than 14,113 British firms in the manufacturing sector for the period from 1990 to 1996 as Table 1 shows. Firms are divided into three types: pure domestic (non-exporters), exporters and firms acquired by domestic and foreign multinationals. There are between 2,441 and 3,137 firms each year and all of them are observed at least for two consecutive years. The earlier partition of the sample into two years overlapping subsamples is the reason why in the first and last year there are fewer observations than in other years as Table 1 shows.

From Table 1 it is also evident that the sample is balanced through the years with regard to the volume of new exporters and new subsidiaries of *MNEs*. The highest number of new exporters is observed in the last year 1996, when 120 British firms began to export, while the minimum was in the year before with only 94 new exporters. Similarly, 1994 was the year with the most acquisitions of British firms by *MNEs*, 75 in total and the year before a minimum of 41 new acquisitions took place. In total, over all the years in the sample there were 624 new exporters and 356 new subsidiaries of *MNEs* in the British manufacturing.

It is clear from Table 1 that changes in the status of firms are not happening at the same time. Hence, I treat the timing of a change in status as an "experimental time" t_e in order to proceed with matching. Observations are grouped according to two "experimental" periods. The first is "experimental" time period zero, t_e^0 , in which all firms are domestic producers and the second is "experimental" time period one, t_e^1 , where some firms have

¹⁶The ELIOS database was constructed by the University of Urbino, Italy.

¹⁷I should greatly acknowledge Dr Surafel Girma for providing me with the sample of the data.

experienced a change in their status¹⁸. Table 2 shows that there are 17,376 domestic producers at "experimental" time period zero and in the next "experimental" time period 624 of them became exporters and 356 were acquired by *MNEs*. It is clear from the above discussion about the construction of the data that all the results refer to short-time causal effects, one year after the change of a firm's status.

8 Results

I perform propensity score matching allowing for replacement, bias adjustment and heteroscedastic variances in order to estimate the Average Treatment Effect on the Treated for three cases. These are the causal effects on *TFP* growth for British firms of: i) becoming exporters in relation to remaining domestic producers, ii) becoming subsidiaries of *MNEs* compared with remaining domestic producers and iii) beginning to export relative to being acquired by *MNEs*. This requires knowledge about each firm's propensity score for all the three cases. Therefore, I estimate a Multinomial Logit model on the entire sample so as to get estimates of the marginal probability for each firm to be in one of the three statuses conditional on a set of variables X . Let ϕ_i indicate the status j of the i th firm

$$\phi_i = j \begin{cases} 0, & \text{if domestic producer} \\ 1, & \text{if exporter} \\ 2, & \text{if acquired by multinational} \end{cases} \quad (15)$$

Assuming that the errors are independent and identically distributed across different statuses with a log Weibull (type I extreme value) distribution, $G(u_{ij}) = \exp(-e^{-u_{ij}})$. The probability that status j is observed for firm i given X is:

$$\Pr(\phi_i = j) = \frac{\exp(\beta_j x_{ij})}{\sum_{j=0}^2 \exp(\beta_j x_{ij})} \quad (16)$$

where x_{ij} includes the logarithm of lagged employment, the logarithm of lagged physical capital and lagged age of the firm. I use one year lagged values for the X variables in an attempt to capture the sequential nature of a firm's decision to change status. The log of the odds for the multinomial logit are given in Table 3. All parameters, with the exception of the two employment coefficients, are statistically significant at the 1% level. There are 30,675 observations in the estimation, because there are missing values for some of the

¹⁸This is achieved using the two years subsample discussed earlier.

lagged X variables.

The assumption about the identical and independent distribution of the errors across statuses implies that the log of the odds for any pair of statuses does not depend on any others. This is referred to as the Independence of Irrelevant Alternatives (IIA) assumption. I test for the Independence of Irrelevant Alternatives assumption using the Small-Hsiao specification and I find that it is satisfied by the data as it is shown in Table 4.

