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Irish firms' productivity and Imported Inputs

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Abstract

In this paper, we investigate the empirical relationship between firms' productivity, and imports of intermediate inputs at plant level. Using a unique dataset for Ireland, we focus our analysis on manufacturing firms by distinguishing for ownership and relative efficiency. Our findings show that an increase in the intensive margin of imports positively affects the efficiency of domestic firms, in particular through the imports of materials. Most importantly, we find heterogeneous responses to variations in import intensity, depending on the initial level of productivity. The more efficient a domestic firm is, and the larger the benefits from importing are. The results are robust to potential endogeneity of imports' decisions, and to reverse casualty: past efficiency levels are not correlated with current import intensity.

JEL Classification: F10, F14, D24, L25

Keywords: Firms' Productivity, Inputs, Import

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1 Introduction

In the last decade the availability of firm-level dataset has developed the research on the causal relationship between export activity and firm efficiency. The main fundamental results are two. First, more efficient firms tend to self-select into the international markets (Roberts and Tybout, 1997; Bernard and Jensen, 1999; Melitz, 2003; Melitz and Ottaviano, 2008). Second, there is little evidence that export activity generates productivity growth after the entry. The so-called "learning-by-exporting" effect has been detected in only a limited number of cases (mostly in developing countries: Bernard and Jensen, 1999; DeLoecker, 2007). However, exporting is not the only international trade activity. The purchase of intermediate input from foreign sellers is firms' trade in the international markets[1]: similarly to exporting also import activity can be correlated with firms' characteristics such as efficiency.

Which factors make appealing imports, and what determines the firm's decision to purchase inputs from abroad? At first, imported inputs may exhibit more desirable characteristics compared to domestic inputs (for the same price). An importing firm can exploit a technology in foreign inputs, which is not available in domestic goods (Goldberg et al., 2008); in other words, for given a price level imported goods may be of higher quality (Castellani, et al., 2010). In addition the origin of imported inputs is potentially relevant because benefits from importing differ in function of imports' country of origin: firms in developing countries benefit more in term of efficiency if they import machinery from developed regions given that those inputs are more intensive in capital and technology (Caselli and Wiston, 2004). Foreign markets may offer a greater variety of intermediate goods with respect to the domestic input market. New varieties can be used to improve the quality and the features of the final output; within a larger pool of varieties it is more likely to find an input that matches the needs of production process (Altomonte Békés, 2009). These arguments are particularly crucial the competitiveness of firms in a small and open economies, since that the domestic market cannot provide enough variety and quality for the intermediate inputs (Damijan et al., 2009). For these reasons, the present paper aims to describe the empirical relationship between importing and efficiency[2] at the firm level.

Our primary objective is to understand if variations in the quantity of imported inputs have an impact on the efficiency of firms in a small open economy: more precisely we focus our

investigation on a sample of firms located in Ireland. We attempt to identify which type of firm (domestic or foreign) benefits more from variations in measured imports, and the role of specific inputs as material or services. In contrast to large part of previous research, we focus on the burden of imported input rather than the dichotomous choice of importing[3]. Finally, we also control for potential reverse causality, i.e. we test if past efficiency determines current level of imports. With respect to the latter issue, we test it both parametrically (dynamic non-linear model for panel data) and not parametrically. Our paper is similar to Görg et al. (2008, GHS onward) in terms of targeted country (Ireland), and research objectives; however we employ a different dataset, we focus on different aspects of importing[4], and we implement an alternative empirical strategy.

We perform short run analysis, and we provide four main results. Firstly, the most productive firms rely less on inputs purchased in the domestic market. Secondly, firms' efficiency (labor productivity) is positively correlated with our measures of import intensity. In contrast with the previous literature, we observe that an increment in the intensive margin of importing (relative to domestic inputs) is associated with higher productivity of firms (Castellani et al., 2010). In addition we find that imports of materials are strongly correlated with firms' productivity compared to imports of services. Thirdly, and most important, we find statistically significant evidence that efficiency gains are heterogeneous across firms. Only Irish-owned firms in the manufacturing sector benefit from raising the import intensity, especially if firms are not too far from the efficient frontier, i.e. if firms reach a minimum level of efficiency. Foreign firms are more efficient and purchase from abroad more than domestic firms, however an increase in import intensity has a negligible impact on foreign firms' efficiency. Fourth, there is weak evidence that past efficiency affects current imports of intermediates. The not-parametric test shows that the probability to consume imported input today is independent from the past levels of efficiency. Our findings are complementary to the results of GHS (2008). The main contribution consists in the identification of heterogeneous responses to variations in import intensity. The magnitude and sign of the effects depends on firm ownership, and on the initial level of productivity.

The paper is structured as follows. In the next section (section 2) we briefly discuss the literature. In section 3, we describe the dataset and its characteristics. In section 4, we analyze the relationship between efficiency and import intensity, and in section 5 we perform robust-

ness check analyses. Section 6 discusses potential reverse causality, and section 7 reports final conclusions.

2 Related Literature

Trade economists have recently analyzed the relationship between firms' productivity and imported inputs. Literature has recognized different channels through which importing determines efficiency gains at firm level. First, the embedded technology plays an important role because inputs with *higher performances* may determine a more efficient production process. The presence of high technology inputs may require the employment of skilled workers, and simultaneously imported inputs can be a source of positive externalities for workers. Imperfect substitution is a second channels of transmission; an increase in the number of varieties employed in production process may raise efficiency through imperfect substitution among inputs[5](Either, 1982). Briefly, imported inputs can be a source of productivity growth via quality, technology, learning, or variety effects (Amiti and Konings, 2007). For example, Halpern et al. (2011) demonstrate, for a sample of Hungarian firms, that gains from importing depend on input quality (technology) and imperfect substitution (variety) among them; the more complex the bundle of imports is, the larger the productivity gains are. In a similar framework, Damijan et al. (2009) show that the level of absorptive capacity is crucial to determine the magnitude of efficiency gains from importing. Even if we are not able to identify exactly the different channels, we know that the magnitude of these effects may depend on the firms' characteristics. We show that the benefits from raising import intensity are heterogeneous, and that efficiency gains differ with respect to firms' ownership and initial level of efficiency. Irish firms' productivity raises with import intensity, and the gains are larger for importers which are relatively more efficient.

Another interesting finding is the existence of complementarity among exports and imports. Altomonte and Békés (2009), using a sample of Hungarian firms, demonstrate that import activity is similar to export activity at firm level. There exists an *ex-ante* advantage for new traders while two-way traders (both importers and exporters) show a productivity *premia*compared to to non-traders [6]. A similar self-selection process is observed by Muûls and Pisu (2011) for the population of Belgian firms; they demonstrate that the productivity premia of exporters, often

reported by the literature, has been potentially overstated because import activity has not been considered.

Productivity gains from importing are often detected for firms located in small open economies. Amiti and Konings (2007) find that the efficiency of Indonesian manufacturing firms increase if taxes on imports are reduced. The results slightly differ when the analysis is carried out for firms in large economies. Vogel and Wagner (2009) find evidence of a positive effect of efficiency on import activity (self-selection) whereas they do not find evidence of learning by the importing effect. Similarly, Castellani et al. (2009) find self-selection into the import market, and they detect some form of *ex-post* benefits due to the import, which are dependent upon geographical factors. Summarizing, we observe at firm level that efficiency determines self-selection in import market for firms in large countries, while efficiency gains from importing exists in small or developing countries. Importing affects efficiency for those firms located in small markets with few varieties of inputs; variety expansion and technology access are identified as important channels of transmission from importing to efficiency. In the present case we focus on Ireland that could be assimilated to a small open economy such as Belgium or Hungary; then we find that importing is positively correlated with productivity growth of domestic firms.

Finally, GHS (2008) are close to the present paper in term of objective and targeted country. We differ in term of methodology, and data source. Firstly, we use the Annual Business Survey Economic Impact (ABSEI) rather than the *Irish Economy Expenditure Survey*. Secondly, we focus on importing rather than outsourcing of a firm's internal task. Third we use a different empirical strategy with firms level data. Our results are complementary to GHS (2008). They find a positive effect from outsourcing services, both for domestic and foreign owned firms. Instead we find evidence that import intensity is positively correlated with domestic firms' efficiency. We show that import of material affects firms' productivity, while GHS (2008) report that outsource of services affects firms' efficiency: in this sense our results are complementary to GHS (2008).

3 Data Analysis

Our primary data source is the Annual Business Survey Economic Impact (ABSEI) provided by Forfás; the dataset collects information about a large sample of anonymous firms that operate in

Ireland. The dataset includes both Irish and foreign owned firms[7], and we have information for twenty industrial sectors (manufactures and services), according to the NACE two-digit classification (Table A.1 in Appendix A). ABSEI provides information about revenues, intermediate inputs (material and services), number of employees, imports, and exports[8], while no measures of capital are reported in the dataset: Table A.2 shows descriptive statistics at the sector level.

The lack of information about capital stocks is a potential drawback of the dataset, because we cannot measure firm's technical efficiency as a residual of a production function (total factor productivity, i.e. TFP). For the same reasons, it is not possible to approximate firms' efficiency nor with index numbers (as Tornqvist index), nor to follow GHS (2008) approach, nor to use other parametric techniques (Levinsohn and Petrin, 2003). Nonetheless, we can measure firms nominal efficiency with value added per worker i.e., labour productivity (LP). The advantage of LP is to abstract from any assumptions about the functional form of production technology, and market structure. However labor productivity is potentially biased by the existence of firms' market power: our indicator of efficiency can measure profitability rather than efficiency. Therefore we are going to include different controls in the empirical analysis in order to minimize such concerns. Despite some drawbacks, LP have been widely used both in trade[9] (Helpman et al., 2004; Lileeva and Trefler, 2010), and industrial economics literature (Bloom et al., 2012) to assess firms' efficiency, so that we are confident that our indicator is a reliable measure of productivity.

