IMPORTS, PRODUCTIVITY AND GLOBAL VALUE CHAINS: A EUROPEAN FIRM-LEVEL ANALYSIS

Mariarosaria Agostino[(a)], Anna Giunta [(b)*], Domenico Scalera [(c)] and Francesco Trivieri[(a)]

[(a)]*University of Calabria,* [(b)]*Roma Tre University,* [(c)]*University of Sannio*

Paper presented at the Workshop:

Global Value Chains. Firms, Trade and Policy Implications
Roma Tre University, 10-11 December 2015

ABSTRACT

The effect of importing on firms' productivity has received adequate attention only recently, with the massive rise of trade in intermediate goods originated by the international dispersion of production. We aim to contribute to this stream of literature by analyzing the relationship between importing intermediate inputs and firms' Total Factor Productivity (TFP). Our econometric investigation, conducted on a sample of more than 14,000 European industrial firms based on the 2010 EU-EFIGE survey, finds that: 1) importing intermediate goods is positively and significantly associated with firms' TFP; 2) the productivity-enhancing effect tends to be amplified for the best performers, i.e. the ones with a TFP higher than median value, and for exporters; 3) a "technology transfer through imports" effect seems to be at play, since firms gain greater rewards from importing when they have a larger absorptive capacity and source customized rather than standardized intermediates from advanced rather than developing countries. These results hold in particular for suppliers, and especially the most capable ones, supporting the hypothesis that belonging to Global Value Chains (GVCs) has a significant impact on firms' performance.

Keywords: Imports, Productivity, Firm Data, Global Value Chains
JEL:D22, F61

[*]*Corresponding author*: anna.giunta@uniroma3.it

1. INTRODUCTION

Until a few years ago, the attention devoted to the role of importing as a determinant of firms' efficiency was definitely scarce, as incisively represented by Bernard et al. (2007: 123): ''the empirical literature on firms in international trade has been concerned almost exclusively with exporting, largely due to limitations in data sets. As a result, the new theories of heterogeneous firms and trade were developed to explain facts about firm export behavior and yield few predictions (if any) for firm import behavior". However, the situation is changing thanks to the availability of new data sets that, by gathering firms' level information, allows to shed some more light on firms' import behavior and investigate determinants and effects of import activities (Castellani et al., 2010; Vogel and Wagner, 2010).

In line with recent developments of the literature, this paper focuses on the role that import of intermediate inputs have on firms' productivity, by conducting an investigation on a sample of more than 14,000 European industrial firms. To this purpose, we employ micro-data coming from the EU-EFIGE Bruegel-Unicredit 2010 survey, including survey and balance-sheet information about firms with more than 10 employees operating in seven European countries: Austria, France, Germany, Hungary, Italy, Spain and United Kingdom.

To investigate the relationship between firms' productivity and attitude to import intermediates, we estimate several econometric specifications containing export and import as explanatory variables of Total Factor Productivity (TFP).We also consider interaction terms, meant to single out complementarities between import and export activities, and the possibility of heterogeneous impact of import on productivity, according to firms' absorptive capacity, as proxied by capabilities in innovation and research. To mitigate concerns of endogeneity, we resort to lagged values of main regressors. Then, to take into account possible problems of sample self-selection, we adopt a Heckman two-stage procedure, in particular when introducing a dummy variable representing the technological content of imports. Finally, we implement a quantile re-

gression approach to allow for heterogeneous impacts on productivity of our explanatory variables, depending on where firms are located in the distribution of the TFP measure.

We contribute to the literature under, at least, three point of views. First, we make some advancements to the stream of the literature of a still under researched area, investigating the impact of intermediate goods imports on firms' TFP, and the channels through which this effect may take place.

Second, while it is widely recognized that trade in intermediate goods is a direct consequence of the international dispersion of production, there is still scarce evidence on the specific behavior and performance of supplier firms, i.e. firms selling 100% of their turnover to other firms, which are among the main actors of GVC. Supplier firms produce for outsourcers and, thus, are complementary to international production sharing in global networks (Giunta et al. 2010). In our econometric investigations we take into specific consideration supplier firms, by running regressions focused on them. To the best of our knowledge, this is among the few papers that, investigating the role of imports on TFP, takes into explicit consideration this typology of firms. Suppliers firms are the bulk of the industrial structure in several countries, Italy is a case in point. They are often regarded as suffering of a productivity discount (Razzolini and Vannoni, 2011), even though some researchers point out to suppliers' heterogeneous behavior and performance (Accetturo et al. 2011, Agostino et al., 2015).

Third, we attempt to fill a gap between the macro-level knowledge of GVC participation of European countries and the paucity of firm-level investigations on the behavior and performances of European firms in GVCs, documented only by a few studies (Agostino et al., 2015; Barba Navaretti et al., 2011; Békés et al., 2011; Del Prete et al., 2015; Giovannetti et al., 2015; Veugelers, 2013). As a matter of fact, while we know that the European countries considered in our sample show a remarkable involvement in the process of international dispersion of pro-

duction (De Backer and Miroudot, 2014), as measured by the GVC participation index,[1] we have only scarce information on the profitability of joining GVCs at a firm level.

Three are our main results: 1) in accordance with the literature reviewed, we find that imports are positively and significantly associated with firms' TFP, pointing to a learning-by-importing effect. This result holds both for all firms and for the subsample of suppliers, suggesting that the performance of suppliers might be enhanced when they source, in turn, foreign intermediate inputs; 2) the potential learning by importing effect tends to be amplified for the best performers, especially in the suppliers' subsample; 3) going to channels through which imports exert their positive impact, we find that importing enhances productivity more when firms source customized intermediates from developed countries and show high share of workers involved in training programs, high turnover from the sale of innovative products and high turnover invested in R&D. We interpret this evidence as an indication that imports improve TFP to the extent that firms have the capacity to absorb the technology embodied in imported inputs. Thus, suppliers with high absorptive capacities may achieve the best performances and fully exploit the chances offered by the international fragmentation of production.

The paper is organized as follows. Section 2 contains a brief review of related literature. Section 3 presents the data (3.1), the econometric methodology (3.2) and some descriptive statistics (3.3). Section 4 analyses the main results of the econometric investigation. Section 5 concludes.

[1] The participation index (Koopman et al., 2011) is expressed as a percentage of gross exports and indicates the share of foreign inputs in exports(backward participation) and domestically produced inputs used in third countries' exports (forward participation). Among the seven countries of our sample, Hungary shows the highest backward participation (40% of gross exports), followed by Austria (around 30%), Germany (around 25%), France (20%), Spain (20%), and Italy (20%), while the United Kingdom exhibits the lowest backward participation index (around 15%).

2. RELATED LITERATURE

The recent upsurge of interest around the import of intermediate inputs is widely justified by the phenomenon of the international dispersion of production occurred in the last two decades, which has led a larger share of firms to undertake intermediates' international trade. As underlined by De Backer and Miroudot (2014), because of the interconnectedness of industries worldwide, more than half of world manufactured imports are currently intermediate goods (primary goods, parts and components, and semi-finished products). These changes have major macro and microeconomic consequences.

From a macroeconomic perspective, the role of foreign inputs in spurring economic growth has been first underlined by the endogenous growth literature (Romer, 1987). On the other hand, the trade value added literature has emphasized the relevance of imports by demonstrating that improving access to imports facilitates a country's exports and even guarantees "an export premium associated with good connectivity to the sources of value added" (Santoni and Taglioni, 2015:71). At the same time, concern has been raised on the impact of imported intermediate inputs on job loss at home and increasing inequality (OECD, 2010), while several authors (Alessandria et al., 2011; Altomonte et al., 2012a; Accetturo and Giunta, 2015) have highlighted the role of intermediate inputs in the shocks transmission in the 2008-09 crisis, causing the Great Trade Collapse. In particular, it is argued that large inventories of imported inputs were used to continue the production process, thus reducing firms' demand to upstream exporters.

The microeconomic consequences for firms are noteworthy as well. An increasing number of empirical studies have recently pointed out a positive relationship between importing activity and firms' productivity (Fernandes, 2007; Kasahara and Rodrigue, 2004; Vogel and Wagner, 2010; Wagner, 2012), underlined by a significant productivity gap between firms that import and firms that do not. The ongoing debate mainly focuses on three issues: *i*) the direction of

causality between intermediate goods importing and firm's performance; *ii*) the channels through which importing may enhance firms' productivity; *iii*) the higher levels of productivity of firms engaged in both importing and exporting activities (two-way traders).

Direction of causality

On the first issue, two hypotheses, not mutually exclusive, contrast. The first maintains that, as for exports (Bernard and Jensen, 1999; Roberts and Tybout, 1997), international operations' sunk costs may cause a self-selection of more productive firms into importing activities (Andersson et al., 2008; Castellani et al., 2008;Kasahara and Lapham, 2008). So far, this hypothesis has found limited empirical support (Kraay et al., 2002; Kasahara and Lapham, 2008;Kugler and Verhoogen, 2008; Vogel and Wagner, 2010).On the other hand, again as for exports (Clerides et al., 1998), it is also likely that once a firm is engaged in importing activities, its productivity can be enhanced by a "learning by importing" effect (Altomonte and Békés, 2009; Andersson et al., 2008;Augier et al., 2013; Halpern et al., 2011; Muuls and Pisu, 2007). Such an effect is confirmed by a number of empirical studies (Altomonte and Békés, 2009; Augier et al., 2013; Baldwin and Yan, 2014; Bas and Strauss-Kahn, 2014; Halpern et al., 2011; Kasahara and Rodrigue, 2008).

The channels

According to the literature, the channels through which imports allow firms to gain dynamic externalities are: a) cost saving, b) technology transfer or inputs' quality improvement; c) complementarity with domestic inputs.

Lowering production costs is the most obvious motivation for importing cheaper (than domestic) intermediate inputs. Resorting to channel (a) means producing a given amount of output at lower costs, which allows firms to increase efficiency and TFP, and raise their profits.