The Small-Hsiao Test for the IIA proceeds as follows: First the entire sample is divided into two random subsamples of the same size. Estimates are obtained from the two subsamples. Then one of the two subsamples is chosen (unrestricted model) and all of its observations associated with a particular status are eliminated. This restricted model is estimated again. Finally, a typical Likelihood Ratio (LR) test is calculated, with the LR statistic of the form $-2[\text{likelihood function (restricted)} - \text{likelihood function (unrestricted)}]$ following a chi-square distribution with degrees of freedom equal to the number of parameters in the restricted model.

The null hypothesis declares that status j and status h are independent of other statuses. For example, in the first row of Table 4 the null hypothesis is that the log of the ratio of the probability that a firm is an exporter relative to the probability that it is a domestic producer is not affected by the other available statuses. Table 4 shows that this null hypothesis cannot be rejected at very high levels of significance. The IIA assumption cannot be rejected for the other two cases either at the 5% level as it is evident from Table 4. This implies that a firm's choice between the two statuses does not depend on the availability of other statuses. Hence, the distinction between domestic producers, exporters and subsidiaries of *MNEs* in the analysis also seems to be valid econometrically.

The descriptive statistics of marginal probabilities by the status of the firm are presented in Table 5. Their mean values and standard deviations are quite similar across firms with different status. It is clear from Table 5 that the Common Support requirement is not satisfied in the case of the ATET of exporting relative to remaining domestic producer. Although the maximum value of the probability $\Pr(\phi = 1)$ for an exporter (5.72) is smaller than the corresponding maximum value for a domestic producer (7.49), the minimum value for exporters (0.70) is smaller than that for domestic producers (0.73). This implies that the support for the exporters $[0.70, 5.72]$ is not a subset of the support for the domestic producers $[0.73, 7.49]$ as the Common Support condition demands for the estimation of the ATET. The Common Support Condition is not satisfied either in the case of the ATET of beginning to export relative to becoming a subsidiary of a *MNE*. Again, the support of exporters $[0.70, 5.72]$ is not a subset of the support for the subsidiaries of *MNEs* $[0.87, 4.93]$. Only in the last case the of ATET of being acquired by a *MNE* relative to remaining a

domestic producer the Common Support condition holds, because as it can be seen from Table 5 the support for subsidiaries of *MNEs* [0.35, 4.21] belongs to the support for domestic consumers [0.18, 6.28].

The fact that the Common Support is not satisfied by the data, suggests that the estimate of ATET might not be accurate. The reason is that failure of the Common Support condition indicates that for some observations in the treated group there are no comparable observations in the control and consequently the counterfactual cannot be identified. A possible solution is to restrict the analysis and perform matching on the subsample of the data, where the Common Support requirement holds. In such a case the ATET, $E[Y^k - Y^l \mid X, \Phi = k]$, is redefined as the causal effect for only those observations that satisfy the Common Support condition.

Following Lechner (2002), I exclude all observations with probabilities lower than the highest value of the minimum probability across statuses. Analogously, I delete all observations with probabilities greater than the lowest value of the maximum probability between different statuses. This results to dropping 4,411 observations, 12.69% of the sample. This is a quite large part of the sample, but about 99% of the observations dropped were for domestic producers that are the most populous group in the data. The remaining 29,372 observations of domestic producers in contrast to the 33,772 in the initial sample still seem to be a good representation of the British firms serving the domestic market. This is also evident from the very similar results produced by propensity score matching on the Common Support and the whole sample as Table 6 and Table 7 present respectively.

Equation (13) has been estimated having as outcome variable the annual total factor productivity growth of British firms in manufacturing. *TFP* growth has been estimated from a translog production function using Generalised Least Squares¹⁹. Pair-Matching is performed on the propensity score with replacement, allowing for a maximum of four matches for each observation on the control group. Table 6 also includes estimates that correct for bias estimation arising from not exact matching (bias adj) and also estimates that allow for heteroscedastic variances of statuses (robust).

From Table 6 it is evident that the ATET for exporters relative to domestic producers in UK is positive and significant at a 5% level of significance for all numbers of matches and variations of estimation. The smallest estimate is just above 7.79% when the number of matches is one and the maximum is above 8.79% when the number of matches is two. This result strongly supports the argument that domestic firms that become exporters gain in terms of productivity. In particular, firms that became exporters gained on average

¹⁹I would like to thank Dr Surafel Girma for providing me with the initial data that also contained the growth of TFP for each firm.

between 7.79 and 8.79 percentage points on their annual productivity a year after the change in their status.