Another notable aspect of the ABSEI dataset is the *selection* process for domestic owned firms. The data reported by ABSEI refer to those (Irish) firms that received or requested support in R&D activities[10]. Thus, we cannot ignore a kind of "self-selection" process for Irish firms: to some extent we consider only more "dynamic" firms[11]. This implies, in turn, that we must interpret the results as the effect of importing activity on the more *active* enterprises. Table 3.1 illustrates differences in performances between firms in the sample and the average Irish economy. The first three columns report the average productivity (LP) growth rates for firms in the dataset[12]. We observe that the efficiency of Irish firms in the sample has grown more than the average Irish economy (from EU-Klems) especially in manufacturing sector (8.7% versus 4.2%); differently there is no difference between growth rates in services (for Irish firms). Later we show that the impact of import intensity varies according to the relative level of efficiency (distance from the frontier).

Table 3.1: Average Growth(LP) 2001-2005‡

	LP Growth(pw) ABSEI			LP Growth(pw) EU-KLEMS
	Irish	Foreign	Total	Average
Agric.	0.085	0.414[a]	0.097	0.061
Manuf.	0.087	0.037	0.074	0.042
Services	0.084	0.061	0.057	0.081
Total	0.086	0.023	0.069	0.061

‡ Value added per worker growth rates. The averages from ABSEI data are calculated as weighted averages, using relative market shares as weights. Source: ABSEI data, and our calculation from EU-KLEMS.
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[a] Just one foreign firm in the agricultural sector.

3.1 Import data

The ABSEI dataset reports information about the value of inputs (both for services and raw materials in thousands of euros), and the origin[13], i.e. if imported or locally produced (domestic). Information on imports allow us to construct our main variable of interest, which is a measure of import intensity at firm level: it is defined as the ratio between foreign inputs and total inputs. At this stage we not distinguish between services and material, so that primary measure of import intensity is defined as follows

$$Ratio_{it} = \frac{M(F)_{it} + S(F)_{it}}{M(T)_{it} + S(T)_{it}}, \tag{3.1}$$

where $M(j)_{it}$ and $S(j)_{it}$ are the consumption of material and services by origin (T=Total; F=Foreign) for firm i at time t. If the ratio increases, firm i uses more intensively foreign inputs. The index is equal to 0 if a firm does not import, and equal to 1 if a firm employs just imported goods[14]. Therefore, variations in Eq.3.1 describes changes in the burden of foreign inputs. Differently from GHS (2008), our indicator aims to proxy the substitutability between domestic and foreign input[15] for a given firm's size, rather than outsourcing of internal tasks. Index 3.1 can be considered as an indicator of how much imported input (purchased abroad) are preferred to inputs in the domestic market. Table 3.2 reports the average ratios by sectors. As expected, the intensity ratio is higher for imports of material rather than for services (Ariu and Mion, 2010): physical goods are more traded than services[16]. Among manufacturing firms, imported inputs are intensively used in textiles (17) or chemical sectors (24).

Table 3.2: Average import intensity ratio[‡]

Sector	Nace2	Ratio	SRatio	MRatio
Agricolture	10	0.164	0.124	0.196
Food Beverages & Tobacco	15	0.215	0.103	0.261
Textile Clothes Leather	17	0.555	0.151	0.727
Wood	20	0.307	0.088	0.365
Pulp Paper & Printing	22	0.392	0.087	0.524
Chemical	24	0.525	0.200	0.663
Rubber and Platics	25	0.506	0.106	0.651
Non-Metallic Minerals	26	0.307	0.081	0.441
Basic Metal & Fabricated Metals	27	0.404	0.092	0.521
Machinery n.e.c.	29	0.442	0.119	0.547
Electrical and Optical Equipment	30	0.484	0.186	0.629
Transport Equipment	34	0.568	0.128	0.684
Manufacturing n.e.c.	36	0.377	0.110	0.491
Networks	40	0.306	0.168	0.595
Construction	45	0.275	0.077	0.340
All Other Services	50	0.243	0.134	0.405
Financial Intermediation	65	0.305	0.274	0.189
Computer and Related Activities	72	0.253	0.186	0.421
Research and Development	73	0.204	0.138	0.393
Other Business Activities	74	0.251	0.131	0.419
Total		0.360	0.139	0.496

[‡] Source: ABSEI. Unweighted average across sectors for import intensity ratio (Eq. 3.1). Ratio is intensity ratio for imported inputs; SRatio is intensity ratio for imported services ; MRatio is intensity ratio for imported material.

Table 3.3 reports the average import intensity, and the average participation rate (in the import market) for different types of firms in manufacturing sectors[17]. We observe that foreign firms import more intensively intermediate goods than Irish firms (0.593 vs 0.410); similarly exporters are more intensive importers than non-exporting firms (0.478 vs 0.391). On average foreign inputs account for the 46% of all inputs used in the production process. The lower part of Table 3.3 shows import participation rate. We observe that almost all foreign firms and Irish exporters are involved in import activity, and "only" the 70% of non-exporting Irish firms purchase intermediate inputs from abroad. Such descriptive statistics suggest that the domestic market lacks of inputs, which are necessary to local production.

Table 3.4 reports the average labor efficiency by firms' ownership and trade status (import and/or export). The rows indicate export status (non-exporter vs. exporter), while the columns report import status (non-importer vs. importer): in each cell we show the average efficiency level for each group. The importers show on average a higher efficiency level compared to non-importers (3.34 vs. 3.12 in row 3), and the difference is statistically significant. However it seems

that such result is determined by foreign firms (row 9) rather than Irish firms (row 6): efficiency of Irish firms is not different between importers (3.126) and not-importers (3.125). Additionally, exporting firms are always more efficient than non-exporting firms independently from ownership (column Total). Similarly to Altomonte and Békés (2009), we find a ranking, where the most efficient firms are those firms involved in both import and export activities, while the less efficient firms are the non-trading firms. Finally, foreign firms generally show a higher efficiency index.

Table 3.3: Import intensity ratio and import participation rate (manufactures)[‡].

Ownership \ Export Status	Not-Exporter	Exporter	Total
	Average imports intensity ratio		
Irish	0.383	0.418	0.410
Foreign	0.476	0.598	0.593
Total	0.391	0.478	0.463
	% of importers		
Irish	71.4	90.1	85.4
Foreign	92.6	95.9	95.7
Total	72.7	91.9	88.1

[‡] Source: ABSEI. Averages calculated across sectors and year for manufacturing firms. Not-Exporter: not-exporting firms. Exporters: exporting firms. Total: averages across classes.

Table 3.4: Average Log(LP) by trade activity and ownership (manufactures)[‡].

Export \ Import	Not-Importer	Importer	Total	row
	Aggregated			
Not-Exporter	3.072	3.121	3.110	row 1
Exporter	3.181	3.394	3.383^{a}	row 2
Total	3.121	3.342^{a}	3.322	row 3
	Irish Firms			
Not-Exporter	3.068	3.084	3.080	row 4
Exporter	3.138	3.206	3.143^{a}	row 5
Total	3.126	3.125^{b}	3.125	row 6
	Foreign Firms			
Domestic	3.395	3.531	3.525	row 7
Exporter	3.025	3.876	3.856^{a}	row 8
Total	3.062	3.858^{a}	3.838	row 9

[‡] Source: ABSEI. Log of value added per worker: Log(LP). Averages calculated across manufacturing sectors and year. In columns import status, in rows export status. The up-scripts reports the significance level for the mean comparison between two values in the same row or in the same column: a means a statistically significant difference between the two variables (means) at 5% confidence interval. b means a difference not statistically significant.

4 Empirical Analysis

Descriptive statistics show that import activity is correlated with firms efficiency. Traders (importers and exporters) are more efficient, larger, and invest more in R&D compared to non-traders: Table A.4 reports import and export *premia*. Exporters import more (column 3) than non-exporters, and foreign firms are more efficient and larger than domestic ones. In this section we define the empirical strategy used to evaluate the impact of imported inputs on firms' efficiency. In our baseline model, firm's productivity depends on import intensity[18] (Eq.3.1). We assume that productivity of firm i at time t takes the form

$$PROD_{it} = PROD_{it-1}^{\alpha} * RATIO_{it}^{\beta} * X(n)_{it}^{\gamma(n)} * A_{it}. \tag{4.1}$$

Productivity is a function of its own past realization ($PROD_{it-1}$), and contemporaneous level of input mix[19] ($RATIO_{it}$) as defined in Eq. 3.1. We include a set of control variables (X_{it}), and a random error term ($A_{it} = \exp^{\varepsilon_{it}}$). Taking the logs of Eq. 4.1, we obtain our reduced form model

$$log(LP)_{it} = \alpha log(LP)_{it-1} + \beta Ratio_{it} + \sum_{n} \gamma_n x(n)_{it} + \varepsilon_{it} \tag{4.2}$$

where $log(LP)$ is our indicator of firms' efficiency in logs (i.e., labor productivity). The coefficient β describes the causal relationship of interest: it measures (in the short run) how firms' efficiency change in function of import intensity ($Ratio$). The identification strategy relies on the variations of import index across firms-years. We expect is positive sign for β: firms' productivity is expected to be positively correlated with the intensive margin of importing. A positive (and significant) coefficient suggests that efficiency positively adjusts to import intensity (in the short run).