Second (channel b), firms may find importing profitable, for advanced technologies embodied in imported intermediate inputs act as a vehicle of knowledge transfer (Andersson et al., 2008; Blalock and Veloso, 2007; Castellani et al., 2008; Bas and Strauss-Kahn, 2014) and/or because importing high-quality intermediates gives to a firm the chance to export higher quality goods at higher prices (Kugler and Verhoogen, 2008). Moreover, when productivity gains occur through the mechanism envisaged by the technology transfer channel, the impact of imports on productivity is likely to be heterogeneous across firms according to individual firm absorptive capacity. In fact, to integrate imported inputs into production processes, particularly with knowledge intensive and/or high quality intermediates, firms need to be endowed with adequate abilities. On this, Augier et al. (2013), using a data set on Spanish firms, find that absorptive capacity – as proxied by firms' skill intensity –significantly enhances the positive effects of importing intermediates on firms' productivity.

Finally and more generally, the interpretation suggested by channel (c) refers to the possibility that complementarities between domestic and foreign inputs play a role in explaining why importing intermediates is associated to higher productivity. The underlying rationale is that, by accessing a greater variety of inputs through import, firms can achieve wide complementarity of inputs that, in turn, enhances its productivity. The love for variety mechanism has found empirical support by Bas and Strauss-Kahn (2014) regarding French firms, and by Halpern et al. (2011) on a panel of Hungarian firms.

Two-way traders

Concerning the third issue, many contributions have discussed why two-way international trade might be more profitable than importing only or exporting only (Aristei et al., 2013; Bernard et al., 2007; Muuls and Pisu, 2009; Díaz-Mora et al., 2015). According to some authors (Kasahara and Lapham, 2008), an explanation could be sunk cost complementarity, for which undertaking each international activity (exporting and importing) would be less costly when the

firm is already carrying out the other one. This happens, for example, when firms acquire information on foreign markets about both potential buyers and suppliers of intermediate inputs, or also about customs procedures, facing sunk costs common to both exporting and importing. Alternatively, other interactions can occur if import increases firms' efficiency and this in turn helps firms to be more competitive and export; or vice versa, exporting may allow firms to bear the sunk costs of importing or induce them to source high quality foreign intermediates to introduce new products or improve product quality. Moreover, Bas and Strauss-Kahn (2014) emphasize that highly productive firms with a wide diversification in imported inputs are also large exporters thanks to complementarity and technology transfer mechanisms. The empirical literature has often confirmed these theoretical predictions, showing that two-way traders, i.e. firms acting as both importers and exporters, usually enjoy better performances (Serti and Tomasi, 2008; Castellani et al., 2010; Conti et al., 2014).

Baldwin and Yan (2014), who also find that two-way traders show higher productivity, identify firms engaged in both importing and exporting as the ones participating in GVCs. This approach, where the productivity advantage of two-way traders is coupled with the benefits of belonging to GVCs, is based on the awareness that nowadays exporting and importing activities are inherently parts of fragmentation of production, with many firms importing intermediates and then exporting processed goods, which in turn may be intermediates themselves. The effects of participation of firms and countries in international production networks and more specifically in GVCs has been the subject of a large literature. In particular, benefits of and requirements for belonging to GVCs (Agostino et al., 2015; Amador and di Mauro, 2015; Antras and Chor, 2013; Giovannetti et al., 2015;Giunta et al., 2012), the importance of the kind of chain governance (Humphrey and Schmitz, 2001; Gereffi et al., 2005; Gereffi and Fernandez-Stark, 2011), the position of firms and countries along GVCs (Amador et al., 2015; Benkovskis

and Worz, 2015; De Backer and Miroudot, 2014; Koopman et al., 2011) have been the main topics dealt with.

3. DATA, METHODS AND DESCRIPTIVE STATISTICS

3.1 Data

We employ microdata coming from the EU-EFIGE Bruegel-UniCredit dataset provided by Bruegel (a Belgian non-profit international association), which includes survey and balance-sheet information about firms with more than 10 employees operating in seven European countries: Austria, France, Germany, Hungary, Italy, Spain and United Kingdom.[2] Though qualitative and quantitative data from the EFIGE survey, conducted in 2010, may in general refer to years 2007-2009, almost all variables included in our econometric model (see sub-section3.2) are available for 2008 only. Balance-sheet information is drawn from Bureau Van Dijk's Amadeus databank and concerns years from 2001 to 2009.

3.2 Empirical model and econometric methodology

To test whether purchasing inputs on international markets affects firms' productivity, we estimate the following model:

$$TFP_i = \beta_0 + \beta_1 PIAB_i + \sum \beta_k \, CTRL_{ki} + \varepsilon_i \qquad (1)$$

where the dependent variable is firms' Total Factor Productivity (TFP), as provided by the EFIGE Bruegel-Unicredit dataset,[3]and PIAB represents imported intermediate inputs. We esti-

[2] More detailed information on EU-EFIGE dataset is available at http://bruegel.org/2012/10/the-eu-efigebruegel-unicredit-dataset/

[3] For a discussion on the method used to estimate TFP in the EFIGE dataset, see Altomonte et al., 2012b and Altomonte et al., 2013.

mate different specifications of equation (1) by using either the share of intermediate goods purchased abroad to total intermediates (PIAB) and the ratio of exports to total sales (EXP) as one of controls or alternatively the corresponding dummies DPIAB and DEXP, respectively equal to 1 if the firm acquires intermediate goods from abroad and if the firm exports, and zero otherwise. Using dummies instead of continuous variables is motivated by the larger number of observations available on DPIAB; also, by using lagged information on imports, i.e. the DPIAB_BEF (dummy coded 1 if firms purchased intermediate goods abroad before 2008), we can mitigate concerns of endogeneity. CTRL is a vector including some control variables, i.e. beside EXP or DEXP: the log of firm's age (AGE); the share of employees involved in formal training programs to total employees (TRAIN); the share of firms' turnover made up by sales of produced-to-order goods (SUPPL); a dummy for firm' size coded 1 if firms are small or medium sized (less than 250 employees, SMES); an innovation index dummy equal to 1 if firms carried out product or process innovation in years 2007-2009 (DINNO); a dummy representing propensity to research equal to 1 if firms carry out R&D activities (DR&D) and a dummy coded 1 if firms belong to a (national or foreign) group (DGROUP). Finally, industry and country dummies are also included among controls.

As a second step, we test the hypothesis that two-way traders achieve better productivity performances than firms acting as importers only or exporters only. To this purpose, we construct an interaction variable PIAB*EXP to be included in the set of regressors.

Furthermore, we investigate the influence of intermediates goods' technological content or quality on TFP. We pursue this objective in a number of ways. First, we test the hypothesis that imported intermediates differently impact on TFP according to firms' absorptive capacity. To do this, we check whether firms' skill intensity (as proxied by the percentage of employees involved in formal training programs, TRAIN), propensity to innovate (as proxied by the share of turnover from innovative products, TINNO) and R&D activity (in particular, the share of turn-

over invested, R&D) enhance the effects of importing intermediates on firms' TFP, by building up interaction terms PIAB*TRAIN, PIAB*TINNO and PIAB*R&D. Second, assuming that suppliers from developed countries provide inputs with higher technological content, as in Bas and Strauss-Kahn (2014) and Smeets and Warzynski (2013), we modify equation (1) by replacing PIAB with TECON – a variable coded 0 if the firm imports standardized intermediates, 1 if it purchases customized inputs from developing countries, and 2 if it purchases customized inputs from developed countries (i.e. UE countries, USA and Canada).[4]

The estimation of the aforementioned specifications posits some econometric problems, which have been addressed compatibly with the data at hand.[5] In particular, besides the standard OLS method, for the last specification we address concerns of selection bias by adopting the Heckman's (1979) model. Indeed, firms sourcing intermediate goods from abroad may be systematically different from those that purchase on the domestic market, displaying a higher productivity, which is not related to inputs' sourcing. In other words, a selection issue may arise if unobservable characteristics determining TFP also affect the decision to buy inputs from abroad. If this is the case, parameters estimates will be biased. To account for this problem, we specify the following selection process:

[4] Our distinction between developing and developed countries is driven by the outcomes of the following survey question: *From which of the following areas the firm has purchased intermediate goods in 2008*?, the options being: UE countries; other European not UE countries (i.e.: Switzerland, Norway, Russia, Turkey, Byelorussia, Ukraine); China and India; other Asian countries (excluded China and India); USA and Canada; Central and South America; other areas.

[5] Indeed, it is worth recalling that our sample is represented by a cross-section of firms operating in seven European countries (as the EFIGE database provides information on most of the variables entering our empirical model only for the year 2008).Therefore, unobservable firms heterogeneity cannot be captured employing static panel methods, neither concerns of endogeneity (pertaining some regressors) and TFP dynamics can be accounted for by adopting dynamic panel estimators.

$$DPIAB_i = 1 \quad \text{if} \quad p_i^* = \theta_0 + Z_i'\theta_1 + v_i > 0$$
$$DPIAB_i = 0 \qquad otherwise \tag{2}$$

where p^* is a latent variable that may be interpreted as the propensity of the firm to purchase inputs from abroad. This propensity is a linear function of a set of regressors Z, and an error term v_i, assumed to be *iid* N(0, 1). The vector Z encompasses the same explanatory variables of the main regression (1), plus a dummy variable equal to 1 if firms carried out active outsourcing (OUTS_A) that affects only the selection process, and thus is excluded from the main equation to better identify the model. The residuals from probit estimation of (2) are used to construct a selection bias control factor λ, equivalent to the inverse Mill's ratio, which is added to the main equation, explaining the TFP. Since this factor reflects the effect of all the unobserved characteristics that are related to the sourcing decision, its inclusion in the substantial equation controls for the effect of the TFP-related unmeasured characteristics, which are also related to the decision to purchase inputs from abroad. Thus, if its coefficient is significant, there exists a bias.[6]

In addition, to allow for heterogeneous impacts on productivity of our explanatory variables, depending on where firms are located in the distribution of the TFP measure, we implement a quantile regression approach. The latter has been applied in several fields of research due to its flexibility (e.g.: Chamberlain, 1994; Bedi and Edwards, 2002; Manning et al., 1995; Cade et al., 1999; Barba Navaretti et al., 2014). Indeed, this method allows researchers not only to overcome some limitations of the conditional mean modelling – such as the sensitiveness to the

[6] The Heckman (1979) method assumes all other regressors are exogenous and is based on the normality assumption. To control also for the potential endogeneity of other regressors included in the TFP equation, an instrumental variable approach has been explored. Unfortunately, due to data limitations, we could not find a sufficient number of valid external instruments. To mitigate the problem, whenever available, we employ the lagged value of the explanatory variables suspected of endogeneity.

presence of outliers, and the normality and homoscedasticity assumptions – but also to deepen the understanding of the phenomenon under investigation. As a matter of fact, by modelling several quantiles, one can inspect the relationship of interest across different strata of the response variable, or focus on the lower and upper tails of a distribution rather than on its central location.