The gains for the firms that were acquired by multinationals relative to domestic producers in UK were even higher and again significant at 5% level. Firms acquired by multinationals had on average experienced an increase in their productivity growth ranging from 11.55% to 13.09% relative to domestic producers a year after they became subsidiaries of *MNEs*. This result verifies empirically the hypothesis that multinational firms have a superior technology compared to domestic producers in UK and are able to transfer this technological advantage to their subsidiaries. This is observed as a higher *TFP* growth for the subsidiaries of *MNEs* when compared with firms only producing for the domestic market.

In contrast, the ATET for exporters relative to firms acquired by multinationals is negative but significant at 6% only when one match and heteroscedastic variance are allowed. For the rest of the cases the level of significance is between 7% and 10%. The 6% statistically significant effect has a coefficient of -9.95% indicating that exporters have on average a lower annual *TFP* growth of almost ten percentage points compared to firms that have been acquired by multinationals. The rest of the estimates present a similar picture showing a lower productivity for exporters varying from just below 8.6% to almost 9.95%, but are significant at a 10% level.

It is clear from the above discussion and Table 6 that the number of "matches" allowed in the estimation has an impact only on the magnitude and not the sign of the estimates or the level of significance²⁰. But even the changes on the magnitude of the estimates are of a quite small size. The maximum difference was 1.54% for the ATET between subsidiaries and domestic producers when one and two "matches" were used. Equally, the bias-correction estimation does not alter significantly the magnitude of the estimates compared to the basic estimation. For most cases, a change in the estimates is observed at the seventh decimal point, while the highest difference occurred at the fourth decimal point. This suggests that there is no problem of non exact matching and that the "quality" of the matching is very high. Moreover, allowing for heteroscedastic variance in the estimation reduces the standard error of the estimates, as expected, but not substantially as it seen from Table 6.

To test the Balancing Property of the Propensity Score I perform a test proposed by

²⁰The only exception is for the ATET between exporters and subsidiaries of *MNEs* when heteroscedastic variances are allowed. When one "match" is allowed, the effect is statistically significant at a 6% level, but for the rest numbers of "matches" it is significant at a 10% level.

Smith and Todd (2005) that suggests running a regression of the following form:

$$x_i = \alpha + \sum_{\rho=1}^4 \beta_{\rho} PSC(X)^{\rho} + \sum_{\rho=1}^4 \gamma_{\rho} [D \times PSC(X)^{\rho}] + u \quad (17)$$

where x_i indicates each of the X variables used to estimate the Multinomial Logit. $PSC(X) = \frac{\Pr(\Phi=j)}{\Pr(\Phi=j)+\Pr(\Phi=h)}$ denotes the propensity score that status j occurs relative to status h .

D is a dummy variable taking the value of one when $\Phi = j$ and the value of zero when $\Phi = h$. The null hypothesis that the coefficients γ_{ρ} are jointly statistically insignificant implies that the balancing property of the propensity score holds. The intuition behind the test is that, if the Balancing Property is satisfied then the decision to change status D conditional on the propensity score does not affect any of the x_i . In other words, the test seeks to check whether there are differences on x_i for those that have $D = 0$ against those that have $D = 1$. The results of the Balancing Property test are presented in Table 8. The null hypothesis that the γ_{ρ} coefficients are jointly statistically insignificant at the 5% level is satisfied in 7 out of 9 cases. Hence, there seems to be evidence that the Balancing Property holds for the great majority of the cases.

9 Conclusions

This paper has tried to assess the causal effects of a change in the status of firms in terms of potential total factor productivity gains. There is a vast literature that highlights the possible gains for different measures of performance, like *TFP*, labour productivity and size, for firms that enter foreign markets through exports. They have also highlighted and analysed theoretically and empirically the problems of causality within this analysis, Roberts and Tybout (1997) and Clerides et al (1998) among others. There is also a growing literature on the gains of horizontal *FDI* or acquisition of firms by multinationals, Helpman et al (2004) and Head and Ries (2003). The purpose of this paper is to analyse and empirically estimate the causal effects of a change in the status of firms from pure domestic producers to either exporters or firms that have been acquired by multinationals and also the effect of becoming an exporter relative to a subsidiary of a *MNE*.