Within the empirical model we consider additional covariates ($X(n)$), which are often related to productivity growth analysis. First of all, we control for total input consumption. Given that, productivity is defined as value added per worker, variations in firms' size (scale effect) or market power is a source of bias: an increase in value added can be caused by market power rather than efficiency gains. Given that, it can be difficult to disentangle the impact of import intensity (our objective) from potential variations in firm's size and market power. For these reasons, we employ

total input consumption (in log as $log(Input)$) to control for size and market power[20]. Then, we take into account export activity using an export dummy ($Export$) to capture the comparative advantage of exporters versus non-exporters[21]. Similarly, we control for the log of exports value in UK ($log(ExpUK)$), in EU ($log(ExpEU)$), and the rest of the world ($log(ExpWR)$). Other controls are indicators for R&D and workforce training activities measured as total expenditures in thousands of euros ($log(R\&D)$ and $log(Train)$) . Finally, we include year-fixed effects and sector dummies at Nace 2-digit level to control for business cycle and industry characteristics respectively. We estimate equation 4.2 with OLS, and the results[22] are reported in Table 4.1.

Table 4.1: OLS Regression: Labor Productivity‡

	(1) Aggr.	(2) Aggr.	(3) Manuf.	(4) Manuf.	(5) Manuf.	(6) Serv.	(7) Serv.	(8) Serv.
$\log(LP)_{it-1}$	0.715***	0.692***	0.706***	0.699***	0.702***	0.715**	0.666**	0.714**
	(0.029)	(0.031)	(0.016)	(0.016)	(0.016)	(0.078)	(0.078)	(0.080)
$\log(\text{Ratio})_{it}$	0.108*	0.091*	0.104*	0.090*	0.102*	0.137	0.043	0.150*
	(0.025)	(0.030)	(0.025)	(0.027)	(0.028)	(0.055)	(0.059)	(0.037)
$\log(\text{Input})_{it}$	0.011**	-0.004	0.018**	0.009	0.013**	0.002	-0.012**	-0.000
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.005)	(0.002)	(0.001)
Export_{it}	0.019	-0.153*	-0.024		-0.017	0.093		0.088
	(0.020)	(0.037)	(0.013)		(0.013)	(0.041)		(0.033)
$\log(\text{ExpEU})_{it}$		0.010*		0.001			0.018**	
		(0.003)		(0.002)			(0.004)	
$\log(\text{ExpUK})_{it}$		0.020**		0.005			0.023	
		(0.004)		(0.002)			(0.010)	
$\log(\text{ExpWR})_{it}$		0.021***		0.015***			0.028**	
		(0.002)		(0.002)			(0.004)	
$\log(\text{Train})_{it}$					0.024**			0.012
					(0.003)			(0.018)
$\log(\text{R\&D})_{it}$					-0.010			0.001
					(0.004)			(0.004)
Cons	0.805***	1.039***	0.868***	0.838***	0.905***	0.867*	0.403*	0.858*
	(0.074)	(0.074)	(0.065)	(0.062)	(0.071)	(0.243)	(0.115)	(0.228)
Obs.	10,528	10,303	7,633	7,454	7,633	2,764	2,722	2,764
R^2	0.614	0.625	0.622	0.626	0.623	0.596	0.618	0.597
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

‡ Robust standard errors are clustered by region and reported in brackets. Each column represents a regression. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Aggr: all industries. Manuf: Manufacturing firms. Serv: service firms.

By examining Table 4.1, we observe that there exists a positive and statistically significant correlation between import intensity and efficiency, especially for firms in manufacturing industries. As expected total input consumption ($log(Input)$) has a negative sign in almost all specifications (but not significant). Export status is not significant suggesting that the export premia could be overestimated if import activity is neglected (Altomonte and Békés, 2009; Muûls

and Pisu, 2009).

Even if first results move in the expected direction, OLS model does not take into account several issues. For example, unobserved heterogeneity among firms (due to location, managerial ability, etc) is neglected, and it may explain differences in efficiency. In order to exploit information provided by data in panel format, we decompose the *i.i.d.* error term ε_{it} into a time-invariant firm-specific error component c_i plus an *i.i.d.* error term ϵ_{it}. With fixed effects c_i we control for cross sectional differentials in productivity, which are potentially constant over the period of analysis (location, products, sector, etc...). In such a framework OLS is inconsistent and not efficient. In addition the autoregressive term of firm's productivity ($log(LP)_{it-1}$), the import intensity ratio ($Ratio$), and control variables $X(n)$ raise concerns related to serial correlation and endogeneity. In our model import intensity can be endogenous because importers could be *ex-ante* more efficient than non-importers (Castellani et al., 2010). Similarly, other control variables as export status are potentially endogenous (Bernard et al., 1999). In conclusion regressors are likely to be jointly endogenous (simultaneity or to two-way causality with the dependent variable), and the error term may suffer of serial correlation (productivity depends on its past realizations). In such a framework OLS is an inefficient and biased estimator, so that we need to employ an estimator that takes into account both endogeneity and the error term's structure.

To estimate our empirical model (Eq. 4.2), we implement a "difference GMM" estimator[23] for a dynamic panel-data (Arellano and Bond, 1991; Blundell and Bond, 1998). The methodology consists in transforming the variables from Eq. 4.2 in first-differences to eliminate the unobserved heterogeneity c_i (time invariant); then first-differences ($\Delta x_{it} = x_{it} - x_{it-1}$) are instrumented with corespondent lagged values in levels. Our empirical model becomes

$$\Delta LP_{it} = \alpha \Delta LP_{it-1} + \beta \Delta Ratio_{it} + \sum_n \gamma_n \Delta x(n)_{it} + \Delta \epsilon_{it}. \tag{4.3}$$

Two critical assumptions must be satisfied by "difference GMM" estimator to be consistent and efficient. At first, the explanatory variables must be predetermined by at least one period (instruments uncorrelated with the contemporaneous error term). Second, the error terms must be serially uncorrelated in the second order. In the present case, all variables are considered endogenous[24], and instruments start from the third lag (e.g., variable $\Delta Ratio_{it}$ is instrumented

with $log(Ratio)_{t-3}$ and its subsequent lags). The validity of assumptions is verfied with two tests. The first test is the Sargan-Hansen test of over-identifying restrictions for the instruments: the null hypothesis state that there is no-correlation between instruments and residuals. The second test is a test for a second-order serial correlation in the residuals. If this test rejects the null hypothesis, a second-order serial correlation is detected in the residuals. In the bottom part of the tables we report the p-values for both the Sargan-Hansen test and autocorrelation test (AR2).

4.1 Results

In this section we present the results obtained by estimating Eq. 4.3 with "difference GMM". In a first set of results we replicate the exercise in Table 4.1: Table 4.2 reports estimated coefficients.

Table 4.2: Difference-GMM: Labor Productivity[‡]

	(1) Aggr.	(2) Manuf.	(3) Manuf.	(4) Manuf.	(5) Serv.	(6) Serv.	(7) Serv.
$\log(LP)_{it-1}$	0.304***	0.035	-0.032	0.030	0.274***	0.216***	0.198***
	(0.064)	(0.039)	(0.044)	(0.039)	(0.093)	(0.066)	(0.050)
$\log(Ratio)_{it}$	0.703*	1.243***	1.091***	0.825***	-1.509*	-0.840	-0.652
	(0.391)	(0.428)	(0.420)	(0.181)	(0.887)	(0.592)	(0.450)
$\log(Input)_{it}$	-0.049	-0.040	-0.088	-0.054	0.055	-0.020	0.009
	(0.183)	(0.117)	(0.094)	(0.072)	(0.113)	(0.059)	(0.034)
$Export_{it}$	-0.362	-0.357	-0.255		0.380***	0.185	
	(0.470)	(0.288)	(0.271)		(0.138)	(0.234)	
$\log(R\&D)_{it}$			0.011			-0.013	
			(0.043)			(0.009)	
$\log(Train)_{it}$			-0.011			0.166**	
			(0.036)			(0.081)	
$\log(ExpEU)_{it}$				0.021			0.107***
				(0.085)			(0.030)
$\log(ExpUK)_{it}$				0.038***			0.090**
				(0.008)			(0.044)
$\log(ExpWR)_{it}$				0.036			-0.001
				(0.122)			(0.008)
Obs.	7,297	5,393	5,393	5,280	1,823	1,823	1,794
Firms	2278	1621	1621	1598	623	623	618
# Instr.	45	45	65	65	45	65	65
Sargan Test	0.978	0.826	0.875	0.560	0.799	0.924	0.556
AR2 Test	0.143	0.333	0.066	0.347	0.604	0.654	0.623

[‡] Dynamic panel-data estimation, Difference GMM estimator. Dependent variable is log of value added per workers ($log(LP)$). Each column represents a regression. The robust standard error are clustered across regions and reported in brackets. For the Hansen Test and AR2 Test are reported the p-values. # Instr: number of instruments. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included. Aggr: aggregated industries. Manuf: Manufactures. Serv: services.

We observe that the relationship between firms' efficiency and import intensity remains statistically significant only for the manufacturing sectors (columns 2, 3, and 4). An increase of 1% in import intensity is associated with an average growth of 1.2% in the efficiency of manufacturing firms (col.2). Correcting for the endogeneity we obtain larger β coefficients compared to Table 4.1. The lagged dependent $log(LP)_{it-1}$ is only significant for firms in services, while $log(Input)_{it}$ is negative as expected (but not significant). Similarly, export status is not significant (excluding col.5) while export sale in UK is positively correlated with firms' efficiency.

Given that import intensity is statistically relevant only for firms in manufacturing sectors, we focus our investigation on this specific group of firms. More precisely, we split the sample of manufacturing firms into Irish-owned and foreign-owned firms to control for ownership effects (as in GHS, 2008). The results are reported in Table 4.3. The indicator of intensive margin of imports ($Log(Ratio)$) is significant only for the sub-sample of Irish firms (negative and significant for foreign firms in col.5).