Finally, it is worth mentioning that the interpretation of a quantile estimated coefficient is analogous to that of an OLS parameter. While the latter represents the marginal impact of an explanatory variable on the conditional mean of the dependent variable, a quantile regression coefficient is the marginal impact of an explanatory variable on a given segment (quantile) of a distribution *ceteris paribus* (for a detailed illustration of the quantile regression approach we refer to Koenker, 2001 and 2005). To test the significance of the quantile coefficients, researchers may opt for an asymptotic or a bootstrap method. Whilst the former relies on strong parametric assumptions (Koenker, 1994), the bootstrap procedure is more flexible and, what is more important for our analysis, allows us to test the equivalence of the coefficients of interest across the different quantiles that we consider.[7]

3.3 Descriptive statistics

A detailed description of variables used in the present and next section, together with their main summary statistics, is supplied in Table 1.

[TABLE 1]

[7] The bootstrap method (Efron, 1979) does not make assumptions on the distribution of the response variable and consists in extracting – with replacements – a large number of samples (of size n) from the observed sample. These resamples will be randomly different from the original sample and will be used to get parameter estimates, as well as variance and covariance estimates. In particular, the covariance matrix will also provide the covariance of the estimated coefficients of the same regressor across distinct quantiles, thus one can verify the equivalence of the marginal impact of a covariate at different quantiles.

Table 2 provides a preliminary view on firms' behavior about sourcing strategies, by showing some descriptive statistics on firms undertaking domestic sourcing, international sourcing of standard or customized intermediates, from developed or developing countries. 8343 firms, i.e. about 59% of firms of our sample, do not purchase intermediates from abroad (column 1). With respect to intermediates' importers (column 2), these firms are on average much smaller (67 employees on average versus 255), less inclined to export (13% of their turnover against 26%), less innovative (the share of those undertaking process and product innovation is around 59% versus almost 75%), and with a smaller propensity to belong to business groups (16% versus 31%). More in detail, the widest differences emerge between firms represented in column 1 (domestic sourcing only) and in columns 4 and 5, i.e. involved in foreign sourcing of customized intermediates. These latter are much more open to international operation for exporting (intensive margin between 25% and 32%) and services importing (23% versus 17%), and more involved in innovative activities and training programs. Also, firms resorting to international sourcing of customized are the ones most often belonging to business groups (36% to 39%). A final interesting comparison concerns firms purchasing customized intermediates respectively from developing or developed countries (columns 4 and 5). Similar for many aspects, these two groups clearly distinguish from each other for size (134 versus 226 employees, on average) and for the share of sales to order to total sales (77% versus 69%).

[TABLE 2]

4. RESULTS

Table 3 summarizes the main results of our regressions. Each column refers to a different specification of equation (1). In particular, column (1) is our benchmark specification, making use of continuous variables PIAB and EXP. Specification (2) replaces those variables with the corresponding dummies DPIAB and DEXP. In this case, we also include the dummy DPSAB, repre-

senting import of services, among regressors.[8] In order to mitigate the problem of endogeneity, specification (3) replicates the previous one by using lagged (rather than current) values for both imported intermediate goods and services, as well as for exports. Further, columns (4) to (7) report estimates of the benchmark specification including additional interaction variables. In column (4), PIAB*EXP is considered to investigate possible differentiated effects of imports on productivity conditional to firms' ability to export (i.e. a two-way trade effect). On the other hand, to explore the hypothesis that the impact of importing varies with the firm's absorptive capacity, as proxied by employees ability and propensity to innovation and research, column (5) presents the interaction PIAB*TRAIN; column (6) replaces DINNO with the corresponding continuous variable TINNO and includes the interaction PIAB*TINNO; column (7) substitutes DR&D with R&D and adds the interaction PIAB*R&D among regressors. Finally, columns (8) and (9) summarize the results of the Heckman model that we use when considering TECON among the explanatory variables of TFP, to take into account the influence of intermediates goods' technological content or quality on firms' productivity.[9]

[TABLE 3]

Coming to the economic interpretation of results, we can preliminarily notice that all control variables are statistically significant at 5% level, the only exception being variables represent-

[8] A number of papers take into consideration the role of international trade of services (for example Conti et al., 2010 and Federico and Tosti, 2012). However, since in our dataset the number of available observations on the share of imported services on total services is relatively small (as shown in Table 1, only 1,380 firms supply this piece of information), the continuous variable PSAB is not included in regressions.

[9] In particular, column 8 refers to the main equation on the determinants of TFP, while column 9 is the selection equation for DPIAB, including OUTS_A as an exclusion restriction. The LR test reported at the bottom line indicates that the null hypothesis of independence of the two equations is rejected, thus confirming the suitability of two-stage Heckman estimation. By contrast, this null hypothesis is accepted when estimating Heckman's models for previous specifications. Hence, the relative results are omitted and available on request.

ing firms' innovation activities which, in most cases, show low significance. The signs of statistically significant coefficients are always consistent with a priori expectations: in accordance with most of the literature, we find that older and larger firms, undertaking training programs are, on average, more productive than others. Concerning the SUPPL variable, our investigation confirm the results of previous literature (Razzolini and Vannoni, 2011; Giunta et al., 2012) indicating that suppliers, on average, suffer a productivity disadvantage. However, although statistically significant, this effect is quantitatively negligible, as an increase of 10 percentage points in the share of produced-to-order sales on overall turnover implies a reduction of less than 0.004 in the value of the TFP index, which varies between -1.36 and 1.41 (i.e. about 0.14% of the whole variation range). Belonging to a business group does significantly affect TFP as well. As it is known, the literature on the effects of the affiliation to a business group does not reach univocal conclusions, being inclined to point out positive consequences on firms' performance, when emphasis is put on cost saving in acquiring additional resources (Scalera and Zazzaro, 2011), and advantages resulting from internal trade relationships and inter-firm labor division (Estrin et al., 2009), or alternatively negative effects, when agency and coordination problems, causing inefficiency and expropriation of wealth from minority shareholders (Morck et al.,2005), are stressed. In our case, estimations suggest that positive effects are prevailing.

Going to the variables of interest, we first address the core issue of this paper, i.e. the relationship between productivity and import. Looking at the results of Table 3, we can state that importing inputs and services from abroad exerts a significant positive effect on TFP, as shown in all regressions we run (however in specifications 6 and 7, only joint statistical significance with innovation and R&D variables holds). To clarify this result, we need to make a number of points, concerning the quantitative measure of this relationship, the differentiated effect of im-

port and export activities connected to firms' heterogeneity, the channels through which import may positively impact on TFP.

Regarding the size of correlation between import and productivity, our estimates point out that the impact of importing intermediates is not very strong, although statistically significant. In detail, the difference in TFP index that can be ascribed to imports of intermediates amounts to about 0.1, i.e. 3.65% of the TFP variation range. The weight of imported services on firms' productivity is very similar: coefficients of DPIAB and DPSAB are very close to each other, in both specifications with current and lagged values. Thus our results, supporting the hypothesis of a positive relationship between importing activity and firms' productivity, are consistent with recent literature (Castellani et al., 2010; Fernandes, 2007; Halpern et al., 2011; Kasahara and Rodrigue, 20084; Vogel and Wagner, 2010), but gauge that the impact of imports on TFP is not very strong.

In evaluating the relationship between intermediates' imports and productivity, we control for export activities, in terms of both extensive (DEXP) and intensive (EXP) margins. As emphasized by the literature (Serti et al., 2010; Conti et al., 2014), this is crucial if complementarities between import and export arise, and failing to control for them may bias upward the estimation of import premia. Also, this allows to assess the role of attitude to export in determining firms' TFP. On the latter point, Table 3 clearly shows that correlation between export activities and TFP is positive and statistically significant, confirming the predictions of a wide literature (for a review, see Castellani et al., 2010). However, once again, and even more than in the case of imports, regression coefficients' values come out to be fairly low, revealing that the effect of export on TFP is quantitatively limited. To check the presence of complementarities between import and export, and give a rationale for a better performance of two-way traders, we include the additional multiplicative variable PIAB*EXP among regressors of specification (4). The test reported at the bottom of Table 3 shows that EXP and PIAB*EXP are jointly significant at

5% level, despite the lack of individual significance. Figure 1 confirms that for a very large portion of firms (the ones exporting up to 90% of sales, i.e. about 97% of our sample) the marginal effect of importing on productivity is increasing with the propensity to export: the more export, the greater the benefits firms obtain from importing intermediates.[10]

[FIGURE 1]

As previously recalled, there are many channels through which importing intermediates may enhance productivity: it may allow firms to use higher quality inputs; to exploit new complementarities in production; to take advantage from potential technology transfers; to give up little efficient production stages and enjoy gains from specialization, and also simply to cut input costs. In particular, the hypothesis that the impact of importing on TFP varies with the firm's ability to absorb more advanced technology or to exploit complementarities can be tested by considering interaction variables between PIAB and variables representing employees' ability (TRAIN) and firms' attitude to innovation (TINNO) and research (R&D). The results shown in Table 3 confirm that the higher share of: a) workers involved in training programs, b) firm's turnover from the sale of innovative products and c) firm's turnover invested in R&D, the larger effect of importing on TFP. In particular, we find that innovating and doing research strongly affects the impact of importing intermediates on productivity: the firms showing values of TINNO and R&D close to mean values enjoy a positive effect of importing which is about doubled with respect to those non innovating and non-undertaking R&D. Figures 2, 3 and 4 confirm the relevance and statistical significance of this impact for most firms of our sample.

