Irish firms' productivity and input's origin.*

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Abstract

In this paper I analyses the pattern of Irish firms' productivity and how their efficiency changes with variations in the input composition. Amiti and Koning (2008) showed when imports of intermediate inputs raise also firm's productivity grows. From the data I observe the burden of Irish and imported inputs on the total amount of intermediates, both for services and raw materials. The main results are that the most efficient firms use more intensively foreign inputs, and that Irish owned firms raise their productivity if they increase the quota of imported services in the production process. Following the large literature about service liberalization and Forás policy reports, the results suggest us an important policy implication: given the low level of competition in Irish services, a process of service liberalization has to be implemented with the objective to improve the quality.

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1 Introduction

Economic efficiency is a wide topic of research and a source of great concern for policy maker, media and institutions Since the mid of fifties with Solow, the issue of productivity became central in the economic analysis for each different field. However productivity is not only an interesting aspect of economic research but it is source of great concern for the policy makers and a whole national economy. Given that productivity is related with growth it is obvious understand that a rasing path of national productivity brings as consequence positive growth rate for the gross domestic product (GDP): for example Oliner and Sichel (2000) showed that the great performances in terms of GDP growth in USA during the second part of nineties were driven by the exceptional performances in productivity due to the introduction of IT technology in the industry. Similarly Gordon (2005) explains the different growth rate among USA and Europe with the difference in productivity in several industries and, in particular for service sectors. Finally it is necessary citing an interesting study case, which is related with this paper, i.e. the exceptional growth of Ireland between nineties and the begin of new millennium; the great performances of Ireland are linked with an unusual productivity growth for Europe. In particular the average Irish productivity growth rate reached 2.6% per year, higher than the USA (2.2%) and European (1.2%) growth rate (Sexton, 2007).

Since the begin it should be clear why efficiency is so important for the policy makers and especially why the national economic policy is often focused to sustain and foster it: I can address four reasons from macro and microeconomic point of view. First of all, as introduced above, when the efficiency[1] of an economic system increases, the whole economy grows (in term of GDP); if we define efficiency as the total amount of output over the input used it is obvious that greater efficiency means larger output for the same quantity of inputs. So any policy focused on foster productivity, has a positive impact on growth. An clear example is given by the so called "Lisbon Targets" proposed by European Union (EU): the main objective is encouraging European government to reach the level of 10% of national income in R&D in order to sustain efficiency and competitiveness.

A second argument relates productivity and competitiveness of developed countries in the global economy because the commodities in high wage counties are more expensive and less competitive respect to developing countries. As some theoretical and empirical papers in international trade suggest (Bernard Jensen, 1997; Bernard et al., 2003; Clerides et al. 1999; Melitz, 2003) only the most efficient firms remains in the market and just superstars become international. Then policy makers are interested in policies to sustain firms' productivity respect to international competitors.

Thirdly, higher efficiency can make a country an interesting destination for foreign investment and at the same time foreign investment may have a positive impact on national efficiency (within and between sectors).The effects of FDI on efficiency are widely studied by economists (Coe Helpman, 1995; Smarzynska-Javorcik, 2003; O'Toole, 2007) even if the results are sometimes in contrast. Fourth argument is related to welfare, as

[1] I will use efficiency and productivity as synonymous along all paper.

mentioned above, an higher level of productivity growth sustains higher level of growth. Consequently each country can benefit from this growth in term of more wealth (GDP growth), more jobs (FDI and competitiveness) or better goods and services (sector efficiency). Therefore economic efficiency in all its aspects is a great concern for policy makers.

In particular this paper studies the productivity of Irish economy using from firm level information. The research objective is to understand why some Irish firms grow more than other and in details which kind of inputs sustain firm's productivity. I am asking if the origin of inputs (national or foreign), used in the production process, matter for firm's efficiency: poorly speaking I am interested in understanding if foreign material and services are better inputs. The relation between productivity and input origin is quite developed. For example Amiti and Konings(2008) find that reducing taxes on the imports, Indonesian manufacturing firms' productivity increased; because the imported goods are used as inputs a reduction of 10% in import tariff increases on average the firms' productivity of 12% via learning, variety effect and quality effect. Using a dataset of Indonesian manufacturing firms with information about the composition of inputs, they can control the quantity (variety effect) and quality (quality effect) of imported goods used as inputs in production process. High quality inputs means quality and efficiency upgrading , while less costly inputs means cheaper final product (increasing competitiveness). In a similar paper Kasahara ad Lapham (2006) create a model where firms simultaneously choose to exports goods and import intermediates. They show as restrictions in imports for input reduce the number of Chilean exporting firms; their simulations show as moving from free trade situation in intermediates to no trade situation, exporters percentage reduces form 17.2% to 12.4%. They suppose that cheaper and greater varieties of inputs increase productivity of firms and consequently their capacity to compete on international markets.

Differently from Amiti-Konings, I have just information about the expenditure for services and materials and the input's value purchased from Irish or foreign producers. Unfortunately it is not possible to collect any data about quality or quantity but just Irish input's cost burden: therefore I am questioning if there is a relation between firm's productivity and input's origin mix as cost burden. There are two basic ideas which are important to verify, in particular for policy makers; even if I do not assume that foreign inputs are better in quality[2] an increasing variety of input used in the production process may have a positive effect on firm's efficiency. For example Grossman-Helpman (1991) demonstrate that a monopolistic competitive sector, which produces horizontally differentiated intermediate inputs for a unique consumption good producer, help to raise the downstream TFP with the expansion of intermediate variates provided. Secondly, the potential competition in inputs market reduces prices and raises the competitiveness of firms which use intensively that inputs. A nice theoretical model is provided by Fugazza and Robert-Nicoud (2007). The demonstrate in a monopolistic competitive framework a la Dixit-Stigliz-Krugman, as more trade liberalization in intermediate inputs decreases the productivity cut-off for the exporting activity, due to a cost reduction: when marginal