A variation in import intensity has an impact of the same sign on the efficiency of Irish-owned firms (in manufacturing industries); an increase of 1% in the $Log(Ratio)$ is associated with a growth of 1.5% in the efficiency (col. 3). Similarly to the previous table $log(Input)_{it}$ has a negative sign as expected[25]. Finally, the over-identification and autocorrelation test support the validity of the GMM estimator.

To conclude, productivity of domestic firms is positively correlated with the intensive margin of importing; on the other side we do not find a similar statistical relationship for foreign firms. Probably, foreign firms may have already exploited the efficiency gains originated by import activity, so that there are no more additional benefits from raising their import quota. Descriptive statistics indicates that foreign firms are more productive and use more intensively imported inputs (Tab. 3.3 and 3.4) compared to Irish ones. In addition, the results are also consistent with the idea that importing play a crucial role for the competitiveness (efficiency) of firms located in small countries with small markets (Damijan et al., 2009). Differently from GHS (2008) we do not find a significant and positive effect for foreign owned firms. However it is important to recall that our measure of import intensity differs from GHS indicator of outsourcing. In the present case, we aim to measure the role of imported input by scaling them for total input purchase. Instead GHS (2008) focus on the outsourcing of internal tasks to analyze the effects

Table 4.3: Difference-GMM: Labor Productivity in Manufactures[‡]

	(1) Irish	(2) Irish	(3) Irish	(4) Foreign	(5) Foreign	(6) Foreign
$\log(LP)_{it-1}$	0.058	0.004	0.050	0.049	-0.028	0.068
	(0.141)	(0.103)	(0.135)	(0.040)	(0.032)	(0.052)
$\log(Ratio)_{it}$	1.577***	1.168***	1.495***	-0.125	-0.312**	-0.078
	(0.538)	(0.382)	(0.132)	(0.536)	(0.133)	(0.267)
$\log(Input)_{it}$	-0.035	-0.049	-0.063***	0.097	0.018	-0.063*
	(0.039)	(0.035)	(0.023)	(0.089)	(0.102)	(0.035)
$Export_{it}$	0.063	0.185		-0.807	-0.105	
	(0.189)	(0.144)		(0.819)	(0.235)	
$\log(R\&D)_{it}$		0.068*			0.014	
		(0.038)			(0.013)	
$\log(Train)_{it}$		-0.080*			0.042	
		(0.042)			(0.074)	
$\log(ExpEU)_{it}$			0.116*			-0.067
			(0.063)			(0.074)
$\log(ExpUK)_{it}$			0.107***			0.009
			(0.039)			(0.016)
$\log(ExpWR)_{it}$			0.072			0.036
			(0.044)			(0.088)
Obs.	3,852	3,852	3,747	1,541	1,541	1,533
Firms	1182	1182	1161	439	439	437
# Instr.	45	65	65	45	65	65
Sargan Test	0.401	0.580	0.965	0.669	0.115	0.033
AR2 Test	0.940	0.445	0.882	0.219	0.070	0.281

[‡] Dynamic panel-data estimation, Difference GMM estimator. Dependent variable is log of value added per workers ($log(LP)$). Each column represents a regression. The robust standard error are clustered across regions and reported in brackets. For the Hansen Test and AR2 Test are reported the p-values. # Instr: number of instruments. Irish and Foreign firms are considered separately. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included.

of externalization of in-house-production on efficiency. More precisely our indicator captures substitutability between local input and foreign input, instead GHS(2008) measure the degree of substitution between imported input and labor force size. Then, our results can be considered as complement to the ones of GHS (2008).

Next step is to understand in details how imports affect a firm's efficiency. Thus, we define a measure of import intensity for both material and services. The former is the ratio of imported material to total material consumption ($Mratio$), while the latter is similarly defined for services ($Sratio$): the sum of the two is equal to Eq. 3.1. We estimate Eq 4.3 for manufacturing firms by substituting *Ratio* with the two measures of import intensity (material and services). Results are reported in Table 4.4. Again, import intensity is correlated with the efficiency of Irish firms (in manufacturing sectors). However we observe that material's import intensity is statistically

significant while imports of services no (both for Irish and foreign firms). The coefficients of $log(Mratio)$ are not very different from estimated coefficients of $log(Ratio)$ reported in Table 4.3; it provides evidence that an increase in the intensive margin of imported material is associated with a higher level of efficiency[26] (at least for Irish firms).

Table 4.4: Manufacturing firms: imports of services and material[‡]

	(1) All	(2) Irish	(3) Irish	(4) Irish	(5) Foreign	(6) Foreign	(7) Foreign
$\log(\text{LP})_{it-1}$	0.014	0.021	-0.028	0.018	0.011	-0.038	0.060
	(0.049)	(0.075)	(0.046)	(0.097)	(0.075)	(0.028)	(0.086)
$\log(\text{Sratio})_{it}$	0.160	0.436	0.418	0.067	-0.774	-0.508	-0.040
	(0.353)	(0.527)	(0.680)	(0.635)	(0.618)	(0.367)	(0.799)
$\log(\text{Mratio})_{it}$	1.160***	1.606***	1.207***	1.537***	-0.140	-0.193	-0.421
	(0.217)	(0.467)	(0.368)	(0.101)	(0.261)	(0.338)	(0.482)
$\log(\text{Input})_{it}$	-0.074	-0.100	-0.091	-0.113	-0.028	-0.085	-0.117
	(0.161)	(0.074)	(0.059)	(0.077)	(0.087)	(0.101)	(0.100)
Export_{it}	-0.431	0.123	0.276*		-0.883***	-0.269	
	(0.326)	(0.218)	(0.141)		(0.239)	(0.308)	
$\log(\text{R\&D})_{it}$			0.056*			0.021	
			(0.032)			(0.015)	
$\log(\text{Train})_{it}$			-0.044			0.029	
			(0.035)			(0.082)	
$\log(\text{ExpEU})_{it}$				0.079			-0.043
				(0.067)			(0.046)
$\log(\text{ExpUK})_{it}$				0.122**			0.023
				(0.059)			(0.019)
$\log(\text{ExpWR})_{it}$				0.076**			0.045
				(0.034)			(0.089)
Obs.	5,275	3,764	3,764	3,663	1,511	1,511	1,503
Firms	1585	1156	1156	1135	429	429	427
# Instr	55	55	75	75	55	75	75
Sargan Test	0.821	0.4464	0.506	0.976	0.694	0.157	0.056
AR2 Test	0.168	0.631	0.126	0.404	0.181	0.075	0.314

[‡] Dynamic panel-data estimation, Difference GMM estimator. Dependent variable is log of value added per workers ($log(LP)$). Each column represents a regression. The robust standard error are clustered across regions and reported in brackets. For the Hansen Test and AR2 Test are reported the p-values. # Instr: number of instruments. Irish and Foreign firms are considered separately. Column 1 reports results for all firms in manufacturing industries. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included.

The not-significant effect of services can be explained by the fact that we are measuring import intensity rather than externalization of internal tasks[27] (outsourcing). It is likely that externalization of an internal tasks such as accountancy or R&D have positive impact on firms' efficiency, while imports of services not. In the former case outsourced services substitute internal labor, in the latter case imported services are used in place of locally purchased services. The same reasoning can be applied to imported materials. To conclude, we can state that Irish firms

benefit from importing material and form outsourcing services: in this sense our results are complementary to GHS[28] (2008).

5 Robustness Checks

In this section we test the robustness of our results. At first, we define an alternative indicator of import intensity. To measure the intensive margin of imports, we employ the following ratio

$$Ratio2_{it} = \frac{M(F)_{it} + S(F)_{it}}{M(I)_{it} + S(I)_{it}}, \tag{5.1}$$

where $M(j)_{it}$ and $S(j)_{it}$ are the consumption of material (M) and services (S) by origin j (I=Irish; F=Foreign) for firm i at time t. When the ratio increases firm i use more intensively foreign inputs. The index is equal to 0 if a firm does not import, and the index grows with import intensity. Similarly to index 3.1, also this index aims to capture the substitutability between domestic and foreign inputs: when $Ratio2$ raises it means that foreign inputs are preferred to domestic ones. We introduce index 5.1 in the estimation of Eq 4.3. Results are reported in Table 5.1 for manufacturing firms only.

Estimated coefficients confirm the previous findings, i.e. the positive correlation between efficiency and import intensity. The coefficient of $Ratio2$ is positive and significant for Irish manufacturing firms (columns 2-4); an increase of 10% in $Ratio2$ is associated with a growth of 4.6% in labour productivity (column 4). We find a positive and significant effect for foreign firms that we did not find before (col.7). Input consumption is negatively correlated with productivity growth (as expected), while R&D expenditures or level of sales abroad are positively correlated with the dependent variable.

In the next robustness exercise we test if efficiency gains from importing vary across firms. We observed that the intensive margin of importing is statistically correlated only with Irish firms' productivity, which are on average less efficient than foreign firms: we want to understand if the empirical relationship (sign and magnitude) changes according to a measure of relative efficiency. This exercise is coherent with the idea of absorptive capacity, and internal skills' level required to exploit "benefits" from imported inputs (Halpern et al., 2011).