[10] Figure 1 depicts the marginal impact of PIAB on TFP with respect to different values of EXP. Marginal impacts are evaluated as $\tilde{\beta}_{PIAB} + EXP * \tilde{\beta}_{PIAB*EXP}$(where $\tilde{\beta}$s are estimated values of βs) and the corresponding standard errors as $\tilde{\sigma} = \sqrt{var(\tilde{\beta}_{PIAB}) + (EXP)^2 * var(\tilde{\beta}_{PIAB*EXP}) + 2EXP * cov(\tilde{\beta}_{PIAB} * \tilde{\beta}_{PIAB*EXP})}$. Marginal impactsshown in Figures from 2 to 4 and 6-7 are calculated consistently.

[FIGURES 2, 3 and 4]

Another way to single out the channels through which importing intermediates impact on productivity is the one followed by Conti et al. (2014) who match each channel to a different commercial partner, assuming that firms located in developed countries are more likely to be positioned close to the technological frontier and supply high-technology inputs, while firms of developing countries more probably supply cheaper intermediates. Following this approach, we build up the trichotomic variable TECON, described above and include it among regressors of equation (1).

Results displayed at column (8) of Table 3 confirm that among firms importing intermediates, those importing customized inputs have an advantage on those importing standardized inputs, while, among firms importing customized inputs, those sourcing from advanced countries enjoy a further gain. So, consistent with previous contributions (Augier et al.,2013; Acharia and Keller, 2009), our results suggest that if importing intermediates is generally beneficial, it is even more so when sourcing is aimed at acquiring technology and high quality inputs rather than motivated only by cost saving.

In the presence of firm heterogeneity, the average intensity of the positive relationship between importing intermediate inputs and productivity, as estimated by specifications (1) to (9) of Table 3, may not accurately describe how TFP of differently productive firms is affected by importing. To address this issue, we resort to a Quantile Regression Analysis[11] which allows to estimate the effect of importing intermediates at different points of the conditional TFP distribution.

Table 4, reporting the results of the quantile regression, both for all firms and the subsample of suppliers, shows that the least productive firms are the ones less capable to reap benefits

[11] A similar exercise is carried out for export only by Yasar et al. (2006) on a sample of Turkish manufacturing firms.

from importing intermediates, while the impact of import is the highest for firms beyond median values of TFP. F-tests at the bottom of Table 4 demonstrate the significance of differences among coefficients' values of different quantiles for both importing and exporting. Concerning the latter, it can be seen that only the most productive firms get a positive reward for exporting, with the highest effects occurring for the last quartile of TFP distribution. An explanation of this evidence may be connected to the fact that only the most capable and efficient firms may be able to enjoy the advantages of technological transfer embodied in imported intermediates, for example because they have a greater absorptive capacity. Figure 5 graphically represents the estimated effect of import on TFP, according to quantiles of TFP distribution.

[TABLE 4]

[FIGURE 5]

4.1 The subsample of suppliers

Table 5 reports results relative to the subsample of suppliers. As for the whole sample, the first two specifications correspond to the benchmark specifications with continuous explanatory variables PIAB and EXP and dummies DPIAB, DEXP and DPSAB; column (3) considers lagged rather than current values for exports and imported intermediate goods and services; columns (4) and (5) go back to current value specifications, taking also into account interactions of PIAB with EXP and TRAIN.

[TABLE 5]

From comparison with Table 3, results for suppliers appear to be qualitatively identical and quantitatively very similar to those obtained for the whole sample. However, significant differences arise when comparing Figures 1 and 2 respectively with Figures 6 and 7, since complementarities come out to be particularly relevant to suppliers. As a matter of fact, if we consider

the whole sample, firms exporting 100% of production turn out to enjoy a marginal effect of importing about 22% higher than those not exporting, whereas for suppliers the difference between exporters and non-exporters is much wider (+75%). In the same vein, absorptive capacities seem to be for suppliers more important than for the others: indeed, the difference in the marginal effect of importing between firms involving all their employees in training programs and firms not undertaking training at all is 89% for the whole sample and 96% for suppliers.

[FIGURES 6 and 7]

Further peculiarities for suppliers emerge from inspection of Table 4, reporting the results of the quantile regression. As shown in the right panel of the table, in the case of suppliers the strength of the link with TFP varies across quantiles in a very similar way for export and import: low productive suppliers are not able to benefit from internationalization, while the impact of importing intermediates and exporting increases with TFP at the same pace and is highest at the last quartile of TFP distribution. The comparison of panels (a) and (b) of Figure 5 allows to appreciate that, once again, disparities across differently productive firms are stronger for suppliers, for which being more productive and enjoying a greater absorptive capacity makes sourcing from abroad most profitable.

This evidence highlights that being capable, in terms of ability to export and training employees, is for suppliers particularly essential in order to gain advantages connected to the import of intermediate inputs. With the exception of marginal producers (those in the first decile of TFP), suppliers are the ones who benefit to the greatest extent from international opening and specifically from importing customized intermediates from developed countries. A suitable interpretation of this evidence is connected to the inclusion of these firms in GVCs: via the governance of their own suppliers' international network, suppliers belonging to GVCs, by performing at the same time the roles of both suppliers and outsourcers, can best exploit the

chances offered by the international fragmentation of production and obtain the highest gains of productivity.

5. CONCLUDING REMARKS

Although international trade in intermediate inputs has become prominent in world trade with the setting up of GVCs and the organizational mode of international dispersion of production, at micro level the role of imports of intermediates in determining firms' efficiency has been little explored and only recently gained the attention of researchers and policy makers. The aim of this paper is to contribute to this recent stream of the literature by exploiting a rich and novel dataset, EU-EFIGE, containing both qualitative and quantitative data on firms' characteristics and activities, that we merge with balance sheet information from Amadeus (Bureau Van Dijk). Our analysis is conducted on a sample of more than 14,000 firms located in seven European countries, i.e. Austria, France, Germany, Hungary Italy, Spain and United Kingdom, which according to the Koopman participation index show a high involvement in GVCs.

Our econometric investigations confirms the existence of a positive relationship between imports and firms' TFP, as pointed out by recent literature. We also find evidence that the size of the beneficial impact of intermediates' import on productivity is affected by a number of complementary factors. In particular, being a two-way trader (i.e. both importer and exporter) and having a high absorptive capacity in terms of employees skill and attitude to innovation and research permits to enjoy the highest reward from importing activities. The latter finding indicates that, by importing intermediates, firms may acquire technology and quality enhancing their productivity performance.

A novel result of our paper concerns the effects of importing intermediates on suppliers' efficiency. Suppliers are firms which in turn produce intermediates for other firms, and thus one of the major actors of GVC operations and international production sharing in global networks.

For this reason, we take suppliers into specific consideration by running regressions focused on them. Econometric results show that suppliers importing intermediate goods exhibit superior productivity; moreover, when endowed with high absorptive capacity and capability to play on international arena as two-way traders, suppliers are the firms which mostly benefit from sourcing abroad. Our interpretation of this evidence is connected to the inclusion of these firms in GVCs. Via the governance of their own suppliers' international network, firms participating in GVCs, by performing at the same time the roles of both suppliers and outsourcers, can best exploit the chances offered by the international fragmentation of production and obtain the highest gains of productivity. While some limitations in the dataset used in this paper can only be overcome with the availability of better micro level quality data, the correlation we find between firms' inclusion in the GVCs, imports and productivity seem to have relevant implications on countries' competitiveness and trade policy.

REFERENCES

Accetturo A., Giunta A., 2015, *Value Chains and the Great Recession: Evidence from Italian and German Firms*, Questioni di Economia e Finanza, Banca d'Italia, Rome.

Accetturo, A., Giunta, A., Rossi, S., 2011, *Le imprese italiane tra crisi e nuova globalizzazione*, Questioni di Economia e Finanza, n. 86, Banca d'Italia, Rome.

Acharya R.C. and Keller W., 2009, Technology Transfer through imports, *Canadian Journal of Economics*, 42(4), 1411-1448.

Agostino M., Giunta A., Nugent J., Scalera D., Trivieri F., 2015, The Importance of Being a Capable Supplier: Italian Industrial Firms in Global Value Chains, *International Small Business Journal*, 33(7), 708-730.

Alessandria, G., Kaboski, J.P., Midrigan, V.,2011, US Trade and Inventory Dynamics, *American Economic Review*, 101 (3), 303-07, May.

Altomonte, C., Aquilante, T., Békés, G., Ottaviano G., 2013, Internationalization and Innovation of Firms: Evidence and Policy, *Economic Policy* 28(76), 663–700

Altomonte, C., Di Mauro, F., Ottaviano, G., Rungi, A., Vicard, V.,2012a, *Global Value Chains During the Great Trade Collapse. A Bullwhip Effect?*, European Central Bank, Working Paper Series, n. 1412.

Altomonte, C., Aquilante, T., Ottaviano G.,2012b,*The Triggers of Competitiveness. The EFIGE Cross-Country Report*, Bruegel Blueprint Series

Altomonte C., Békés G., 2009, *Trade Complexity and Productivity*, IEHAS Discussion Papers 0914, Institute of Economics, Hungarian Academy of Sciences.

Amador J., di Mauro F., 2015, *The Age of Global Value Chains*, VoxEu.org E Book

Amador J., Cappariello R., Stehrer R., 2015, Foreign Value Added in Eurozone Exports, in Amador J. and di Mauro F. (edited by) *The Age of Global Value Chains*, VoxEu.org E Book, 24-35

Andersson, M., Johansson S., Loof H., 2008, Productivity and International Trade: Firm Level Evidence from a Small Open Economy, *Review of World Economics*, 144, (4), 774–801.

Antras, P, Chor D., 2013, Organizing the Global Value Chain,*Econometrica*81(6): 2127-2204.

Aristei D., Castellani D. and Franco C., 2013, Firms' Exporting and Importing Activities: Is There a Two-Way Relationship?, *Review of World Economics*, 149(1), 55-84.