[2]I can not observe quality from data, nor infer it.

cost shrinks due to cheaper input a direct consequence is an increased competitiveness of domestic firms in all markets[3]. Do firms which use intensively foreign inputs are more productive? Is better to use foreign or national services in the production process? Is the optimal choice using only foreign or Irish inputs? These are some issues that the paper try to clarify.
Basically the paper provides three main results. First of all the most productive firms rely less on inputs purchased in the domestic market (Ireland); so it means that as firm's productivity increases also the consumption of foreign inputs (both services and material) increases. Secondly there is evidence that foreign inputs are source of productivity growth in particular for input service: it suggests that maybe imported services show higher feature rather than Irish services. Thirdly, in particular Irish owned firms benefit from the variation in the output mix. I can state that the mass of varieties used is important in the production process and probably foreign inputs (services) are different in term of quality from Irish inputs.
The paper is structured as follows as following: in the next section I introduce a theoretical model which provides a framework which will be used to interpret the results. Then I describe the dataset and its feature. In the fourth section I defines the empirical analysis and the results. Finally I provide conclusions and implications.

2 Data Analysis

The data comes from Annual Business Survey Economic Impact (ABSEI) and it provides information for a large sample of anonymous firms which operates in Ireland from 2000 to 2006. The dataset includes both Irish and foreign owned firms and it covers eighteen industrial sectors (manufactures and services), according to NACE two digit classification. In Table 1 is described the composition of the dataset by sector composition and origin. Large part of the observations include Irish firms however one quarter of the observations are related to foreign firms.

[3]Moreover if domestic market offers cheaper and large variety of inputs there exists a potential aspect of attractiveness for foreign investments. Then input markets affect productivity also indirectly, attracting foreign capitals and knowledge.

Table 1: Dataset description

Sector	Obs	Irish	Foreign	Percen.	Cum.
Agric./Fish./Min.	70	65	5	1.43	1.43
All other services	659	519	140	13.48	14.92
Basic/fabricated metals	412	345	67	8.43	23.35
Chemicals	256	112	144	5.24	28.59
Construction	21	20	1	0.43	29.02
Electronic	365	188	177	7.47	36.48
Food/Drink/Tob.	619	554	65	12.67	49.15
Machinery n.e.c.	271	215	56	5.55	54.7
Manuf. n.e.c.	207	191	16	4.24	58.93
Non-metallic Mineral	133	113	20	2.72	61.65
Other computer related	179	89	90	3.66	65.32
Print/Publish/	194	170	24	3.97	69.29
Professional Goods	205	103	102	4.19	73.48
Rubber/Plastic	183	117	66	3.74	77.23
Software development	749	553	196	15.33	92.55
Text/Cloth/Leath	175	141	34	3.58	96.13
Transport equip.	79	46	33	1.62	97.75
Wood Products	110	104	6	2.25	100
Total	4,887	3,645	1,242	100	

Source: ABSEI Datset

Foreign firms are concentrated in particular in Chemicals, Electronic and Software sectors, probably the most advanced sectors. The ABSEI dataset has very important peculiarity to consider, because it includes firms which receives financial support in particular for R&D activity[4]. Therefore it is not possible to assume the sample as representative of Irish economy; I can not ignore a process of self selection in the dataset, and it implies that just good firms are included in the ABSEI dataset. Poorly speaking the final results will tell us why some firms grow more than other firm, or which is the difference between good firms and "superstars".
The Table 2 below shows some descriptive statistics. In the first two column it is clear the innovative effort, as R&D expenditure or training activities per worker, for several sectors and in particular Chemicals, Electronics and Software.

[4]Thanks to an anonymous referee in Forfás.

Table 2: Descriptive statistics

Sectors	Train(pw)	R&D(pw)	Exp(Ratio)	Exp(UK)	Exp(EU)	Exp(WR)
Agric./Fish./Min.	0.310	1.618	0.330	0.466	0.392	0.228
All other services	0.851	19.333	0.386	0.502	0.404	0.438
Basic/fabricated metals	0.554	2.062	0.154	0.621	0.249	0.208
Chemicals	0.467	10.921	0.510	0.858	0.621	0.555
Construction	0.397	0.710	0.074	0.098	0.110	0.098
Electronic	0.592	12.729	0.443	0.648	0.565	0.529
Food/Drink/Tob.	0.517	2.259	0.323	0.740	0.500	0.280
Machinery n.e.c.	0.590	3.738	0.298	0.765	0.521	0.419
Manuf. n.e.c.	0.759	3.028	0.250	0.754	0.222	0.217
Non-metallic Mineral	0.361	0.907	0.188	0.695	0.364	0.417
Other computer related	0.887	12.335	0.408	0.665	0.502	0.529
Print/Publish/	0.342	0.856	0.186	0.751	0.337	0.293
Professional Goods	0.913	16.892	0.565	0.689	0.701	0.630
Rubber/Plastic	0.377	2.465	0.342	0.847	0.484	0.324
Software development	0.894	25.721	0.491	0.626	0.401	0.443
Text/Cloth/Leath	0.443	2.761	0.459	0.888	0.601	0.531
Transport equip.	0.433	3.238	0.417	0.784	0.368	0.310
Wood Products	0.321	1.531	0.125	0.612	0.078	0.078
Total	0.624	9.150	0.340	0.678	0.423	0.371

Source: ABSEI Datset. Pw: per worker. Exp: export dummy, 1 if firm export, 0 if domestic.
Exp(ratio) is the export value over total revenues R&D(pw) is the expenditure per worker in Th. of Euros.
Train(pw) are the hours of training per worker. The averages are across years