Table 5.1: Robustness: alternative index‡

	(1) Aggr.	(2) Irish	(3) Irish	(4) Irish	(5) Foreign	(6) Foreign	(7) Foreign
$\log(LP)_{it-1}$	0.072***	0.213	0.024	0.053	0.071**	-0.018	0.070
	(0.021)	(0.139)	(0.094)	(0.106)	(0.032)	(0.014)	(0.043)
$\log(Ratio2)_{it}$	0.311**	0.520***	0.370***	0.463***	0.119	0.096	0.217**
	(0.155)	(0.134)	(0.041)	(0.047)	(0.199)	(0.150)	(0.103)
$\log(Input)_{it}$	-0.073	-0.097	-0.038	-0.068***	0.012	-0.056	-0.080*
	(0.090)	(0.060)	(0.037)	(0.026)	(0.054)	(0.079)	(0.047)
$Export_{it}$	-0.320	-0.089	0.168		-1.064*	-0.303	
	(0.274)	(0.332)	(0.182)		(0.564)	(0.373)	
$\log(R\&D)_{it}$			0.073**			0.014***	
			(0.031)			(0.003)	
$\log(Train)_{it}$			-0.094***			-0.017	
			(0.031)			(0.104)	
$\log(ExpEU)_{it}$				0.081			-0.078
				(0.065)			(0.081)
$\log(ExpUK)_{it}$				0.107***			0.010
				(0.041)			(0.013)
$\log(ExpWR)_{it}$				0.081			0.050
				(0.057)			(0.068)
Obs.	5,363	3,831	3,831	3,727	1,532	1,532	1,524
Firms	1615	1178	1178	1157	437	437	435
# Instr.	45	35	65	65	45	65	65
Sargan Test	0.583	0.580	0.591	0.897	0.177	0.011	0.036
AR2 Test	0.540	0.424	0.421	0.687	0.336	0.090	0.320

‡ Dynamic panel-data estimation, Difference GMM estimator. Dependent variable is log of value added per workers ($log(LP)$). Each column represents a regression. The robust standard error are clustered across regions and reported in brackets. For the Hansen Test and AR2 Test are reported the p-values. # Instr: number of instruments. Irish and Foreign firms are considered separately. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included.

To formalize this idea, we construct a firm-level measure of "distance-to-the-frontier", where distance is an indicator of how productive each firm is relatively to the most productive firm in the sector. Following the approach of Konings and Vandenbussche (2008), "distance" for each firm i is defined as the ratio of a firm's efficiency (LP) to the efficient frontier, in year 2000. The frontier is defined by the firm with the highest productivity level in year 2000 in each NACE 3-digit sector j. Then, distance indicator is defined as follows

$$Dist_{ij2000} = \left(\frac{(LP)_{ij2000}}{max(LP)_{j2000}} \right), \tag{5.2}$$

where LP_{ij2000} is value added per worker for firm i in year 2000, and $max(LP)_{j2000}$ is the maximum level of efficiency that we observe in sector j (i.e. frontier). The variable $Dist$ is defined between 0 and 1, and it assumes negative values with the logarithmic transformation; zero indicates the most efficient firm, while highly negative values refer to "laggard" firms[29].

Finally, *Dist* variable (in log) is interacted with import intensity ratio (from Eq. 3.1) in order to assess if efficiency gains from import change conditional to the initial value of relative efficiency ($Ratio*Dist_{00}$). Similarly to Halpern et al. (2001), we expect that efficiency gains from importing are larger for firms close to the efficient frontier.

We estimate Eq. 4.3 using difference GMM estimator. We eliminate year 2000 from the estimation sample: in this way, we do not consider information from year 2000 (as instruments) that may be correlated with the distance term (otherwise the Hansen-Sargan rejects the orthogonality of instruments). Table 5.2 reports results obtained from the unbalanced panel, while in Table A.7 we show the estimation's results for a balanced sample. The first three columns show the estimated coefficients for Irish firms (col. 1-3) in manufacturing sector. We find again a positive (and significant) correlation between importing and firms' efficiency. The coefficient of interacted term ($Ratio * Dist_{00}$) is positive and significant. It suggests that for the same variation in import intensity, firms close to efficient frontier gain more compared to "laggard" firms. Given that distance in log is negative (0 defines the frontier firm), an increase in the distance shrinks positive effects generated by imports. The coefficient of $Ratio*Dist_{00}$ is positive, so that efficiency gains from importing increase with a reduction in the (negative) term $Ratio * Dist_{00}$. The result is in line with the arguments of internal absorptive capacity (Halpern et al., 2011) or with the idea of organization complexity (Altomonte and Bèkès 2009). An in increase of 1% in import intensity is associated with an average increase of 1.64% in efficiency (Lin.Comb in col.3).

With respect to foreign firms (columns 4-6), we find a statistically significant relationship between import intensity and efficiency. Similarly to Irish firms, efficiency gains shrink as long as a firm is relatively less efficient. However, the linear combination of the two coefficients is not statistically significant (Lin.Comb from columns 4 to 6). We slightly differ from GHS (2008), which find a positive correlation between and efficiency also for foreign firms. A plausible explanation is that Irish firms need a minimum level of efficiency to exploit benefits from imported inputs (Halpern et al. 2011), while foreign firms have already exploited benefits from importing intermediate goods.

In the last two columns of Table 5.2 we perform a different exercise. Firstly, we calculate the maximum level of distance above which gains from imports turn to be zero. The thresholds are defined in function of coefficients estimated for Irish (col.2) and foreign firms (col.5), so that

thresholds are -2.82 and -1.54 for the Irish and foreign firms respectively. In other words, if distance increases over the mentioned thresholds the positive effects from importing disappear. Then, we create two dummies (one for Irish and one for foreign firms) equal to 1 if a firm's distance is below the threshold (close to the frontier), otherwise zero. Finally, we create the variable $log(Ratio)_{it} * DistDum_{00it}$, which is the interaction between the import ratio (index 3.1) and the dummy. As expected, the coefficient of the interacted term is positive and statistically significant while import ratio has a negative sign: an increase in import has a positive effect on efficiency if the distance from efficient frontier decreases. Instead the linear combination of the two variables is significant only for Irish firms and not for foreign ones. To conclude, the estimations reported in Table 5.2 provides evidence that efficiency gains from importing are realized for Irish firms if a minimum level of internal efficiency is reached. This result is crucial to understand previous findings. The ABSEI dataset collects information about the most dynamic firms in the Irish economy (Tab. 3.1), and it is likely that the effects reported in Tab.4.3 and Tab.4.4 rely on the dataset construction. Sample selection may explain the empirical relationship we find, so that internal capabilities are crucial to exploit benefits (in term of efficiency) from importing intermediate inputs.

Table 5.2: Efficient Frontier: Manufacturing Sector[‡]

	(1) Irish	(2) Irish	(3) Irish	(4) For.	(5) For.	(6) For.	(7) ID	(8) FD
$\log(LP)_{it-1}$	0.143***	0.120**	0.167***	0.013	0.027**	-0.007	-0.053	-0.147
	(0.023)	(0.060)	(0.024)	(0.025)	(0.012)	(0.055)	(0.038)	(0.133)
$\log(Ratio)_{it}$	3.461***	3.497***	3.559***	1.996***	2.327***	2.116***	-1.293	-1.027**
	(0.666)	(0.759)	(0.721)	(0.581)	(0.281)	(0.220)	(1.239)	(0.418)
$\log(Ratio)_{it}$*$Dist_{00it}$	1.162***	1.238***	1.276***	1.364***	1.511***	1.465***		
	(0.074)	(0.082)	(0.148)	(0.225)	(0.034)	(0.167)		
$\log(Ratio)_{it}$*$DistDum_{00it}$							2.716***	1.773***
							(0.842)	(0.458)
$\log(Input)_{it}$	-0.045	-0.026	0.019	0.096	0.062	0.152**	-0.089***	0.140
	(0.061)	(0.056)	(0.054)	(0.068)	(0.076)	(0.074)	(0.033)	(0.139)
$Export_{it}$	0.215	0.119		-0.626*	-0.408		0.407	-0.615
	(0.208)	(0.172)		(0.381)	(0.260)		(0.289)	(0.709)
$\log(R\&D)_{it}$		-0.018			0.038			
		(0.055)			(0.039)			
$\log(Train)_{it}$		0.027			0.010			
		(0.043)			(0.083)			
$\log(ExpEU)_{it}$			0.119			0.031		
			(0.086)			(0.032)		
$\log(ExpUK)_{it}$			0.002			-0.020		
			(0.057)			(0.037)		
$\log(ExpWR)_{it}$			-0.095			-0.076		
			(0.075)			(0.097)		
Lin.Comb.	1.723***	1.646***	1.652***	-0.138	-0.036	-0.176	1.659***	-0.096
	(0.618)	(0.654)	(0.595)	(0.238)	(0.229)	(0.481)	(0.654)	(0.229)
Obs.	3,065	3,065	3,059	1,207	1,207	1,207	3,065	1,207
Firms	1063	1063	1063	400	400	400	1063	400
# Instr.	26	32	32	26	32	32	37	37
Sargan Test	0.041	0.012	0.477	0.431	0.417	0.561	0.129	0.197
AR2 Test	0.965	0.798	0.361	0.560	0.291	0.716	0.047	0.233

[‡] Unbalanced panel estimation, with difference GMM estimator for dynamic panel. Dependent variable is log of value added per workers ($log(LP)$). Each column represents a regression. The robust standard error are clustered across regions and reported in brackets. Lin. Comb is the marginal effect from importing given by the combinations of parameter log(Ratio) and log(Ratio*$Dist_{00}$): calculations are based on the "delta method". ID stays for Irish dummy, while FD stays for foreign dummy. For the Hansen Test and AR2 Test are reported the p-values. # Instr: number of instruments. Irish and Foreign firms are considered separately. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included.

6 Reverse Causality

In this final section we control if reverse causality affect our results, i.e. if past efficiency level determines current import intensity ratio (eq 3.1). In first test we control for potential reverse causality with a not-parametric exercise for manufacturing firms. Table 6.1 shows a transitional matrix where the rows refer to quintiles of labor productivity distribution in time t ($log(LP_n)_t$), and columns refer to quintiles of import intensity growth one period ahead ($\Delta_n Ratio_T$). Each cell in a row reports the *average* share of firms that belong to a given quintile of import intensity

growth, conditional to the quintile position of efficiency in the previous period (t).