Augier P., Cadot O., Dovis M, 2013, Imports and TFP at the Firm Level: The Role of Absorptive Capacity, *Canadian Journal of Economics*, 46, (3), 956 – 981.

Baldwin J., Yan B., 2014, *Global Value Chains and the Productivity of Canadian Manufacturing Firms*, Economic Analysis Research Paper Series, March.

Barba Navaretti, G., Castellani, D., Pieri, F., 2014, Age and Firm Growth: Evidence from Three European Countries, *Small Business Economics*, DOI 10.1007/s11187-014-9564-6.

Barba Navaretti, G., Bugamelli, M., Schivardi, F., Altomonte, C., Horgos, D., Maggioni, D., 2011, *The Global Operations of European Firms*. The Second EFIGE Policy Report. Bruegel Blueprint Series, Volume XII.

Bas M., Strauss-Kahn V., 2014, Does Importing More Inputs Raise Exports? Firm-Level Evidence from France, *Review of World Economics*, 150 (2), 241-475.

Bedi, A., Edwards, J., 2002, The Impact of School Quality on Earnings and Educational Returns: Evidence from a Low-Income Country, *Journal of Development Economics*, 68, 157-185.

Békés, G., Halpern, L., Koren, M., Muraközy, B., 2011, *Still Standing: How European Firms Weathered*, The Third EFIGE Policy Report. Bruegel Blueprint Series 22 December.

Benkovskis K., WörzJ., 2015, "The Interpretation of Changes in Global Market Shares: Adding the Global Value Chain Dimension" in Amador J. and di Mauro F. (edited by) *The Age of Global Value Chains*, VoxEu.org E Book, 148-162.

Bernard A., Jensen B., 1999, Exceptional Exporter Performance: Cause, Effect, or Both? *Journal of International Economics*, 47, (1), 1-25.

Bernard, A. B., Jensen, J. B., Redding, S. J. and Schott, P. K., 2007, Firms in International Trade, *Journal of Economic Perspectives* 21, 105- 130.

Blalock, G.,. Veloso F.M, 2007, Imports, Productivity Growth and Supply Chain Learning, *World Development* 35, 1134–51.

Cade, B.S., Terrell, J.W., Schroeder, R.L., 1999, Estimating Effects of Limiting Factors with Regression Quantiles, *Ecology*, 80, 311-323.

Castellani D., Serti F., Tomasi C., 2010, Firms in International Trade: Importers' and Exporters' Heterogeneity in Italian Manufacturing Industry, *The World Economy*, 33 (3), 424-457, March.

Chamberlain, G., 1994, Quantile Regression, Censoring, and the Structure of Wages. *Advances in Econometrics*, Sims Christopher (ed.). New York: Elsevier.

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* 113**,** 903–947.

Conti, G., Lo Turco, A. and Maggioni, D., 2010, Exporters in Services: New Evidence from Italian Firms. *Applied Economic Quarterly* 56, 73-98.

Conti, G., Lo Turco, A. and Maggioni, D., 2014, Rethinking the Import-Productivity Nexus for Italian Manufacturing, *Empirica*, 41(4), 589-617.

De Backer K., Miroudot S., 2014, *Mapping Global Value Chains*, European Central Bank, Working Paper Series, n. 1677, May.

Del Prete D., Giovannetti G. Marvasi E., 2015, Participation in Global Value Chains: macro and micro evidence for North Africa.

Díaz-Mora C., Córcoles D. and Gandoy R., 2015, Exit from exporting: Does being a two-way trader matter?, *Economics Discussion Papers*, No. 2015-15, www.econstore.eu

Efron, B., 1979, Bootstrap Methods: Another Look at the Jackknife, *The annals of Statistics*, 1-26.

Estrin S., Poukliakova S. and Shapiro D., 2009, The Performance Effects of Business Groups in Russia, *Journal of Management Studies*, 46(3), 393-420.

Federico, S. and Tosti, E., 2012, *Exporters and Importers of Services: Firm-Level Evidence on Italy*, Economic Working Papers n. 877, Bank of Italy.

Fernandes, A.M., 2007, Trade Policy, Trade Volumes and Plant-Level Productivity in Colombian Manufacturing Industries, *Journal of International Economics*, 71, 422-40.

Gereffi G. and Fernandez-Stark K., 2011, *Global Value Chains Analysis: A Primer*. Center on Globalization, Governance & Competitiveness (CGGC) Duke University.

Gereffi G.~~,~~ Humphrey J. and Sturgeon T., 2005, The Governance of Global Value Chains, *Review of International Political Economy*, 12(1), 78-104.

Giovannetti, G., Marvasi, E., Sanfilippo M., 2015, Supply Chains and the Internationalization of SMEs: Evidence from Italy, *Small Business Economics* 44, 845-865.

Giunta A, Nifo A., Scalera D.,2012, Subcontracting in Italian Industry: Labour Division, Firm Growth and the North–South Divide, *Regional Studies* 46, (8), 1067–1083.

Halpern L., Koren M., Szeidl A., 2011, *Imported Inputs and Productivity*, CeFiG Working Papers 8, Center for Firms in the Global Economy.

Heckman J.J., 1979, Sample Selection Bias as a Specification Error, *Econometrica*, 47(1), 153-161.

Humphrey J. and Schmitz H., 2001, *Governance in global value chains*, IDS Bulletin 32.3, Institute of Development Studies.

Kasahara, H., Lapham B., 2008, *Productivity and the Decision to Import and Export: Theory and Evidence*, CESifo Working Paper 2240, CESifo Group Munich.

Kasahara, H. and Rodrigue, J., 2008, Does the Use of Imported Intermediates Increase Productivity? Plant-Level Evidence, *Journal of Development Economics* 87(1), 106 -118.

Koenker, R., 1994, Confidence Intervals for Regression Quantiles. In: Mandl, P., Huskova, M. (Eds.) *Asymptotic Statistics*, Physica Verlag,349-359

Koenker, R., 2001, Quantile Regression. *Journal of Economic Perspectives*,15 (4), 143-156.

Koenker, R., 2005,*Quantile regression*. Econometric society monograph series. Cambridge University Press.

Koopman, R., Powers W., Wang Z., Wei S., 2011, *Give Credit Where Credit is Due*: *Tracing Value-Added in Global Production Chains*, NBER Working Paper No. 16426.

Kraay, A., Soloaga I., Tybout J., 2002, *Product Quality, Productive Efficiency, and International Technology Diffusion: Evidence from Plant-level Panel Data*, World Bank Policy Research Working Paper 2759, Washington, DC: The World Bank.

Kugler, M., Verhoogen E., 2008, *The Quality–Complementarity Hypothesis: Theory and Evidence from Colombia*, NBER Working Paper Series 14418, Cambridge, MA: National Bureau of Economic Research.

Manning, W., Blumberg, L., Moulton, L., 1995, The Demand for Alcohol: the Differential Response to Price, *Journal of Health Economics*, 14, 123-148.

Morck, R., Wolfenzon, D. and Yeung, B. 2005, Corporate governance, Economic Entrenchment and Growth, *Journal of Economic Literature*, 43, 657-722.

Muuls, M., Pisu M., 2009, Imports and Exports at the Level of the Firm, *World Economy*, 32, 692-734.

OECD, 2010, *How Imports Improve Productivity and Competitiveness*, OECD, Paris, May.

Razzolini T., Vannoni D., 2011, Export Premia and Subcontracting Discount: Passive Strategies and Performance in Domestic and Foreign Markets, *World Economy* 34(6): 984–1013.

Roberts, M. J., Tybout J., 1997, The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs, *American Economic Review*, 87, (4), 545–64.

Romer P., 1987, Growth Based on Increasing Returns due to Specialization, *American Economic Review* 77, 56-62.

Santoni, G., Taglioni, D., 2015 "Networks and Structural Integration in Global Value Chains", in: Amador, J. di Mauro, F. (Edited by), The Age of Global Value Chains, a VoxEU.org eBook, 68-84,

Scalera D., Zazzaro A., 2011, *Do Inter-Firm Networks Make Access to Finance Easier? Issues and Empirical Evidence*, in Cafaggi F. (ed.), "Contractual Networks, Inter-Firm Cooperation and Economic Growth", Edward Elgard, Cheltenham.

Serti F. and Tomasi C.(2008) Firm Heterogeneity: Do Destinations of Exports and Origins of Imports Matter?, in. Piscitello L. Santangelo G. (eds.) "Multinationals and Local Competitiveness", Franco Angeli, Milano.

Smeets V. and Warzynski F. (2013), Estimating productivity with multi-product firms, pricing heterogeneity and the role of international trade, Journal of International Economics, 90 (2), 237-244.

Veugelers R., 2013, Innovative firms in Global Value Chains, *European Commission Policy Brief*, n. 21, October.

Vogel A., Wagner J., 2010, Higher Productivity in Importing German Manufacturing Firms: Self-Selection, Learning from Importing, or Both?, *Review of World Economics*, 145, 641-665.

Wagner J., 2012, International Trade and Firm Performance: A Survey of Empirical Studies since 2006, *Review of World Economiccs/Weltwirtschaftliches Archiv*, 148(2), 235–267.

Yasar M., Nelson C.H. and Rejesus R. 2006, Productivity and Exporting Status of Manufacturing Firms: Evidence from Quantile Regressions, *Review of World Economics*, 142(4), 675-694.