There are simultaneity problems that have been highlighted in the literature of evaluation methods that is mainly concern about the effectiveness of labour market programmes, Blundell, Dearden and Sianesi (2005) for example. Motivated by this literature and also by some new research on applied international trade that employed these techniques in the case of a single treatment, Girma et al (2004) and Wagner (2002), I have tried to analyse

the effects described above within the context of multiple treatments methods and this is the most significant novelty of the paper. Multiple treatment matching methods are able to identify the counterfactual and consequently estimate causal effects.

The matching technique in the case of multiple treatments has been used having as different treatments three possible statuses for a firm. These are: i) domestic producer, ii) exporter and iii) subsidiary of a multinational company. Pair-matching on the propensity score with replacement was implemented, allowing for a maximum of four "matches" for each observation in the target group for the estimation of each ATET. The marginal probabilities on being in any of these three possible statuses were estimated by a Multinomial Logit model, where the variables X affecting each of the decisions were lagged employment, lagged physical capital and lagged age of the firm. Descriptive statistics of the resulting estimates for the marginal probabilities by status are presented in Table 5, from where it is clear that the probability of being a domestic producer is by far the higher reflecting the big number of pure domestic firms in our sample.

The estimated ATETs presented in Table 6 are for the sample that it is restricted to satisfy the Common Support condition. It shows that the short-term *TFP* gains for exporters relative to domestic producers are between 7.79% and 8.79% depending on the number of matches allowed and are all significant at a 5 % level of significance. Identical in sign and again statistically significant at a 5% level, but higher in magnitude are the gains experienced by subsidiaries of multinationals relative to domestic producers, one year after the acquisition. On average firms that were acquired by *MNEs* had a higher annual productivity growth between 11.55% to 13.09% relative to domestic producers. Finally, the difference in *TFP* growth, one year after the change in status, between exporters and firms that were acquired by *MNEs* was negative for all the number of matches. But only one was significant at the 6% level with a value of 9.94%. The rest of the estimates were ranging between 8.58% and 9.49% less productivity for exporters, but only significant at the 10% level.

Concluding, it can be said that new exporters experience higher *TFP* growth, between 7.79% to 8.79% a year after beginning to export, with respect to domestic producers. Productivity gains were also experienced for firms acquired by multinationals relative to domestic producers ranging from 11.55% to 13.09%, after controlling for the likely problems of simultaneity in our analysis.. In both of these case all the effects estimated were statistically significant at the 5% level. The last case, which assessed the difference in *TFP* between exporters and firms that were acquired by *MNEs* had only one significant estimate at 6% level. This suggests that exporters have a lower annual *TFP* growth compared to firms acquired by *MNEs* by around 9.95 percentage points, but this result is less robust.