In the other four column are described the export activity for firms in the sample: on the average the 34% of revenues comes from export activities. In the other columns I can notice as large part of exporters export to UK (68%) or Europe (45%). The export ratio suggests that the firms in the sample are representative for the entire population, at least for the export activity: for example Eaton Kortum and Kramarz (2005) show that just one third of French firms are exporters. In the Appendix B. are provided additional tables with the same statistics but divided by origin.
As I can observe the tables below, firms in the sample show very good performances. The Table 3 and Table 4 illustrates growth rates (output and value added based) both for ABSEI dataset and for the overall Irish economy (Source: EU-KLEMS)

Table 3: Average growth (output based) 2001-2005

	Growth Output(pw)			Growth Output (pw) EU-KLEMS	
	Irish	Foreign	Total	Average	2000-2005
Agric.	0.037	0.065	0.039	0.023	0.088
Manuf.	0.107	0.091	0.103	0.003	0.018
Services	0.184	0.085	0.152	0.000	-0.033
Total	0.130	0.088	0.119	0.000	0.000

Source: ABSEI Datset and EU-KLEMS.

Table 4: Average TFP growth(Value added based) 2001-2005

	Growth VA(pw)			Growth VA(pw) EU-KLEMS	
	Irish	Foreign	Total	Average	2000-2005
Agric.	0.073	0.073	0.073	0.052	0.277
Manuf.	0.102	0.077	0.096	-0.005	-0.032
Services	0.056	0.053	0.055	0.002	0.011
Total	0.087	0.068	0.082	0.000	-0.003

Source: ABSEI Datset and EU-KLEMS.

The first three columns shows the average productivity growth rates for firms in the dataset: productivity is measured both as output per worker and value added per worker with deflated values[5]. Instead the growth rates are calculated on standardized values of efficiency: it means that at time t the efficiency of firm i which belongs sector m is divided by the average productivity of sector m in year t. It is a standard procedure to compare efficiency growth across heterogenous sectors (Basedina, 2008) and to generate more reasonable averages. In order to make data compatible with EU-KLEMS information I calculate just the averages from 2001 to 2005.
Then in the last two column of each table are reported the average growth rate and the net growth rate calculated from the data in EU-KLEMS dataset which cover the history of Irish economy from 1971 to 2005. As I can notice the gap between the Irish Economy information and the ABSEI sample is quite huge. On average Irish efficiency did not grow as calculated from EU-KLEMS. In addition it is interesting to observe that Irish firms in the sample grows more than foreign firm in the sample in particular if efficiency growth is accounted as output per worker. Finally I can not infer if service or manufacturing sector have higher growth rates.
Table 5 describes the average growth rate of value added per worker by year sector from ABSEI dataset. It is direct to notice the bad performance of construction sector and as the productivity growth rates has declined in the first year to recover later. The sector which perform better over the observed period are Electrical equipment and Machinery n.e.c.

[5]Deflators are sector specific and they are collected from EU-KLEMS dataset.

Table 5: Average Value Added growth rate by sector

Sector	2001	2002	2003	2004	2005	2006	Total
Agric./Fish./Min.	-0.067	-0.022	0.191	-0.022	0.117	0.234	0.073
All other sevices	0.020	0.000	0.086	0.071	0.049	0.116	0.059
Basic/fabricated metal prod	0.071	-0.014	0.055	0.112	0.115	0.057	0.066
Chemicals	0.043	-0.050	0.126	0.172	0.141	0.076	0.086
Construction	-0.162	-0.090	-0.118	-0.179	-0.025	-0.248	-0.134
Elec/Electronic equip	0.260	-0.009	0.074	0.140	0.276	0.247	0.165
Food/Drink/Tob	0.075	0.080	0.010	0.075	0.086	0.109	0.073
Machinery nec	0.115	0.100	0.065	0.172	0.341	0.134	0.153
Manuf. n.e.c.	0.069	-0.001	0.066	0.172	0.018	0.173	0.079
Non-metallic Minerals	0.133	0.064	-0.012	0.037	0.112	0.127	0.076
Other Computer related	0.048	-0.037	0.209	0.102	0.382	0.028	0.123
Print/Publish/	0.040	0.112	0.027	0.029	0.126	0.147	0.079
Professional Goods	0.033	0.049	0.020	0.028	0.103	0.078	0.053
Rubber/Plastic	0.052	0.014	0.068	0.072	0.156	0.102	0.076
Software Development	0.045	0.023	0.011	-0.019	0.151	0.040	0.044
Text/Cloth/Leather	0.075	0.065	0.109	0.114	0.108	0.081	0.089
Transport Equipment	0.146	0.004	0.004	0.001	0.134	0.238	0.082
Wood/Wood Prods	0.094	0.165	0.029	0.151	0.080	0.176	0.116
Total	0.076	0.030	0.057	0.083	0.138	0.108	0.082

Source: ABSEI Datset.

The Table 5 is in line with the results of Sexton (2007) where he shows that best efficiency improvements are in manufactures rather than services (in particular construction shows negative growth rate).
I notice that even if dataset does not represent the Irish economy in the whole, it share some common features. However the paper's objective is to understand if input use matter are important factors for the efficiency level. For this purpose ABSEI dataset is useful because it provides information about the consumption of inputs divided by typology (services and raw materials) and by origin (Irish or foreign). The aim is to understand if an increase in the share of imported inputs raises firm's efficiency. Before to continue can be useful to give some definitions. First of all firm's efficiency is measured as value added per worker or output per worker, as above. These indices are used to proxy firm's productivity for two reasons. First of all ABSEI dataset does not provide any information about capital consumption but only data on operating revenues, labor force and value added: it means that it is not possible to use any parametric method to calculate firm's productivity as TFP (Olley and Pakes, 1996; Levinsohn and Petrin, 2003). Secondly, the presence of service sectors makes in the data makes the use of these indices. Then in order to obtain accurate efficiency indices I deflate operating revenues and value added with sector specific price deflators (from EU-KLEMS).