TABLE 1 - Description of the variables used in the estimations and their main summary statistics

VARIABLE	DESCRIPTION	Mean	Std. Dev.	Min	Max	Obs
TFP	Total Factor Productivity	-0.08	0.44	-1.36	1.41	6,938
PIAB	Share of intermediate goods purchased from abroad to total purchased intermediate goods	0.11	0.22	0	1	13,552
DPIAB	Dummy = 1 if in 2008 a firm purchased intermediate goods for its domestic production from abroad	0.41	0.49	0	1	14,167
TECON	Coded 0 if a firm acquired standard intermediates from abroad, 1 if it purchases customized intermediates from developing countries, and 2 if customized intermediates originate from developed countries (2008)	0.60	0.78	0	2	5,703
PSAB	Share of services purchased from abroad to total purchased services	0.19	0.23	0	1	1,380
DPSAB	Dummy = 1 if in 2008 a firm purchased services from abroad	0.10	0.30	0	1	14,167
EXP	Export to total sales	0.18	0.26	0	1	13,514
DEXP	Dummy = 1 if in 2008 a firm sold abroad some or all of its own products/services	0.58	0.49	0	1	14,167
DPIAB_BEF	Dummy = 1 if *before* 2008 a firm purchased intermediate goods for its domestic production from abroad	0.29	0.45	0	1	14,097
DPSAB_BEF	Dummy = 1 if *before* 2008 a firm purchased services from abroad	0.10	0.30	0	1	14,085
DEXP_BEF	Dummy = 1 if *before* 2008 a firm sold abroad some or all of its own products/services	0.45	0.50	0	1	14,143
SMES	Dummy = 1 if a firm is small or medium sized one (less than 250 employees)	0.52	0.50	0	1	14,168
AGE	2008 minus firm's year of establishment (years)	34	31	0	188	14,125
TRAIN	Percentage of employees involved in formal training programs in 2008	0.22	0.29	0	1	13,935
DINNO	Dummy = 1 if a firm carried out (in the triennium 2007-2009) product or process innovation	0.65	0.48	0	1	14,167
TINNO	Share of firms' turnover from innovative products sales on average in the period 2007-2009	0.21	0.22	0	1	6,651
DR&D	Dummy = 1 if a firm undertook (in the triennium 2007-2009) R&D activity	0.51	0.50	0	1	14,164
R&D	Share of firm's turnover invested in R&D on average in the period 2007-2009.	0.07	0.10	0	1	7,288
SUPP	Share of firm' turnover made up by sales of produced-to-order goods to total turnover	0.71	0.40	0	1	14,165
DSUPP	Dummy = 1 (= 0) if firm's share of sales to order to total sales is 100% (0%)	0.53	0.50	0	1	14,165
DGROUP	Dummy = 1 if firm belongs to a (national or foreign) group	0.22	0.42	0	1	14,168

All variables come from EU-EFIGE/Bruegel-UniCredit dataset dataset.

TABLE 2 - Descriptive statistics by import status

	Do not purchase intermediate goods from abroad	Purchase intermediate goods from abroad	Purchase standardized intermediates from abroad	Purchase customized intermediates from developing countries	Purchase customized intermediates from developed countries
Number of firms	8,343	5,824	3,344	1,300	1,059
Number of employees	67	255	302	226	134
Firm's age	32	35	34	41	34
Share of services purchased from abroad	17.3%	20.1%	16.7%	23.6%	22.2%
Export to total sales	12.8%	25.5%	23.2%	32.3%	24.9%
Product and process innovation	58.7%	74.3%	71.9%	83.6%	70.8%
Employees in training programmes	21.6%	23.8%	22.7%	26.9%	24.1%
Share of sales to order to total sales	70.3%	71.7%	70.9%	69.0%	76.7%
Group	16.0%	31.0%	26.5%	38.7%	35.9%

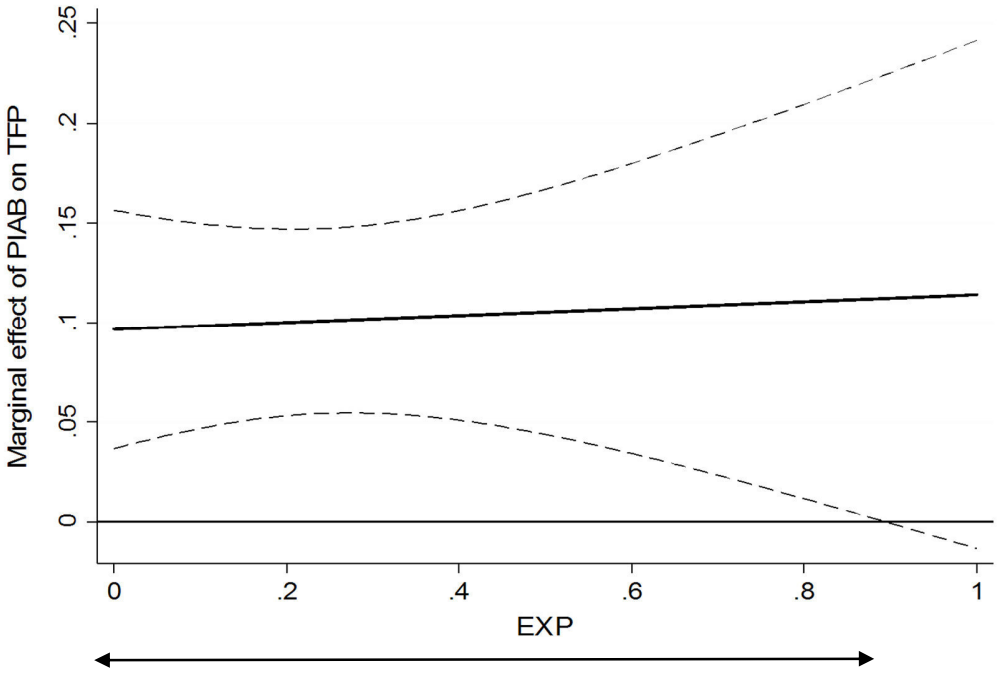
Authors' calculations from EU-EFIGE/Bruegel-UniCredit dataset

TABLE 3 - Estimation results. All firms

	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*	*Column 8*	*Column 9*
								Heckman	
								Main eq. (Dep: TFP)	*Sel. eq.* (Dep: DPIAB)
PIAB	0.100***			0.094***	0.082***	0.0240	0.0420		
	0.000			*0.002*	*0.007*	*0.598*	*0.370*		
DPIAB		0.055***							
		0.000							
TECON								0.015**	
								0.040	
DPSAB		0.055***						0.161***	0.684***
		0.001						*0.000*	*0.000*
EXP	0.078***			0.075***	0.078***	0.101***	0.129***		
	0.000			*0.002*	*0.000*	*0.001*	*0.000*		
DEXP		0.027***						0.136***	0.609***
		0.008						*0.002*	*0.000*
DPIAB_BEF			0.050***						
			0.000						
DPSAB_BEF			0.049***						
			0.005						
DEXP_BEF			0.033***						
			0.002						
SMES	-0.373***	-0.357***	-0.357***	-0.373***	-0.372***	-0.376***	-0.348***	-0.135**	1.166***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.016*	*0.000*
lnAGE_1	0.020***	0.020***	0.018***	0.020***	0.020***	0.018*	0.032***	0.032***	0.095***
	0.002	*0.001*	*0.003*	*0.002*	*0.002*	*0.051*	*0.002*	*0.000*	*0.000*
TRAIN	0.103***	0.103***	0.104***	0.103***	0.095***	0.124***	0.143***	0.121***	0.0770
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.162*
DINNO	0.0130	0.0150	0.0160	0.0130	0.0130		-0.0290	0.061***	0.191***
	0.241	*0.181*	*0.152*	*0.239*	*0.251*		*0.478*	*0.002*	*0.000*
DR&D	0.027**	0.026**	0.028**	0.027**	0.027**	0.038**		0.080**	0.227***
	0.018	*0.017*	*0.011*	*0.018*	*0.018*	*0.027*		*0.010*	*0.000*
SUPP	-0.037***	-0.038***	-0.035***	-0.037***	-0.037***	-0.036*	-0.0290	-0.043**	0.0170
	0.007	*0.004*	*0.009*	*0.007*	*0.007*	*0.055*	*0.179*	*0.012*	*0.774*
DGROUP	0.158***	0.164***	0.160***	0.158***	0.157***	0.170***	0.160***	0.253***	0.483***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
PIAB*EXP				0.0210					
				0.792					
PIAB*TRAIN					0.0730				
					0.398				
TINNO						-0.100**			
						0.011			
PIAB*TINNO						0.2420			
						0.117			
R&D							-0.1650		
							0.130		
PIAB*R&D							0.962***		
							0.006		
OUTS_A									0.424***
									0.000
Observations	6,250	6,699	6,685	6,250	6,250	2,953	2,199	10,907	
Model test	75.20	81.80	80.51	72.46	72.40	43.50	37.64	997.68	
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	
R^2	0.25	0.25	0.25	0.25	0.25	0.28	0.28		
Test joint sign. (PIAB,PIAB*EXP)				9.06					
				0.000					
Test joint sign. (PIAB, PIAB*TRAIN)					8.84				
					0.000				
Test joint sign. (PIAB, PIAB*TINNO)						3.51			
						0.030			
Test joint sign. (PIAB, PIAB*R&D)							8.43		
							0.000		
LR-test of ind.eqs								22.31	
								0.000	

For the description of variables see Table 1. The dependent variable is firm's Total Factor Productivity. Superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent level, respectively. In italics are reported the p-values of the tests. The standard errors (not reported) are robust to heteroskedasticity and autocorrelation. Country and sector dummies always included but not reported. lnAGE_1 is the log of (1 + firm's age) lagged once. OUTS_A in the selection equation of Heckman estimation is a dummy variable coded 1 if firm implemented active outsourcing practices.