References

1. Abadie, A., D. Drukker, J. L. Herr, and G. W. Imbens, (2004). "Implementing matching estimators for average treatment effects in Stata", *Stata Journal*, vol. 4, issue 3, pp. 290-311.
2. Alvarez R. and Lopez R., (2005), "Exporting and performance: evidence from Chilean plants", *Canadian Journal of Economics*, vol. 38, no 4, pp 1384-1400.
3. Arellano, M., and S. Bond, (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, vol. 58, pp. 277-297.
4. Baldwin R. E., (1989), "Sunk-Cost Hysteresis", NBER working paper No 2911.
5. Bernard A. and Jensen B., 1999, "Exceptional Exporter Performance: cause, effect, or both?" *Journal of International Economics*, vol. 47, pp. 1-25.
6. Bernard A. and Jensen B., (2004), "Why Some Firms Export", *Review of Economics and Statistics*, vol. 86, issue 2, pp 561-569.
7. Blanchard O. and Diamond P., (1989), "The Beveridge Curve", *Brookings Paper on Economic Activity*, vol. 1, pp.1-60.
8. Blanchard O. and Diamond P., (1990), "The Aggregate Matching Function", in *Growth, Productivity, Unemployment, Essays to Celebrate Bob Solow's Birthday*, ed. by P. Diamond, pp. 159-201, MIT Press, Cambridge.
9. Blundell R. and Costa-Dias M., (2000), "Evaluation methods for non-experimental data", *Fiscal Studies*, Vol. 21, No. 4, pp. 427-468.
10. Blundell R., Dearden L. and Sianesi B., (2005), "Evaluating the effect of education on earnings: models, methods and results from the National Child Development Survey", *Journal of the Royal Statistical Society: Series A*, Vol. 168, No. 3, pp. 473-512.
11. Clerides S., Lach S. and Tybout J., (1998), "Is Learning By Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico and Morocco", *Quarterly Journal of Economics*, vol 113, issue 3, pp 903-947.
12. Conyon M., Girma S., Thompson S. and Wright P., (2002), "The Productivity and Wage Effects of Foreign Acquisition in the United Kingdom", *The Journal of Industrial Economics*, vol 1, no 1, pp 85-102.
13. Frolich M, (2002), "Programme Evaluation with Multiple Treatments", Discussion paper no 202-17, Dept. of Economics, University of St. Gallen.
14. Dixit A., (1989), "Entry and Exit Decisions Under Uncertainty", *Journal of Political Economy*, vol. 97, iss. 3, pp. 620-638.
15. Girma S. and Gorg H., (2007), "Multinationals' Productivity Advantage: Scale or Technology?", *Economic Inquiry*, vol. 45, no. 2, pp 350-362.

16. Girma S., Greenaway D. and Kneller R., (2003), "Export Market Exit and Performance Dynamics: A Causality Analysis of Matched Firms", *Economics Letters*, vol 80, pp 181-187.
17. Girma S., Greenaway D. and Kneller R., (2004), "Does Exporting Increase Productivity? A Microeconometric Analysis of Matched Firms", *Review of International Economics*, vol. 12, iss. 5, pp 885-866.
18. Girma S., Kneller R and Pisu M., (2005), "Exports versus FDI: An Empirical Test", *Review of World Economics/Weltwirtschaftliches Archiv*, vol 141, iss. 2, pp 193-218.
19. Harris R. and Robinson C., (2002), "The Effect of Foreign Acquisitions on Total Factor Productivity: Plant-level Evidence From U.K. Manufacturing, 1987–1992", *Review of the Economics and Statistics*, vol 84, no 3, pp 562-568.
20. Head K. and Ries J., (2003), "Heterogeneity and the FDI versus Export Decision of Japanese Manufacturers", *Journal of Japanese International Economics*, vol. 17, pp. 448-467.
21. Heckman J., (1981), "The Incidental Parameters Problem and the Problem of Initial Conditions in Estimating a Discrete Time-Discrete Data Stochastic Process," in C. Manski and D. McFadden, eds., *Structural Analysis of Discrete Data with Econometric Applications* (Cambridge, MA: MIT Press).
22. Heckman J. and Robb R., (1985), "Alternative Methods for Evaluating the Impact of Interventions", in *Longitudinal Analysis of Labour Market Data*, ed. by J. Heckman and B. Singer, Cambridge University Press, Cambridge.
23. Heckman J. and Smith j., (1995), "Assessing the Case of Social Experiments", *Journal of Economic Perspectives*, vol. 9, pp. 85-110.
24. Heckman J. and Navarro-Lozano S., (2003), "Using Matching, Instrumental Variables and Control Functions to Estimate Economic Choice Models", IZA discussion paper No. 768.
25. Helpman E., Melitz M. J., Yeaple S. R., (2004), "Export Versus FDI with Heterogenous Firms", *American Economic Review*, vol.. 94, iss. 1, pp.300-316.
26. Imbens G., (2000), "the Role of the Propensity Score in Estimating Dose Response Functions", *Biometrika*, vol. 87, pp. 706-710.
27. Keane M. P., (1994), "A Computationally Practical Simulation Estimator for Panel Data", *Econometrica*, vol. 62, iss.1, pp. 95-116.
28. Krugman P., (1989), "Exchange-Rate Instability", Cambridge: MIT Press.
29. Lechner M., (2001), "Identification and Estimation of Causal Effects of Multiple Treatments Under the Conditional Independence Assumption", in *Econometric Evaluation of Labour Market Policies*, ed. by M. Lechner and P.Pfeiffer, pp. 43-58, Physica/Springer,

Heidelberg.