To which regard input use, I calculate two indices, both for material and services. The first one is defined for material as

$$MRT_{it} = \frac{M(I)_{it}}{M_{it} + S_{itt}} \tag{1}$$

where IM_{it} is the consumption of Irish material by firm i at time t and M and S is the total firm's consumption for material and services: the same index is constructed for services. A second index used in the analysis measure which is the percentage of Irish material (service) over the total raw material (services) used.

$$MRI_{it} = \frac{M(I)_{it}}{M_{it}} \tag{2}$$

If one of the two ratios increases it means that firm i use more intensively Irish input in the production process[6]. In the Table (6)below are described the average ratios by sector and firm's origin.

Table 6: Average input mix ratio

	Irish		Foreign	
Sectors	SRI	MRI	SRI	MRI
Agric./Fish./Min.	0.895	0.773	0.921	0.979
All other services	0.880	0.617	0.781	0.445
Basic/fabricated metals	0.924	0.516	0.831	0.289
Chemicals	0.891	0.464	0.740	0.254
Construction	0.937	0.700	0.715	0.154
Electronic	0.864	0.476	0.772	0.255
Food/Drink/Tob.	0.919	0.760	0.738	0.593
Machinery n.e.c.	0.904	0.483	0.787	0.324
Manuf. n.e.c.	0.900	0.508	0.794	0.419
Non-metallic Mineral	0.923	0.578	0.894	0.451
Other computer related	0.857	0.526	0.750	0.557
Print/Publish/	0.918	0.509	0.887	0.265
Professional Goods	0.864	0.481	0.772	0.297
Rubber/Plastic	0.918	0.415	0.853	0.223
Software development	0.840	0.606	0.730	0.560
Text/Cloth/Leath	0.866	0.285	0.762	0.214
Transport equip.	0.906	0.405	0.826	0.192
Wood Products	0.918	0.630	0.853	0.666
Total	0.892	0.560	0.776	0.342

Clearly Irish firms use more intensively domestic input and in particular domestic services rather than foreign firms and the gap is wider if I consider raw materials. While material are easily tradeable, services are more related with the place of provisions[7]. More interesting are the next descriptive statistics. First of all, as trade literature

[6]The ratio for services are defined as $SRT_{it} = \frac{S(I)_{it}}{M_{it}+S_{itt}}$ and $SRI_{it} = \frac{S(I)_{it}}{S_{it}}$

[7]Input as electricity or public services are not easily tradeable.

(Meltiz, 2003; Melitz Ottaviano, 2008) demonstrated that exporters are on average more productive than domestic firms. In Table 7 I compare as the exporting firms use more intensively foreign inputs rather than Irish inputs: the differences maintain the sign also among Irish and foreign owned firms.

Table 7: Average intensity ratios for domestic and exporting firms

		Domestic		Exporters	
		SRI	MRI	SRI	MRI
Irish	Mean	0.94	0.66	0.88	0.53
	Median	1.00	0.80	0.95	0.50
Foreign	Mean	0.86	0.44	0.77	0.34
	Median	0.91	0.30	0.89	0.20
Total	Mean	0.93	0.65	0.84	0.47
	Median	1.00	0.80	0.90	0.40

It seems that the differences in term of input use across firms is larger between domestic and exporter rather than Irish and foreign firms. However I am not able to say if the exporting activity is forcing firms to expand the variety of input used (learning by exporting for inputs) or if input's choice generates a process of self section in the export market. Poorly speaking, I can just infer that exporters use more intensively foreign inputs rather than domestic firms, but not the causal relation or the optimal mix.
Finally I can conclude the section of data description with a tables of correlations. Ln(YL) and Ln(Prod) are respectively the log of output efficiency and value added[8] per worker. They are negatively correlated with MRI index (2) both for services and materials, while MRT index (1) provides coefficients with opposite sign. With Table 8 I can infer that firm's efficiency is negatively correlated with the use of Irish services while material index does not provide a clear answer.

Table 8: Correlation Table (a)

	SRT	SRI	MRT	MRI	Ln(YL)	Ln(Prod)
SRT	1					
SRI	0.2508*	1				
MRT	-0.4593*	0.2350*	1			
MRI	0.1287*	0.2189*	0.8311*	1		
Ln(YL)	*-0.3746**	*-0.1555**	*0.1349**	*-0.0656**	1	
Ln(Prod)	*-0.5141**	*-0.0721**	*0.2514**	*-0.0547**	0.8716*	1

Pairwise correlation tables with Bonferroni transformation. Significance level: * is a p-value<0.05.

It may depend on the fact that large part of firms reached the optimal material input mix. However the index (2) is not very reliable because the denominator (input consumption) may be related negatively with efficiency. When efficiency raises the input consumption decreases and consequently the (2) increases via denominator. Moreover as I will see

[8]Value added is calculated as operating revenues minus total payroll expenses.