FIGURE 1- Marginal effect of PIAB on TFP as EXP changes. <u>All firms</u>
(---95% confidence interval)



96.9% of the estimating sample observations

FIGURE 2- Marginal effect of PIAB on TFP as TRAIN changes. <u>All firms</u>
(---95% confidence interval)

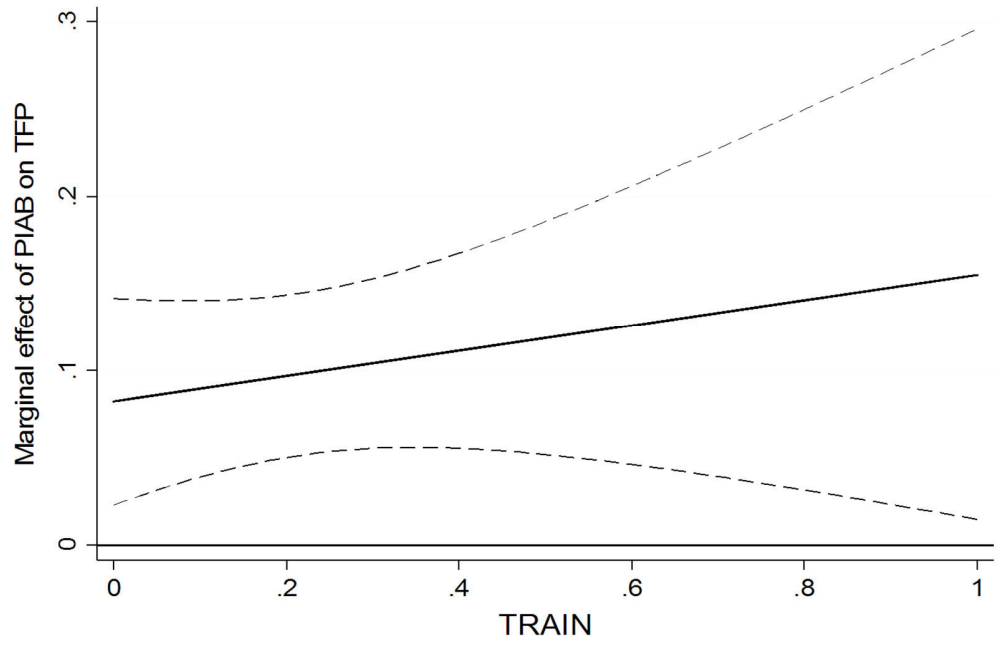
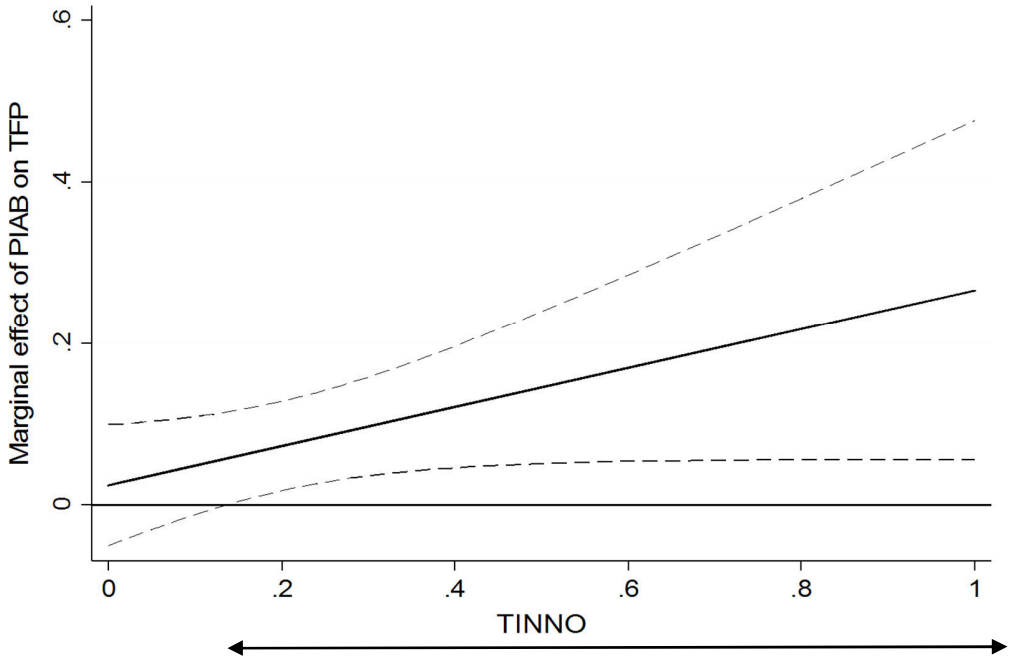
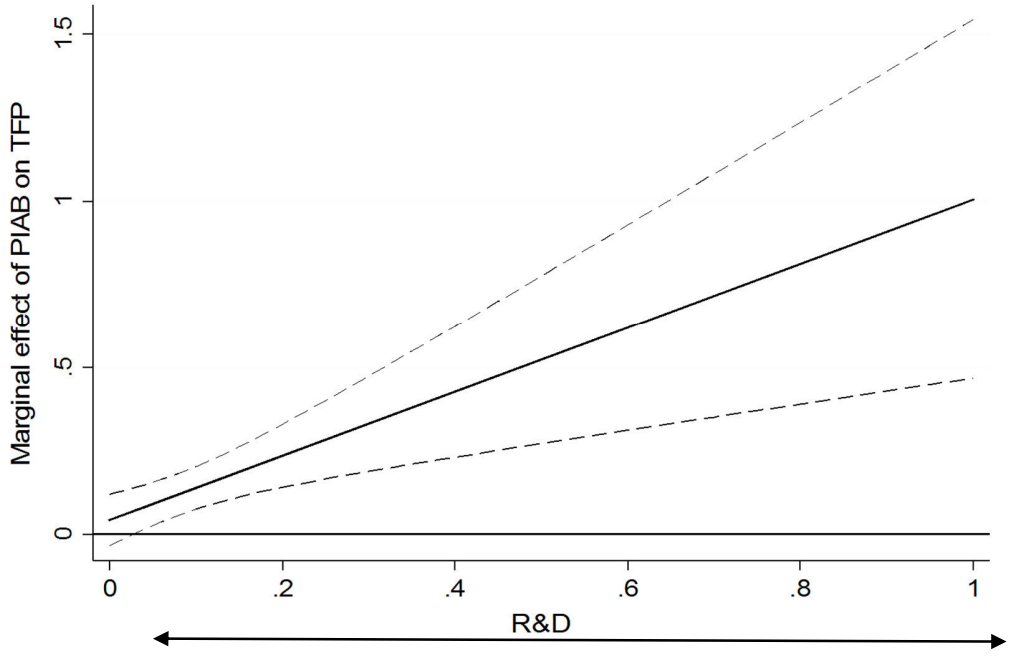


FIGURE 3- Marginal effect of PIAB on TFP as TINNO changes. All firms
(---95% confidence interval)



43.3% of the estimating sample observations

FIGURE 4- Marginal effect of PIAB on TFP as R&D changes. All firms
(---95% confidence interval)



79% of the estimating sample observations

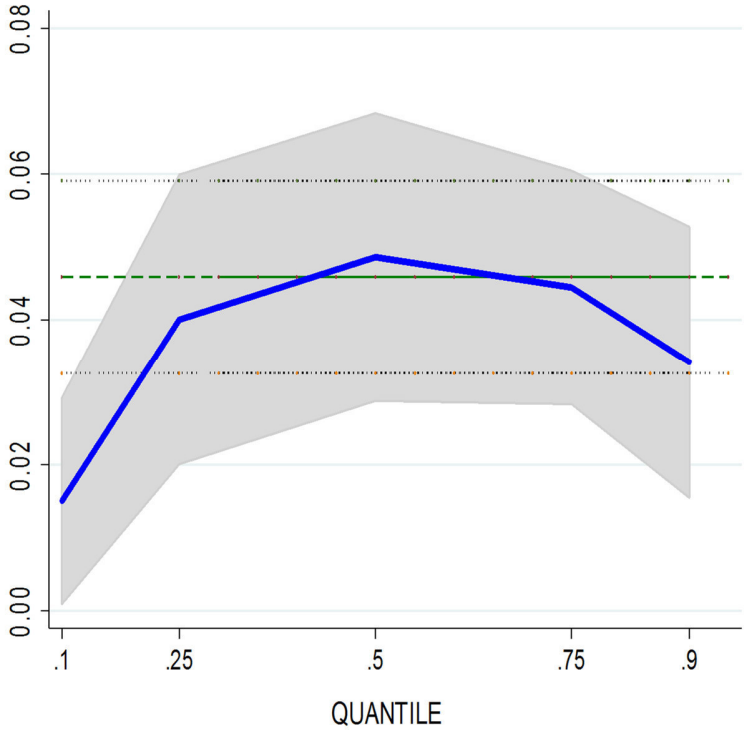
TABLE 4 - Quantile regressions

	All firms					Suppliers (100%) only				
	q10	**q25**	**q50**	**q75**	**q90**	**q10**	**q25**	**q50**	**q75**	**q90**
DPIAB	0.016**	0.038***	0.049***	0.046***	0.030**	0.0120	0.030*	0.054***	0.071***	0.043***
	0.022	*0.001*	*0.000*	*0.000*	*0.015*	*0.177*	*0.055*	*0.000*	*0.000*	*0.007*
DPSAB	0.0360	0.057***	0.037**	0.0090	0.0240	0.0300	0.071**	0.056**	0.0130	0.0100
	0.134	*0.009*	*0.018*	*0.535*	*0.157*	*0.334*	*0.015*	*0.022*	*0.517*	*0.626*
DEXP	0.0020	0.0150	0.031***	0.049***	0.047***	0.0020	0.0220	0.029*	0.063***	0.035*
	0.689	*0.168*	*0.006*	*0.000*	*0.001*	*0.748*	*0.128*	*0.063*	*0.001*	*0.078*
SMES	-0.276***	-0.358***	-0.312***	-0.205***	-0.101***	-0.247***	-0.300***	-0.284***	-0.189***	-0.094***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
lnAGE_1	0.0040	0.023***	0.035***	0.019***	0.0000	0.009*	0.033***	0.041***	0.023***	0.0080
	0.243	*0.000*	*0.000*	*0.001*	*0.958*	*0.093*	*0.000*	*0.000*	*0.010*	*0.402*
TRAIN	0.020*	0.063***	0.075***	0.084***	0.059**	0.0070	0.0240	0.041*	0.0410	0.070**
	0.064	*0.006*	*0.000*	*0.000*	*0.011*	*0.598*	*0.394*	*0.059*	*0.136*	*0.012*
DINNO	0.0040	0.0140	0.0150	-0.0050	-0.0060	0.0070	0.0080	0.0010	-0.0190	0.0000
	0.400	*0.234*	*0.226*	*0.751*	*0.628*	*0.427*	*0.502*	*0.947*	*0.263*	*0.982*
DR&D	0.0050	0.032***	0.028**	0.030**	0.0200	0.0080	0.054***	0.048***	0.042**	0.0110
	0.335	*0.006*	*0.015*	*0.030*	*0.110*	*0.274*	*0.000*	*0.003*	*0.021*	*0.497*
SUPP	0.0100	-0.0060	-0.024*	-0.041***	-0.039***					
	0.223	*0.633*	*0.097*	*0.005*	*0.005*					
DGROUP	0.043**	0.108***	0.149***	0.170***	0.115***	0.0390	0.081***	0.125***	0.136***	0.083***
	0.026	*0.000*	*0.000*	*0.000*	*0.000*	*0.106*	*0.000*	*0.000*	*0.000*	*0.000*
Observations			6,699					3,618		
Bootstrap replications			500					500		
F-Test (q10=q25=q50=q75=q90):										
- DPIAB			2.670					3.170		
			0.030					*0.013*		
- DEXP			3.660					2.620		
			0.006					*0.033*		

For the description of variables see Table 1. The dependent variable is firm's Total Factor Productivity. Superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent level, respectively. In italics are reported the p-values of the tests. Bootstrapped standard errors (500 replications) are omitted. Country and sector dummies included but not reported. AGE is the log of (1+firm's age) and lagged once. The F-test reported verifies the equivalence of the DPIAB and DEXP coefficients across quantiles.