30. Lechner M., (2002), "Some Practical Issues in the Evaluation of Heterogeneous Labour Market Programmes by Matching Methods", *Journal of Royal Statistical Society, Series A*, 165, pp. 59-82.
31. Manski C., (1991), "Anatomy of the Selection Problem", *Journal of Human Resources*, vol. 24, pp. 343-360.
32. OneSource CD-ROM, "UK companies, vol. 1", October 2000.
33. Roberts M. and Tybout J., (1997), "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs", *American Economic Review*, September, pp 545-564.
34. Rosenbaum P. and Rubin D., (1983), "The Central Role of the Propensity Score in Observational Studies for Causal Effects", *Biometrika*, vol. 70, pp. 41-55.
35. Rubin D., (1974), "Estimating Causal Effects of Treatments in Randomized and Non-randomized Studies", *Journal of Education Psychology*, vol. 66, pp. 688-701.
36. Rubin D., (1980), "Comment on Randomization Analysis of Experimental Data: The Fisher Randomization Test by B. Basu", *Journal of the American Statistical Association*, vol. 91, pp. 267-275.
37. Smith J. and Todd P., (2005), "Rejoinder", *Journal of Econometrics*, vol. 125, pp 365-375.
38. Wagner J., (2002), "The Causal Effects of Exports on Firm Size and Labour Productivity: First Evidence From a Matching Approach", *Economic Letters*, vol 77, pp 287-292.

Table 1: DESCRIPTIVE STATISTICS OF SAMPLE
all years

year	Treatment (Status)			Total
	pure domestic	exporters	<i>MNE</i> acquired	
1990	2,441	0	0	2,441
1991	4,976	115	58	5,149
1992	5,348	102	67	5,517
1993	5,658	98	41	5,797
1994	5,985	95	75	6,155
1995	6,273	94	63	6,430
1996	3,091	120	52	1,677
Total	33,772	624	356	34,752

Table 2: DESCRIPTIVE STATISTICS OF SAMPLE
Experimental Time

Experimental Time	Treatment (Status)			Total
	pure domestic	exporters	<i>MNE</i> acquired	
0	17,376	0	0	17,376
1	16,396	624	356	17,376
Total	33,772	624	356	34,752

Table 3: MULTINOMIAL LOGIT
Log of the Odds

		coef	std error	p-value
$\frac{\Pr(\phi_i=0)}{\Pr(\phi_i=2)}$	age	0.007	0.002	0.004
	log employment	0.010	0.063	0.869
	log capital	-0.213	0.049	0.000
	constant	6.706	0.378	0.000
$\frac{\Pr(\phi_i=1)}{\Pr(\phi_i=2)}$	age	0.020	0.003	0.000
	log employment	-0.063	0.079	0.429
	log capital	-0.249	0.060	0.000
	constant	3.269	0.466	0.000
Observations	30675	LR test of joint significance		
Log likelihood	-4922	χ^2 (p-value)		0.000
Pseudo R^2	0.0118			

Table 4: SMALL-HSIAO TEST FOR THE IIA ASSUMPTION
Ho: outcome j vs outcome h are independent of others

Outcome j	Outcome h	χ^2	p-value	Evidence
1	0	0.947	0.918	Ho true
1	2	8.416	0.077	Ho true
0	2	2.811	0.590	Ho true

Table 5: DESCRIPTIVE STATISTICS OF MARGINAL PROBABILITIES (%) BY STATUS

Marginal Probabilities	domestic producer	exporter	subsidiary of MNE
Pr($\phi_i = 0$)			
mean	96.80	96.70	96.80
std. dev	0.005	0.006	0.005
min	92.17	92.89	94.22
max	97.83	97.57	97.57
Pr($\phi_i = 1$)			
mean	2.03	2.22	1.86
std. dev	0.006	0.007	0.005
min	0.73	0.70	0.87
max	7.49	5.72	4.93
Pr($\phi_i = 2$)			
mean	1.16	1.06	1.33
std. dev	0.004	0.004	0.004
min	0.18	0.30	0.35
max	6.28	6.40	4.21
Observations	(29695)	(624)	(356)