Table 9: Correlation Table (b)

	R&D(pw)	Train(pw)	IH(R&D)	IH(R&D Work)	Ln(YL)	*Ln*(Prod)
R&D(pw)	1					
Train(pw)	0.01	1				
IH(R&D)	0.1058*	0.0537*	1			
IH(R&D Work)	0.0413*	0.0175	0.3325*	1		
Ln(YL)	-0.0272*	0.0270*	0.0483*	0.0672*	1	
Ln(Prod)	-0.0579*	0.007	-0.0506*	0.0204	0.8716*	1

Table 10: Correlation Table (c)

	Exp	Exp(UK)	Exp(EU)	Exp(WR)	Exp(Ratio)	Ln(YL)	Ln(Prod)
Exp	1						
Exp(UK)	0.6488*	1					
Exp(EU)	0.4796*	0.3083*	1				
Exp(WR)	0.4114*	0.2504*	0.5088*	1			
Exp(Ratio)	0.5626*	0.2243*	0.5836*	0.5420*	1		
Ln(YL)	0.1633*	0.2677*	0.2885*	0.2318*	0.2147*	1	
Ln(Prod)	0.1071*	0.2606*	0.2294*	0.1533*	0.0816*	0.8716*	1

in the next section only MRT index 1) will be used in the parametric analysis. It is necessary because MRI indexes are highly correlated among them (.45). To conclude these section I can notice two interesting results. Table 9 suggests us that does not exist a clear effect of R&D and training activity on firm's efficiency (positive on Ln(YL) and negative on Ln(Prod)). Then Table 10 shows that export activity is significantly correlated with firm's efficiency: the results is standard and in line with the literature.

3 Empirical Analysis

In this section I introduce how the empirical analysis is performed[9]. In the previous section I observe that there exists a potential negative correlation between the Irish input intensity and firm's efficiency: in addition exporters, which are the most competitive firms, tend to use in their production process less Irish inputs (both services and materials) respect to domestic firms. The aim of the paper is to verify if the input's origin is matter for firm's efficiency. As illustrated in the introduction, the relevance of inputs in the production quality is widely analyzed both empirically (Ackerberg et al., 2006; Amiti Konings, 2008; Forlani 2008) and theoretically (Grossman Helpman, 1991; Fugazza Robert-Nicoud, 2007).
From the ABSEI dataset I can observe the burden of domestic input for service and material; the data provide information about the proportion of input (material and

[9]All the regressions are performed on the 98% of the observations. The first and last centile of the observations (according to the distribution of sales) are not considered in order to avoid outliers.

services) produced in the Republic of Ireland. Unfortunately I can not observe the mass of variety consumed nor the quality. However if the relevance of national input reduces (MRI or SRI decrease) it is reasonable to assume that the quality of imported services or material is superior rather than Irish ones: even if transport or trade cost occur, foreign inputs are more convenient. Then variation in input composition may depend on three factors

1. The price of imported input is lower given a certain level of quality.
2. The quality of foreign input is higher for a given price.
3. The mass of foreign input used in the production process increases.

When the burden of foreign input increases I can hypothesize that the productivity changes because of variation in the quality and number of inputs. If I find a negative sign for SRI or MRI I may state that as the Irish input intensity decreases firm's productivity grows and this variation may depend on by unobserved input quality effects or variation in the mass of variety used.

3.1 Baseline model

The baseline regression is a simple pooled OLS (POLS) with Ln(YL) and Ln(Prod) as dependent variable, i.e.

$$Ln(TFP)_{it} = \alpha + \beta_m MRI_{it} + \beta_s SRI_{it} + \gamma X_{it} + \delta SD_i + \delta TD_t + \varepsilon_{it}. \quad (3)$$

The coefficients of interests are β_s and β_m which we expect negative: if they are negative it means that an increasing employment of foreign input affects positively firm's productivity. Then in (3), I add also control variables (X_{it}) as export status, R&D expenditure (total and in house), training and the firm ownership. Finally I introduce also year dummies(TD_t) and sector dummies(SD_i) at NACE two digit to control for business cycle and sector characteristics. In particular sector dummies are important because of firms' heterogeneity in the dataset. The estimation method is very standard but it gives us some interesting intuition; the coefficients will tell us which is the gains in term of productivity with the employment of imported inputs. The results are showed in Table 11 and Table 12, where Ln(YL) Ln(Prod) are respectively the dependent variables.
Looking at Table 11, from the first line of coefficients I can infer that plants which use intensively foreign services in the production process are more productive than the other. The negative sign is always highly significant for each specification, changing also the control variables. It means that if index SRI (2) decreases of 1%, firm's efficiency raise of 0.38% on average (if I exclude column 6): it is a quite huge variation. Instead the MRI index is not significant and it probably suggest us that firms are indifferent between Irish of foreign raw materials. Then in the last column I add quadratic term to control for potential concave effects: the idea is to control if the sign of index (2) change with

Table 11: Log of output per worker baseline equation - Irish input intensity use

	(1) Ln(YL)$_{it}$	(2) Ln(YL)$_{it}$	(3) Ln(YL)$_{it}$	(4) Ln(YL)$_{it}$	(5) Ln(YL)$_{it}$	(6) Ln(YL)$_{it}$
SRI$_{it}$	-0.395***	-0.366***	-0.376***	-0.413***	-0.382***	-0.819**
	[0.088]	[0.088]	[0.091]	[0.091]	[0.089]	[0.385]
MRI$_{it}$	0.013	0.022	0.024	0.016	0.010	-0.209
	[0.039]	[0.040]	[0.041]	[0.040]	[0.040]	[0.145]
SRI$^2{}_{it}$						0.331
						[0.280]
MRI$^2{}_{it}$						0.195
						[0.135]
Ln(W)$_{it}$	0.786***	0.782***	0.798***	0.798***	0.789***	0.801***
	[0.032]	[0.032]	[0.033]	[0.033]	[0.033]	[0.033]
Status$_i$	0.423***	0.387***	0.389***	0.411***	0.400***	0.419***
	[0.040]	[0.042]	[0.041]	[0.041]	[0.040]	[0.040]
Exp(UK)$_{it}$			0.203***			
			[0.030]			
Exp(EU)$_{it}$			0.085***			
			[0.028]			
Exp(WR)$_{it}$			0.006			
			[0.029]			
LnIH(R&D)$_{it}$			-0.022***			-0.010*
			[0.006]			[0.006]
Exp(Ratio)$_{it}$		0.106***				
		[0.038]				
R&D(pw)$_{it}$				-0.001		
				[0.001]		
Train(pw)$_{it}$				0.008**		
				[0.003]		
R&D$_{it}$					0.000***	
					[0.000]	
IH(R&D)$_{it}$					-0.000**	
					[0.000]	
Train$_{it}$					0.000**	
					[0.000]	
Obs	13446	13446	12256	13191	12676	12774
R^2	0.339	0.341	0.353	0.343	0.350	0.343