We construct Table 6.1 as follows. (i) we compute import intensity growth rate. (ii) we calculate by sector (Nace 2-digit), year, and ownership (Irish/Foreign) the thresholds for the 20th, 40th, 60th, and 80th percentile both for import intensity growth rate and labor productivity. Then we cluster firms in the five quintiles groups. (iii) we count for each year t the number of firms that enters in the five quintile of import intensity growth at time *t+1*, conditional on their position in productivity distribution at time *t*. Therefore for each of the five clusters of productivity distribution in t, we know how many firms belong to different quintiles of import growth rate in the period ahead. (iv) we calculate for each group of productivity the share of firms that moves to one of five quintiles of import growth in *t+1*; we come out with six tables for each year pairs (productivity in t vs. import growth in *t+1*). (v) finally we take the mean of each cell across the 6 time observations. Each row should sum equal to one.

We report two tables, one for Irish firms (upper table) and one for foreign firms (lower table). For example in the upper part of Table 6.1, the value 0.195 (in the first row) tells that on average the 19% of firms with the lowest productivity level (below 20th percentile) are in the lower quintile of import intensity growth distribution (in the subsequent year); similarly the cell in first row and last columns (0.198) suggests that on average the almost the 20% of firms with the lowest productivity level (below 20th percentile in given year sector) show the highest increase in import intensity in the subsequent year. If we suspect reverse causality, we expect that large part of firms with low productivity level in t should increase by a small amount import intensity in the subsequent period, while firms with high productivity (top quintile $log(LP_5)$) should increase by a large amount import intensity. In other words we should expect an uneven distribution of shares across rows. In the first row we expect high share in the first columns, i.e. less productive firms increase by a few import intensity, while in bottom rows ($log(LP_5)$) we expect high shares in the last columns i.e. more productive firms increase by a large amount import intensity. What we observe is that shares are evenly distributed across different columns (around 20%): the past distribution of efficiency is not correlated with distribution of import growth in the next period. More precisely firms concentrate in the $\Delta_2 Ratio_T$ quintile of import growth distribution. Similarly, few firms concentrate in the third group (between 40th and 60th percentile) of import intensity growth ($\Delta_3 Ratio_T$), both for irish and foreign firms. To conclude, Table 6.1 provides

evidence that past productivity is not correlated with current growth in import intensity.

Table 6.1: Transitional Matrix: Irish and Foreign‡

	Irish Firms				
	$\Delta_1 Ratio_T$	$\Delta_2 Ratio_T$	$\Delta_3 Ratio_T$	$\Delta_4 Ratio_T$	$\Delta_5 Ratio_T$
$log(LP_1)_t$	0.195	0.260	0.111	0.236	0.198
$log(LP_2)_t$	0.210	0.280	0.091	0.218	0.202
$log(LP_3)_t$	0.179	0.288	0.102	0.246	0.185
$log(LP_4)_t$	0.202	0.314	0.091	0.207	0.186
$log(LP_5)_t$	0.184	0.300	0.123	0.207	0.186
	Foreign Firms				
	$\Delta_1 Ratio_T$	$\Delta_2 Ratio_T$	$\Delta_3 Ratio_T$	$\Delta_4 Ratio_T$	$\Delta_5 Ratio_T$
$log(LP_1)_t$	0.235	0.275	0.076	0.219	0.195
$log(LP_2)_t$	0.200	0.260	0.053	0.220	0.268
$log(LP_3)_t$	0.206	0.298	0.054	0.268	0.174
$log(LP_4)_t$	0.193	0.295	0.067	0.221	0.223
$log(LP_5)_t$	0.205	0.316	0.099	0.207	0.173

‡ Average transitional matrix. Each rows sums to one. Rows refer to the percentile distribution of labor productivity, columns refer to percentile distribution of import intensity ratio growth rate.

In the second exercise, we control for potential reverse causality by testing parametrically the existence of a correlation between current import intensity and past efficiency level. For this analysis we employ a tobit estimator (non-linear model within panel data), which is not biased by the censored dependent variable *Ratio*. As discussed in Section 4.1, we are concerned about the dynamic nature of the dependent variable, and by the unobserved heterogeneity of firms (c_i). Also import intensity ratio (*Ratio*) may depend on its past realizations, especially if we assume the existence of sunk costs related to the entry in international markets (Roberts Tybout, 1997; Castellani et al., 2010). In addition within a non-linear panel, we should consider the initial value of the dynamic dependent variable (Wooldridge, 2005); the initial value (at the begin of observational period) is potentially correlated with unobserved firms' heterogeneity (c_i). The traditional solutions to get rid off unobserved heterogeneity (as first difference) do not work with non-linear panel data models. Similar arguments have been discussed by Roberts and Tybout (1997) to test self-selection into the export market. Here, we propose an alternative solution from Roberts and Tybout (1997), and we implement the strategy suggested by Wooldridge (2005) to deal with dynamic non-linear panel data with unobserved heterogeneity.

We assume a specific distribution for the unobserved heterogeneity (c_i) given the initial level of import intensity ($Ratio_{i0}$) and a row vector of exogenous explanatory variables[30] ($\mathbf{Y}_i$). In

our case, we use as predetermined variables the log of wage bill ($log(WB)$), the log of export value ($log(Exp)$), and the log of R&D ($log(R\&D)$); we take the mean of variables at firm level. Unobserved heterogeneity c_i is statistically distributed as a normal with mean and the standard deviation given by $(a_i + \xi_0 Ratio_{i0} + \xi_i \mathbf{Y}_i, \sigma_a)$. Wooldridge (2005) demonstrates that the standard conditional maximum likelihood method applies, and the dynamic panel with a fixed effect can be estimated using a random effect tobit model by including initial condition ($Ratio_{i0}$) and a vector of exogenous variables ($\mathbf{Y}_i$).

$$Ratio_{it} = g[a_0 + \sum_{s=1}^{2} \beta_s Ratio^m_{it-s} + \xi_0 Ratio_{i0} + + \gamma Log(LP)_{it-1} + \tag{6.1}$$
$$+ \xi_i Log\mathbf{Y}_i + TD_t + SD_i + a_i + \varepsilon_{it}] > 0$$

We consider manufacturing firms, which are more sensible to imports of intermediate goods. The sample is unbalanced, and it considers data from 2000 to 2006: Table 6.2 reports the results. The first three columns present the results for all manufacturing firms with different specifications (pooled, tobit random effect, and Eq. 6.1 without initial condition); in columns 4, and 5 we consider Irish and foreign firms separately by including initial condition. Finally, in columns 6 we reports results for Eq. 6.1 obtained from dynamic tobit models for all the sample, and column 7 shows OLS estimation.

Table 6.2: Import Intensity : Tobit Model[‡]

	(1) Pooled	(2) R.E.	(3) F.E.	(4-Irish) F.E. & I.C.	(5-Foreign) F.E. & I.C.	(6-All) F.E. & I.C.	(7-All) OLS
$\log(\text{Ratio})_{it-1}$			0.901***	0.686***	0.820***	0.706***	0.817***
			(0.007)	(0.024)	(0.018)	(0.021)	(0.009)
$\log(\text{Ratio})_{i00}$				0.175***	0.067***	0.159***	0.044***
				(0.022)	(0.019)	(0.018)	(0.009)
$\log(\text{LP})_{it-1}$	0.013***	0.006***	0.001	0.001	0.002	0.002	0.003**
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
mean $\log(\text{WB})_i$			-0.004	-0.015*	-0.006	-0.009	-0.010**
			(0.004)	(0.009)	(0.008)	(0.007)	(0.005)
mean $\log(\text{Exp})_i$			0.002***	0.002*	0.000	0.002**	0.001
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
mean $\log(\text{R\&D})_i$			0.000	0.000	-0.001	-0.000	-0.001
			(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
$\log(\text{Exp})_{it}$	0.012***	0.010***					
	(0.001)	(0.001)					
$\log(\text{Exp})_{it}$	-0.022***	-0.009					
	(0.007)	(0.006)					
$\log(\text{Exp})_{it}$	-0.003***	-0.001					
	(0.001)	(0.001)					
Cons.	0.076***	-0.015	-0.011	0.008	-0.024	-0.016	0.016
	(0.025)	(0.023)	(0.014)	(0.028)	(0.029)	(0.020)	(0.014)
Obs.	7,908	7,908	7,884	4,501	1,967	6,468	6,468
Firms	.	2128	2119	1081	446	1527	.
rho	.	0.721	0.000	0.250	0.000	0.202	.
sigma_e	.	0.109	0.110	0.105	0.092	0.099	.
sigma_u	.	0.176	0.000	0.060	0.000	0.050	.

[‡] Tobit with import intensity as dependent variable. The regressions consider always balanced samples. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included. R.E.: random effect model. F.E.: fixed effect model. I.C.: initial condition included.

The coefficient of lagged productivity ($Log(LP)_{it-1}$) is not significant when we consider dynamic pattern of import ratio. It suggests that past efficiency is not strongly correlated with current level of import intensity ratio[31]. We observe that there is a strong persistency in import intensity, i.e. current levels depend on past realizations and initial condition status ($log(Ratio)_{i00}$). Jointly with previous results (Tab. 6.1), we are quite confident that the intensive margin of import is not determined by firms' efficiency. Such result does not rule out the existence of sunk cost associated to trade activity (import). It is likely that decisions concerning import intensity does not depend on past efficiency but on other factors; differently selection driven by efficiency has been detected for firms large economies (Castellani et al., 2010; Vogel and Wagner, 2010). In the present case the geographic location of Ireland, and the existence of multinationals may explain importing decision better than efficiency; indeed for a small economy such Ireland importing is a widely established activity (Tab. 3.3). Therefore, the high persistency in import activity is coherent with the presence of sunk cost associated to importing, but intensity (and

selection) is potentially determined by other firms' characteristics such as location, management, labor force characteristics, etc....