Table 6: CAUSAL EFFECTS ON *TFP* GROWTH (%)
common support; standard error $\times 100$ in parenthesis

ATET	number of matches				bias robust adj.	
	one	two	three	four		
exporter vs domestic producer	7.79590*** (3.099)	8.79102*** (2.947)	8.22852*** (2.774)	8.00229*** (2.700)	no	no
	7.79584*** (3.0.99)	8.79101*** (2.947)	8.22856*** (2.774)	8.00227*** (2.700)	yes	no
	7.79590*** (2.711)	8.79102*** (2.815)	8.22852*** (2.728)	8.00229*** (2.675)	no	yes
subsidiary of <i>MNE</i> vs domestic producers	11.55923*** (3.926)	13.09936*** (3.713)	12.18942*** (3.550)	12.46378*** (3.441)	no	no
	11.55941*** (3.926)	13.09964*** (3.712)	12.18955*** (3.550)	12.46364*** (3.441)	yes	no
	11.55923*** (3.461)	13.09936*** (3.564)	12.18942*** (3.439)	12.46378*** (3.330)	no	yes
exporter vs subsidiary of <i>MNE</i>	-9.95368* (5.840)	-8.58146* (5.283)	-9.49664* (5.154)	-8.93627* (5.057)	no	no
	-9.94769* (5.840)	-8.58231* (5.283)	-9.49665* (5.154)	-8.93506* (5.057)	yes	no
	-9.95368** (5.116)	-8.58146* (5.053)	-9.49664* (5.211)	-8.93627* (5.161)	no	yes

***, ** and * indicate 1%, 6% and 10% level of significance, respectively

Table 7: CAUSAL EFFECTS ON *TFP* GROWTH (%)
whole sample; standard error $\times 100$ in parenthesis

ATET	number of matches				bias robust adj.	
	one	two	three	four		
exporter vs domestic producer	7.77871*** (3.066)	8.57184*** (2.907)	8.05816*** (2.739)	8.04524*** (2.671)	no	no
	7.77850*** (3.066)	8.57184*** (2.907)	8.05822*** (2.739)	8.04535*** (2.671)	yes	no
	7.77871*** (2.685)	8.57184*** (2.793)	8.05816*** (2.705)	8.04524*** (2.652)	no	yes
subsidiary of <i>MNE</i> vs domestic producers	11.31803*** (3.924)	12.87603*** (3.714)	11.89894*** (3.535)	12.54700*** (3.418)	no	no
	11.31754*** (3.924)	12.87727*** (3.714)	11.89982*** (3.535)	12.54666*** (3.418)	yes	no
	11.31803*** (3.451)	12.87603*** (3.524)	11.89894*** (3.419)	12.54700*** (3.317)	no	yes
exporter vs subsidiary of <i>MNE</i>	-9.96814* (5.806)	-8.30246* (5.218)	-9.55183* (5.098)	-9.38215* (5.011)	no	no
	-9.97213* (5.806)	-8.30713* (5.218)	-9.55408* (5.099)	-9.38403* (5.011)	yes	no
	-9.96814*** (5.073)	-8.30246* (4.970)	-9.55183* (5.125)	-9.38215* (5.048)	no	yes

***, ** and * indicate 1%, 5% and 11% level of significance, respectively

Table 8: BALANCING PROPERTY TEST

$$H_0 : \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$$

Propensity Score	y_x		
	age	employment	capital
$\frac{\Pr(\phi_i=1)}{\Pr(\phi_i=1)+\Pr(\phi_i=0)}$	reject H_0 (0.026)	reject H_0 (0.032)	accept H_0 (0.072)
$\frac{\Pr(\phi_i=1)}{\Pr(\phi_i=1)+\Pr(\phi_i=2)}$	accept H_0 (0.363)	accept H_0 (0.437)	accept H_0 (0.405)
$\frac{\Pr(\phi_i=2)}{\Pr(\phi_i=2)+\Pr(\phi_i=0)}$	accept H_0 (0.494)	accept H_0 (0.447)	accept H_0 (0.529)

p-values in parenthesis