Standard errors in squared barckets are robust and clusterd across individuals. Time dummies and sector dummies are included(Nace two digits). SRI is defined as the consumption of Irish services (as input) over thetotal input service consumption. MRI is calculated in the same way for materials
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

the its level. I just obtain SRI coefficient less significant (and again negative) but the quadratic term are not significantly different from zero.
The results do not change if I change control variables. Labor cost ($Ln(W)$) and especially ownership dummies are always present in the regressions because I notice from Table 6 that foreign firms use more intensively imported inputs; I can notice as foreign firms are more productive than Irish firms (ownership premia) and that firms which incur in higher unit labor cost are more efficient. The former result suggest that foreign

firms are superior in technology[10] while the ladder may be a signal that higher unit labor cost is an indicator of labor quality; highly qualified workers are more productive and efficient but are paid more (Monfort et al., 2008). Then I can notice that exporting firms are more productive than non-exporting firms and that the exporting premia decreases with the distance of reached markets. Finally I can notice the positive effect of R&D expenditure and Training activity on firms productivity, however the coefficients are significant but the parameter value is very small. It is interesting to notice as the In-House R&D is negatively correlated with firms efficiency. It is reasonable to assume that the significance and sign for the parameters related to R&D is affected by dataset composition. Given that the firms in the dataset are firms which received a support in R&D (in particular in Software Development sector) it is difficult to disentangle the effect of R&D from the effect of subsidy/support on firm's efficiency.
In Table 12 are reported the results for the same equation (3) but the dependent variable changes. I obtain the same sign and significance level for large part of the variables. Even if I evaluate firm's efficiency as value added per worker, the importance of imported services does not change rather the magnitude increases: if SRI decreases of 1% the labor productivity grows of 0.40% (on average). The quadratic term are not significant as well as material index. Then the control variables remains with the same sign, in particular the ownership dummy and $Ln(w)$; firms which export in UK or EU are more efficient.
With Table 11 and Table 12 I can illustrate some initial results[11]. Firm's productivity raises if the use of foreign inputs increases. The mechanism may depend on the better quality of foreign services, on the price, or on the fact that there exists abroad some services that are not sold by Irish service providers. The results are reliable because they are not sensible to a variation in firm's efficiency measurement; both with output per worker and with labor productivity, the sign of coefficient does not change.
However the equation (3) suffers of some problems. First of all the indices SRI or MRI may be endogenous, i.e. correlated with the error term. The endogeneity is caused by a simultaneity problem[12]: the most efficient firms may decide to use foreign inputs rather than domestic firms. Secondly, firm's productivity may be an autoregressive process, then the actual firms efficiency has to be explained with past values. Thirdly, it is reasonable to take into account firm's heterogeneity, with unobserved effect. In order to deal with these three issue I perform in the next section as dynamic panel analysis (Arellano Bond, 1991; Blundell Bond, 1998).

[10]The presence of foreign firms has a potential positive effect on Irish firms' productivity. In Table 3 I saw that Irish firms grow faster than foreign firms. This phenomenon may be explained by spillover effects from multinational enterprises.

[11]In the baseline equations sector dummies are jointly significant while year dummies are not significant.

[12]The same issue exists for export status, because the most productive firms self-select in export market (Bernard et al., 1997).

Table 12: Log Labor Productivity baseline equation: Irish input intensity use

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}
SRI_{it}	-0.402***	-0.398***	-0.375***	-0.479***	-0.402***	-1.118*
	[0.140]	[0.141]	[0.145]	[0.141]	[0.139]	[0.599]
MRI_{it}	-0.017	-0.015	0.012	-0.012	-0.013	0.227
	[0.072]	[0.072]	[0.075]	[0.071]	[0.072]	[0.265]
$\text{SRI}^2{}_{it}$						0.553
						[0.452]
$\text{MRI}^2{}_{it}$						-0.262
						[0.246]
Ln(W)_{it}	0.471***	0.470***	0.486***	0.510***	0.465***	0.499***
	[0.060]	[0.060]	[0.062]	[0.060]	[0.063]	[0.061]
Status_i	0.702***	0.696***	0.656***	0.666***	0.671***	0.707***
	[0.070]	[0.077]	[0.072]	[0.070]	[0.070]	[0.072]
Exp(UK)_{it}			0.430***			
			[0.058]			
Exp(EU)_{it}			0.157***			
			[0.053]			
Exp(WR)_{it}			-0.018			
			[0.053]			
$\text{LnIH(R\&D)}_{it}$			-0.048***			-0.030***
			[0.010]			[0.010]
Exp(Ratio)_{it}		0.017				
		[0.074]				
$\text{R\&D(pw)}_{it}$				-0.005**		
				[0.003]		
Train(pw)_{it}				0.011**		
				[0.005]		
$\text{R\&D}_{it}$					0.000***	
					[0.000]	
$\text{IH(R\&D)}_{it}$					-0.000**	
					[0.000]	
Train_{it}					0.000**	
					[0.000]	
Obs	13446	13446	12256	13191	12676	12774
R^2	0.190	0.190	0.215	0.198	0.201	0.197