7 Conclusions

This paper analyzes the empirical relationship between firms' efficiency and the intensive margin of imports at plant level. Using a unique dataset for Irish economy, we observe two main features. At first, foreign firms use more intensively imported inputs in their production process; second, importers are more productive than non-importers. This evidence lead us to the following question: Do imports of intermediate goods affect firms' productivity? We use different techniques to take into account potential endogeneity concerns and firms' unobserved heterogeneity that may determine import choices. A short run analysis it is performed, and the paper provides three main results. At first, we find statistically significant evidence that an increase in imports positively affect firms' efficiency, in particular for Irish firms in the manufacturing sector. Second, the import of materials determines the empirical relationship between importing and efficiency. Finally, we provide evidence that the responses to variations in import intensity are heterogeneous across firms. We show that Irish firms close to the efficient frontier largely benefit from raising quota of imported input. In other words, the positive effects of importing are exploited only by relatively efficient firms. By contrast we do not find evidence of an impact of import intensity on foreign firms. A plausible motivation is that foreign firms have already exploited benefits from importing intermediate goods, or alternatively foreign firms own technologies that could not be improved by imported inputs. In the final part of the paper we show that the results are not biased by reverse causality, i.e. past levels of efficiency do not affect current import intensity ratio. However these results do not rule out the self selection process in the import market (Castellani et al., 2010).

To conclude, the internationalization process of inputs market has a positive effect for the efficiency of Irish manufacturing firms, and the findings are in line with the expectations for firms in small markets. The results suggest that heterogeneity at firm level is crucial to understand the effects of imports on firms competiveness: some internal characteristics are fundamental to exploit benefits from importing. Future research in this area necessitates to better understand

the net gains in term of aggregate productivity (reallocation), as well as channels through which the imported goods generate efficiency growth.

Notes

[1]In the present paper, we do not consider if the intermediate inputs are relabeled to be resold (Bernard et al., 2010), nor we consider other forms of tasks' outsourcing (Görg et al., 2008).

[2]We use efficiency and productivity as synonymous throughout the paper.

[3]Given that we do not observe much variation in the entry/exit of in the import market, we cannot measure how firms' efficiency is related to the dichotomous decision of importing or no.

[4]More precisely our indicator captures substitutability between local input and foreign input, instead GHS (2008) measure the degree of substitution between imported inputs and firms' labor force size: Section3.

[5]Combining different intermediate input, we create gains that are more than the sum of the single parts.

[6]Bernard et al. (2009) consider the characteristics of two-way traders. They show that importing/exporting firms (two way traders) account for a large part of the U.S. trade flows, and they also account for a large share of labour employment (18% of the civilian labour force). In addition, two-way traders grow faster, and they have higher survival probability in international markets when compared to single traders.

[7]Ownership is a time invariant information. Forfás defines a plant as foreign owned if 50% or more of its equity is held by foreign stakeholders. Foreign firms are primarily concentrated in chemical, electronic and software sectors. Data are trimmed by eliminating the first and the last percentile of value added distribution.

[8]Data are deflated by specific sector deflators (Source: EU-Klems).

[9]In addition the findings in Amiti and Konings (2007) are similar in the case of employing both TFP and labor productivity.

[10]Those firms that requested any type of support from the Enterprise Development Agency (IDA) were required to complete a questionnaire.

[11]The rate of response is approximately 60%. The very large firms are not included, i.e., firms with 80% or more of the market share with the market defined at Nace 3-digit level

[12]We obtain the same result if we calculate efficiency as output per worker.

[13]Foreign inputs are inputs produced outside the Republic of Ireland; therefore among the domestic inputs we consider those produced by multinationals located in Ireland. In this way we are confident to minimize potential externalities due to the presence of multinationals (backward spillovers in our case).

[14]The logarithm of our index, it is calculated as Log(Ratio+1).

[15]GHS measure outsourcing, i.e. the substitutability of in house production using the ratio of imported input to total wage bill.

[16]In the case of Ireland, service use is more often related to spillover effects from multinationals (Görg and Strobl 2003).

[17]In table A.3 we report the same import intensity measures for material and services separately (in manufacturing sector).

[18]Within the current paper we focus our attention on intensive margin of importing rather than the extensive margin (import choice) because we do not observe enough variability in the import status to perform a reliable statistical analysis. Only 32 firms out of 4887 decide to begin import activity across all sectors/year.

[19]Similarly to Levinsohn and Petrin (2003), we assume that intermediate input level is fully adjustable; if we assume that material is a dynamic factor ($PROD_{it} = f(RATIO_{it-1})$), we obtain the same results.

[20]We expect a negative sign from input consumption. Martin(2010) shows how market power is negatively correlated with input consumption. However, even if we eliminate input consumption from our model results do not change.

[21]The dummy assumes a value of one if a firm exports, otherwise zero.

[22]Standard errors are clustered across three main regions to allow for common shocks in efficiency due to same geographical location (regions: Dublin; Border, Midland and Western; Southern and Eastern).

[23]The "system GMM" estimator is not appropriate to this case for several reasons. First, the lagged dependent variable is not a random-walk process ($\alpha < 1$). Second, the additional initial condition assumption required by Blundell and Bond (1998) is not satisfied with the proper tests; finally the lagged differences is not valid instruments for level equations.

[24]Correlated with contemporaneous and past error term.

[25]Similar results are obtained by using the ratio of wage bill to total revenues as a control instead of total inputs: look Table A.5.

[26]In Table A.6 we report beta coefficients to compare the results obtained with aggregated and detailed index of import intensity.

[27]I.e., Substitution among foreign sourced inputs and internal labor force size. Indeed total wage bill is an imperfect measure for labor force size given that it can encompass also changes in labor force skills.

[28]If we introduce an interaction term between material and services' import index we find a net positive effect from imported services. The coefficients of $Sratio_{it}$ is negative while interacted term positive: the net effect is positive.

[29]Konings and Vandenbussche (2008) use the same approach to estimate the effect of antidumping protection on firms' efficiency, conditional on the "distance to the frontier". We define the frontier with the 99th percentile of labor productivity for a year-sector-ownership triple, in order to eliminate outliers and unreal values. The distance variable is time invariant.

[30]In his journal version, Wooldridge suggests to use a row vector of exogenous explanatory variables in all time periods for fixed effects. In Wooldridge 2008, the author proposes to use averaged or, at least, predetermined exogenous variables for each individual. We implement the 2008 version tominimize concerns about exogeneity of explanatory variables.

[31]The results do not change if we use also the second lag of productivity.

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A Data Description

- **Material**: Total cost of material and components used directly in the production of goods and the provision of services.
- **Irish material**: Material produced in the Republic of Ireland.
- **Services**: Total costs of all bought in services, e.g., advertising, transportation, fuel, power repairs, royalties, telephone, postage, stationery, computing services, professional fees, etc.
- **Irish Services**: Services sourced in the Republic of Ireland.
- **Log(LP)**: Log of labour productivity. It is calculated as the value added per worker. The value added is deflated with a sector-specific deflator (source:EU-KLEMS).
- **R&D**: Dummy variable equal to one if a firm performs research and development activities. Alternately, we report the total expenditure in R&D.

- **Train**: Dummy variable equal to one if a firm performs formal structured training of management and staff (in-house and external). Alternately, we report the total expenditure in training activities.
- **Exp(UK, EU, WR)**: Dummy variable that is equal to one if one firm exports to the UK, European Union or other countries in the world and equals zero otherwise. Export is a dummy equal to one if a firm export.

Table A.1: Dataset description: Firms[‡]

Sector	Nace Sector	Firms	Domestic	Foreign
Agriculture	10	41	39	2
Food Beverages & Tobacco	15	620	555	65
Textile Clothes Leather	17	175	141	34
Wood	20	111	105	6
Pulp Paper & Printing	22	194	170	24
Chemical	24	259	114	145
Rubber and Plastics	25	183	117	66
Non-Metallic Minerals	26	133	113	20
Basic Metal & Fabricated Metals	27	413	346	67
Machinery n.e.c.	29	272	216	56
Electrical and Optical Equipment	30	564	285	279
Transport Equipment	34	79	46	33
Manufacturing n.e.c.	36	211	196	15
Networks	40	65	46	19
Construction	45	21	20	1
All Other Services	50	262	231	31
Financial Intermediation	65	41	20	21
Computer and Related Activities	72	929	643	286
Research and Development	73	51	45	6
Other Business Activities	74	263	197	66
Total		4887	3645	1242

[‡] Source: ABSEI Dataset.