FIGURE 5

Panel [A] - Quantile results. <u>All firms</u>



Panel [B] - Quantile results. <u>Supplier firms</u>

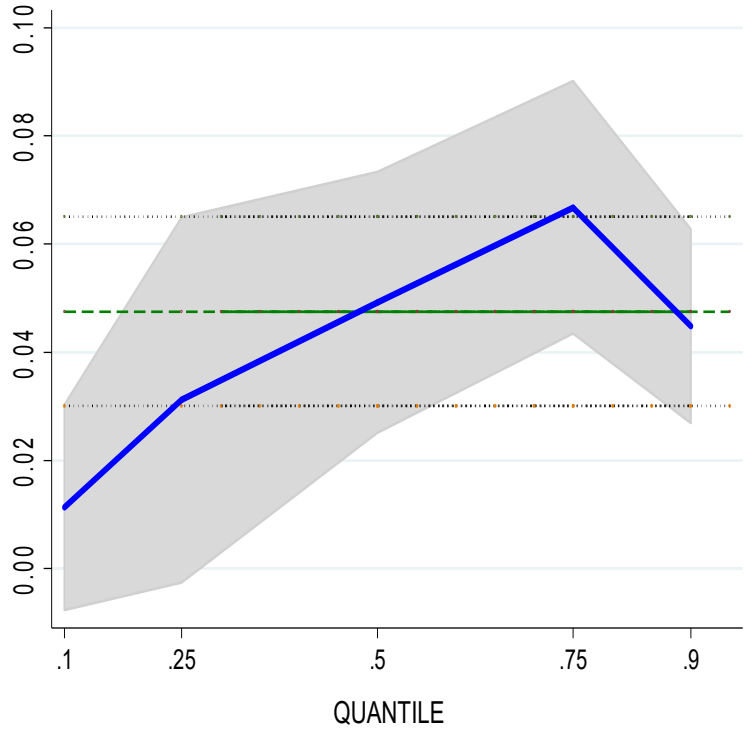
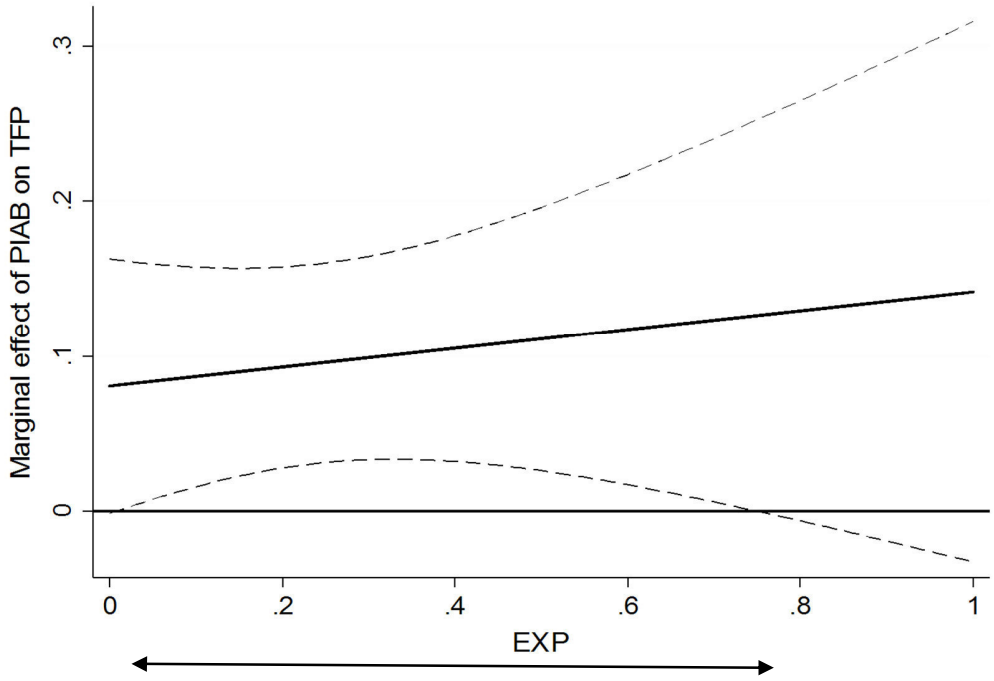


TABLE 5 - Estimation results. Supplier firms

	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*
PIAB	0.096***			0.076*	0.079*
	0.004			*0.069*	*0.058*
DPIAB		0.057***			
		0.000			
TECON					
DPSAB		0.062***			
		0.009			
EXP	0.094***			0.084***	0.093***
	0.001			*0.006*	*0.001*
DEXP		0.031**			
		0.024			
DPIAB_BEF			0.050***		
			0.001		
DPSAB_BEF			0.0200		
			0.420		
DEXP_BEF			0.028**		
			0.048		
SMES	-0.336***	-0.331***	-0.335***	-0.334***	-0.335***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*
lnAGE_1	0.030***	0.032***	0.029***	0.030***	0.030***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*
TRAIN	0.064***	0.062***	0.062***	0.064***	0.056**
	0.008	*0.007*	*0.008*	*0.009*	*0.032*
DINNO	0.0030	0.0040	0.0050	0.0040	0.0030
	0.815	*0.788*	*0.707*	*0.807*	*0.835*
DR&D	0.040***	0.037***	0.042***	0.040***	0.040***
	0.008	*0.009*	*0.003*	*0.007*	*0.007*
DGROUP	0.126***	0.135***	0.138***	0.126***	0.125***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*
PIAB*EXP				0.0690	
				0.526	
PIAB*TRAIN					0.0760
					0.544
Observations	3,418	3,618	3,612	3,418	3,418
Model test	37.53	40.60	39.58	36.15	36.06
	0.000	*0.000*	*0.000*	*0.000*	*0.000*
R^2	0.22	0.23	0.23	0.22	0.22
Test joint sign. (PIAB,PIAB*EXP)				4.18	
				0.015	
Test joint sign. (PIAB, PIAB*TRAIN)					4.26
					0.014

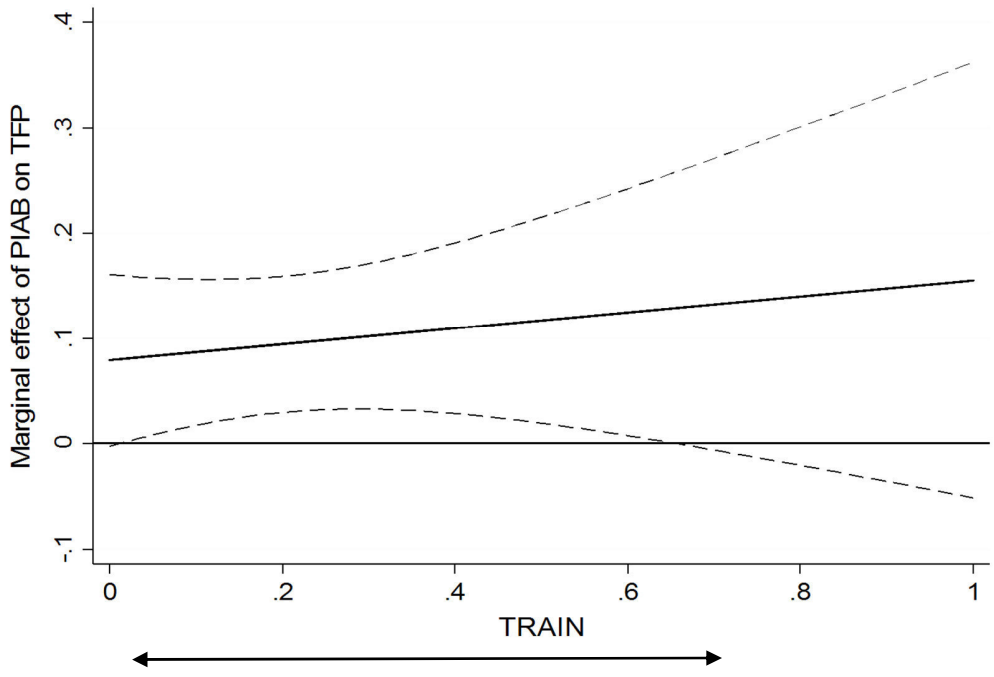
For the description of variables see Table 1. The dependent variable is firm's Total Factor Productivity. Superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent level, respectively. In italics are reported the p-values of the tests. The standard errors (not reported) are robust to heteroskedasticity and autocorrelation. Country and sector dummies always included but not reported. lnAGE_1 is the log of (1 + firm's age) lagged once.

FIGURE 6 - Marginal effect of PIAB on TFP as EXP changes. Supplier firms
(---95% confidence interval)



92.7% of the estimating sample observations

FIGURE 7 - Marginal effect of PIAB on TFP as TRAIN changes. Supplier firms
(---95% confidence interval)



88.7% of the estimating sample observations