Standard errors in squared barckets are robust and clusterd across individuals. Time dummies and sector dummies are included(Nace two digits). SRI is defined as the consumption of Irish services (as input) over thetotal input service consumption. MRI is calculated in the same way for materials Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

3.2 Dynamic analysis

The estimation of equation (3) may be problematic even if I use fixed effect or random effect estimator to take into account unobserved firms' heterogeneity. Many of the variables in the equation are likely to be jointly endogenous (simultaneity or to two-way causality with dependent variable), and the presence of the lagged endogenous variable for firm's productivity will bias coefficient estimates. Then to address these problems I use dynamic panel estimation technique developed by Arellano and Bond and in particular the so called "system-GMM" by Blundell and Bond (1998). This esti-

mator first-differences each of the variables in order to eliminate the firm-specific effects, and then uses lagged levels of the variables as instruments. A concern arises with this GMM estimator if there is no evidence of firm-specific effects, so in that case it is more efficient to estimate the equation in levels (using lagged levels as instruments) than in first differences. For this reason I test the presence of firm-specific effects using equation 3. I estimate it in levels and I test for the presence of first-order serial correlation, which would indicate the presence of unobserved firm-specific effects[13].
To improve the efficiency of the estimator I implement the so called "system-GMM" instead of "difference" GMM; it consists in the introduction of a second equation in levels to the first-difference equation. The idea is to augment the number of observations and consequently the efficiency. Blundell and Bond employ the same equation in levels and then use lagged first differences as instruments for the variables in levels[14]. The estimated equation is similar to (3) , i.e.

$$Ln(YL)_{it} = \alpha_0 + \alpha_1 Ln(YL)_{it-1} + \beta_m MRI_{it} + \beta_s SRI_{it} + \gamma X_{it} + \delta SD_i + \delta TD_t + c_i + \varepsilon_{it}, \quad (4)$$

where c_i capture firm's unobserved characteristics. I add for the estimation of (4) the lagged values for the variables of interest (MRI and SRI) and control variables (X_{it}). The coefficients are obtained estimating a system of two equations, one with the variables in first differences and the other with the variables in levels[15]: clearly in the equation in levels the unobserved term c_i remains.
Three critical assumptions have to be satisfied for this estimator to be consistent and efficient. First, the explanatory variables must be predetermined by at least one period. Second, the error terms cannot be serially correlated. The third one, necessary only for "system" GMM, requires that there is no correlation between the differenced explanatory variables and the firm-specific effects. More specifically, if $\mathbf{X}'_{it}$ is the vector of explanatory variables in equation (4), ε_{it} is the error term and c_i is firm's unobserved heterogeneity, then the three conditions are:

$$E\left(\mathbf{X}'_{it}\varepsilon_{is}\right) = 0 \text{ for all } s > t, \quad (5)$$

$$E\left(\varepsilon'_{it}\varepsilon_{i,t-s}\right) = 0 \text{ for all } s \geq 1 \text{ and} \quad (6)$$

$$E\left(\Delta X_{it} c_i\right) = 0. \quad (7)$$

[13] An alternative approach is to estimate the model in levels with firm-dummy variables and then test for the joint significance of the firm-dummy variables. If the dummies are jointly significant, it is a signal of unobserved firm's heterogeneity.

[14] A potential problem is that the lagged levels of the variables can be weak instruments for the regression estimated in differences.

[15] It is not the esitmation of two simulatneous equation but just one equation is estimated. For more pratical details look Roodman (2006).

Arellano and Bond (1991) propose two tests for the accuracy of this estimator, which are valid also for "system" GMM. First, a Sargan-Hansen test of over-identifying restrictions, which tests the null hypothesis of no correlation between the instruments and the residuals (Eq.(5)): it controls if instruments are good, then if Sargan-Hansen test passes it means that also the third condition holds (Eq.(7)) because in the "system" GMM also first differences are used as instruments. Second one is a test for different-order serial correlation in the residuals. If this test is unable to reject the null hypothesis of no second-order serial correlation in the differenced equation, then the level variables lagged by one period are valid instruments. If there is evidence of second-order serial correlation, but not third-order (or higher) serial correlation, then the level variables lagged by two periods are valid instruments[16].
Just two final remarks for the estimation techniques. First of all the differences are not calculated as "first differences" but as orthogonal deviations (Arellano Bover, 1995): it means that for the observation at time t is subtracted the mean of observation from year $t+1$ onwards. In this case I lose the last year of observations but I minimize the missing values in case of no observations between two consequent years. Secondly I perform the two step estimator, which produces less biased standard errors in case of large samples; moreover the Sargan Hansen test is corrected for the heteroskedasticity (test is robust).
The results are showed in Table 13, Table 14 and Table 15 only for the case of value added per worker as dependent variable: in the Appendix D. In Table 13 are presented the results for the full sample both with Irish and with foreign firms[17]. I can notice that now there exists a weaker evidence that foreign inputs and in particular services have a positive impact on firm's productivity: the significant coefficients for SRI are only in column (1) (4) and (6), confidence interval is smaller and standard errors are large. Also the other control variables are not significant if I exclude Ownership dummy (Status) which is again positive and highly significant. Even if the relevance of input origin shrinks, the ownership premia remains while export premia disappear. Instead the Sargan-Hansen test and Autocorrelation test pass, meaning that condition listed above are satisfied.
The coefficient of Status in Table 13 may suggest a huge heterogeneity between Irish and foreign firms in term of production structure; then a second kind of estimations on a smaller sample is performed. In Table 12 and Table 13 the sample is splitted respectively in a sub-sample of Irish firms and foreign firms. Comparing the results in Table 14 I can notice as the relevance of foreign services raises for Irish firms' efficiency: as the burden of imported services increases firm's efficiency grows. For almost all specifications the SRI coefficient is negative and significant; moreover in column (6) the quadratic term for SRI suggests a significant change of sign. However with simple calculations it is straightforward as the change in sign happens for values of SRI>1and it is impossible given that SRI$\in [0,1]$ by construction. Indeed I can not exclude concave effects, i.e. that an excessive consumption of foreign services hurts firms' efficiency. It is possible that

[16]In my specific case I will instrument SRI and MRI with one lag period, using them as predetermined variables. There is no evidence to use lags of higher order.