Table A.2: Descriptive statistics: Sector Averages‡

Nace	Revenues	Empl	YL	LabProd	RD	Train	Export	Ownership	Firms
10	9275.1	49.92	137.7	39.45	0.903	0.839	0.286	0.050	41
15	40445.0	139.6	241.6	52.08	1.499	1.292	0.375	0.105	620
17	5081.2	53.06	97.43	2.60	1.192	0.862	0.441	0.196	175
20	9520.7	64.60	121.1	31.93	1.530	1.180	0.354	0.051	111
22	6475.6	55.60	98.39	34.28	0.708	0.983	0.369	0.123	194
24	174391.3	158.0	549.1	194.76	2.013	1.901	0.480	0.561	259
25	6839.0	53.83	114.9	33.97	1.358	1.113	0.479	0.358	183
26	21242.9	136.9	105.5	33.56	1.050	0.998	0.324	0.151	133
27	6053.0	49.49	97.10	38.61	0.881	0.918	0.312	0.163	413
29	7243.5	56.61	108.1	38.83	1.663	1.224	0.472	0.208	272
30	93954.8	171.0	300.0	51.19	2.093	1.586	0.467	0.494	564
34	14545.7	139.2	126.2	32.07	1.583	1.481	0.490	0.418	79
36	3576.8	39.72	83.59	23.64	1.234	0.864	0.401	0.073	211
40	7019.6	72.83	106.3	20.37	0.780	0.997	0.282	0.295	65
45	26373.8	169.9	111.6	37.55	0.947	2.145	0.145	0.041	21
50	6841.5	35.10	350.4	177.59	0.644	0.722	0.300	0.119	262
65	71431.5	249.5	421.6	306.17	0.503	1.807	0.321	0.511	41
72	34033.4	66.47	191.5	88.06	1.775	1.045	0.328	0.306	929
73	1981.6	32.20	72.96	-101.62	1.394	0.81	0.239	0.114	51
74	9840.24	104.0	106.3	40.43	0.884	1.42	0.389	0.249	263
Total	37390.66	94.9668	200.3616	63.89596	1.430	1.189	0.381	0.254	4887

‡ Source: ABSEI Dataset. Revenues: deflated value of revenues in Th of Euros. Empl: number of employees. YL: Output per worker. LabProd: value added per worker. R&D: expenditure in R&D in Th. of Euros per worker. Train: training expenditure in Th. of Euros per worker. Export: aggregate percentage of exporter. Ownership: percentage of foreign firms. Firms: number of firms by sector.

Table A.3: Service and material import intensity: manufactures‡.

Imports of services			
Export Status / Ownership	Not-Exporter	Exporter	Total
Irish	0.080	0.117	0.110
Foreign	0.122	0.230	0.225
Total	0.083	0.155	0.143

Imports of material			
Export Status / Ownership	Not-Exporter	Exporter	Total
Irish	0.483	0.538	0.527
Foreign	0.626	0.725	0.721
Total	0.494	0.600	0.583

‡ Eq. 3.1. Manufactures.

Table A.4: Import Premia‡

	(1) Log(LP)$_{it}$	(2) Log(YL)$_{it}$	(3) Export$_{it}$	(4) Log(Labor)$_{it}$	(5) Log(Cost)$_{it}$	(6) Log(R&D)$_{it}$
Import$_{it}$	0.072**	0.233***	1.934***	0.262***	0.516***	0.203***
	(0.036)	(0.035)	(0.071)	(0.039)	(0.051)	(0.074)
Export$_{it}$	0.116***	0.323***		0.243***	0.394***	1.096***
	(0.043)	(0.040)		(0.043)	(0.061)	(0.088)
Exp.∗Imp.	-0.040	-0.081*		0.135***	0.176***	0.532***
	(0.048)	(0.045)		(0.049)	(0.067)	(0.100)
Owner.$_i$	0.626***	0.636***	3.278***	1.048***	1.518***	-0.608***
	(0.024)	(0.022)	(0.059)	(0.024)	(0.030)	(0.054)
Con.	3.420***	4.406***	2.689***	3.898***	8.315***	1.154***
	(0.072)	(0.082)	(0.275)	(0.146)	(0.199)	(0.198)
Obs.	14440	16098	16635	16120	16126	16126
R^2	0.135	0.203	0.277	0.237	0.312	0.180
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes	Yes	Yes

‡ OLS regression across all firms in the data-set. Import: import dummy. YL: Output per worker. Export: export dummy. Exp∗Imp: interacted term between the two trade dummies. Ownership: ownership dummy, equal one if a firm is foreign owned. Expo: Total value of exports. Labor: numbers of workers. Cost: total value of costs (wages plus intermediate input). R&D: total expenditure in R&D activities. Each column represents a regression. Robust standard errors are squared brackets. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

Table A.5: Difference-GMM: Labor Productivity in Manufactures. Wage bill ratio control‡

	(1) Irish	(2) Irish	(3) Irish	(4) Foreign	(5) Foreign	(6) Foreign
log(LP)$_{it-1}$	0.149	0.071	0.102	-0.078	-0.116	0.015
	(0.142)	(0.120)	(0.154)	(0.075)	(0.088)	(0.045)
log(Ratio)$_{it}$	1.505***	1.024***	1.420***	0.517	0.233	0.176
	(0.250)	(0.216)	(0.065)	(1.209)	(0.695)	(0.564)
log(WBRatio)$_{it}$	-2.267***	-2.173***	-2.392***	-7.345***	-6.540***	-8.577***
	(0.140)	(0.112)	(0.362)	(0.595)	(0.262)	(1.268)
Export$_{it}$	-0.222	-0.124		-1.835	-1.894	
	(0.276)	(0.192)		(1.956)	(1.828)	
log(R&D)$_{it}$		0.057			-0.026	
		(0.036)			(0.019)	
log(Train)$_{it}$		-0.114**			0.020***	
		(0.057)			(0.007)	
log(ExpEU)$_{it}$			0.063			-0.072*
			(0.058)			(0.043)
log(ExpUK)$_{it}$			0.087**			-0.009
			(0.036)			(0.047)
log(ExpWR)$_{it}$			0.012			0.026
			(0.032)			(0.041)
Obs.	3,852	3,852	3,747	1,541	1,541	1,533
Firms	1182	1182	1161	439	439	437
# Instr.	45	65	65	45	65	65
Sargan Test	0.887	0.806	0.991	0.630	0.467	0.298
AR2 Test	0.594	0.907	0.719	0.123	0.089	0.216

‡ Dynamic panel-data estimation, Difference GMM estimator. Dependent variable is log of value added per workers ($log(LP)$). The robust standard error are clustered across regions and reported in brackets. For the Hansen Test and AR2 Test are reported the p-values. # Instr: number of instruments. $log(WBRatio)$: ratio of wage bill to total revenues. Irish and Foreign firms are considered separately. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included.

In Table A.6 we report beta coefficients ($b.c.$) for $log(Ratio)$ (in Table 4.3), and beta coefficients for $log(Mratio)$ and $log(Sratio)$ (in Table 4.4) to compare marginal effects obtained with a general index of import intensity (Eq. 3.1) from a situation where we use two indicators, one for material and one for services.

Table A.6: Beta coefficients: manufacturing firms‡

	(1) All	(2) Irish	(3) Irish	(4) Irish	(5) Foreign	(6) Foreign	(7) Foreign
$log(Ratio)$	0.245***	0.467***	0.346***	0.440***	-0.020	-0.049**	-0.012
$log(Sratio)$	0.025	0.074	0.071	0.011	-0.117	-0.077	-0.006
$log(Mratio)$	0.308***	0.570***	0.428***	0.542***	-0.024	-0.033	-0.072

‡ Beta coefficients from difference GMM estimator. The beta coefficients are the coefficients that we would obtain if the outcome and predictor variables were all transformed standard scores. Each column represents a regression; first line report beta coefficients for table 4.3, while second and third lines report standardized coefficients from estimation reported in table 4.4. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

Table A.7: Efficient Frontier: Balanced Panel‡

	(1) Irish	(2) Irish	(3) Irish	(4) For.	(5) For.	(6) For.	(7) ID	(8) FD
$\log(\text{LP})_{it-1}$	0.112***	0.114**	0.112***	-0.024	0.023	-0.162***	0.168***	0.283***
	(0.021)	(0.046)	(0.022)	(0.051)	(0.053)	(0.045)	(0.036)	(0.033)
$\log(\text{Ratio})_{it}$	4.917***	4.289***	4.595***	3.401***	3.292***	5.098***	-0.834*	-2.743***
	(1.348)	(1.015)	(1.194)	(1.204)	(0.962)	(1.325)	(0.441)	(0.297)
$\log(\text{Ratio*Dist}_{00})_{it}$	2.242***	1.997***	2.013***	1.845***	1.776***	2.304***		
	(0.417)	(0.256)	(0.292)	(0.061)	(0.068)	(0.186)		
$\log(\text{Ratio*Dummy}_{00})_{it}$							1.610***	1.592***
							(0.384)	(0.501)
$\log(\text{Input})_{it}$	0.013	0.011	0.032**	-0.067**	-0.096**	-0.114*	0.059**	0.073
	(0.066)	(0.042)	(0.014)	(0.030)	(0.039)	(0.063)	(0.023)	(0.096)
Export_{it}	0.363	0.092		-0.181	-0.210**		-0.106	-0.186
	(0.528)	(0.199)		(0.142)	(0.093)		(0.215)	(0.338)
$\log(\text{R\&D})_{it}$		-0.048			0.049*			
		(0.112)			(0.029)			
$\log(\text{Train})_{it}$		0.094			-0.003			
		(0.088)			(0.023)			
$\log(\text{ExpEU})_{it}$			0.114			0.196***		
			(0.074)			(0.072)		
$\log(\text{ExpUK})_{it}$			0.060			0.066***		
			(0.049)			(0.024)		
$\log(\text{ExpWR})_{it}$			0.029			-0.092***		
			(0.032)			(0.017)		
Obs.	2,034	2,034	2,029	855	855	855	2,034	855
Firms	510	510	510	214	214	214	510	214
# Instr.	26	32	32	26	32	32	37	37
Sargan Test	0.159	0.151	0.429	0.485	0.746	0.998	0.0453	0.596
AR2 Test	0.111	0.211	0.797	0.109	0.048	0.497	0.577	0.492

‡ Balanced panel estimation, with difference GMM estimator for dynamic panel. Dependent variable is log of value added per workers ($log(LP)$). Each column represents a regression. The robust standard error are clustered across regions and reported in brackets. ID stays for Irish dummy, while FD stays for foreign dummy. For the Hansen Test and AR2 Test are reported the p-values. # Instr: number of instruments. Irish and Foreign firms are considered separately. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value. Year dummies included.