[17]In all estimations with System-GMM both year dummies and sector dummies are jointly significant.

Table 13: Log of Labor Productivity System-GMM (full sample)

VARIAB.	(1) $Ln(Prod)_{it}$	(2) $Ln(Prod)_{it}$	(3) $Ln(Prod)_{it}$	(4) $Ln(Prod)_{it}$	(5) $Ln(Prod)_{it}$	(6) $Ln(Prod)_{it}$
$Ln(Prod)_{it-1}$	0.338***	0.370***	0.555***	0.324***	0.525***	0.390***
	[0.082]	[0.080]	[0.078]	[0.085]	[0.085]	[0.077]
MRI_{it}	-0.104	-0.011	-0.015	-0.090	0.065	-0.630
	[0.112]	[0.093]	[0.099]	[0.112]	[0.139]	[0.493]
SRI_{it}	-0.726**	-0.408	-0.150	-0.741**	-0.313	-2.178*
	[0.328]	[0.274]	[0.231]	[0.324]	[0.353]	[1.260]
SRI^2_{it}						1.215
						[0.843]
MRI^2_{it}						0.476
						[0.411]
$Ln(W)_{it}$	0.221	0.184	0.375*	0.218	0.056	0.331
	[0.318]	[0.326]	[0.207]	[0.360]	[0.336]	[0.226]
$Exp(UK)_{it}$			0.014			
			[0.175]			
$Exp(EU)_{it}$			-0.028			
			[0.184]			
$Exp(WR)_{it}$			0.009			
			[0.160]			
$LnIH(R\&D)_{it}$			0.006			-0.019
			[0.032]			[0.031]
$Status_i$	0.378***	0.517***	0.190**	0.369***	0.303***	0.305***
	[0.087]	[0.132]	[0.082]	[0.091]	[0.084]	[0.076]
$Exp(Ratio)_{it}$		-0.828				
		[0.589]				
$R\&D(pw)_{it}$				0.002		
				[0.003]		
$Train(pw)_{it}$				-0.002		
				[0.003]		
$R\&D_{it}$					0.000	
					[0.000]	
$IH(R\&D)_{it}$					-0.000	
					[0.000]	
$Train_{it}$					0.000	
					[0.000]	
Obs	10068	10037	9091	9855	9410	9487
Sargan−Hansen	0.9218	0.8495	0.8991	0.9094	0.9281	0.9989
AR2 Test	0.6274	0.7969	0.5960	0.5003	0.3154	0.8135

Dynamic panel-data estimation, system GMM. SRI is defined as the consumption of Irish services (input) over the total input service consumption. MRI is calculated in the same way for materials. Robust standard errors and two step estimator are used. Sector and year dummies included
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

the coefficient intensity is not reliable because the index for firm's productivity is not a perfect measure; more sophisticated analysis for firms' productivity can be necessary, using for example some parametric method (Olley Pakes, 1996; Levinsohn Petrin, 2003). Instead Table 15 shows us that the in the case of foreign firms is more relevant the use of foreign inputs rather than imported services. The significance of coefficient is not very high but I can suppose that if foreign firms increases the their share of imported

raw materials the productivity grows raise. The results can be explained by the fact that foreign firms use more intensively imported services as input rather than Irish firms (Table 6): a further change in the composition of inputs does not affect their productivity. While the positive relation between imported materials and foreign firms' productivity can suggest that non-Irish firms use inefficiently Irish inputs.
To conclude I can state that the origin of input is important for firm's productivity, both for Irish and foreign owned firms. In all estimations the coefficients of interests (SRI and MRI) have always the negative sign when they are significant: it means that if the variety and origin of input used in the production process change in the direction of more foreign inputs, there can be gains in terms of efficiency for the firms considered. Finally the tables in Appendix D confirm the presents results and reinforce them. The only difference is that now the log of unit labor cost is significant.

Table 14: Log of Labor Productivity System-GMM (Irish Firms)

	(1)	(2)	(3)	(4)	(5)	(6)
	$Ln(Prod)_{it}$	$Ln(Prod)_{it}$	$Ln(Prod)_{it}$	$Ln(Prod)_{it}$	$Ln(Prod)_{it}$	$Ln(Prod)_{it}$
$Ln(Prod)_{it-1}$	0.344***	0.373***	0.522***	0.423***	0.497***	0.371***
	[0.101]	[0.104]	[0.088]	[0.084]	[0.087]	[0.104]
MRI_{it}	-0.182	-0.029	0.086	0.135	0.070	-0.843
	[0.180]	[0.179]	[0.195]	[0.216]	[0.207]	[0.862]
SRI_{it}	-1.291**	-0.651	-0.997**	-0.997**	-0.950**	-5.862**
	[0.540]	[0.457]	[0.507]	[0.423]	[0.477]	[2.553]
$MRI^2{}_{it}$						0.571
						[0.693]
$SRI^2{}_{it}$						3.873**
						[1.820]
$Ln(W)_{it}$	0.771	0.113	0.835*	-0.177	0.375	0.804*
	[0.566]	[0.491]	[0.430]	[0.432]	[0.397]	[0.483]
$Exp(UK)_{it}$			0.156			
			[0.274]			
$Exp(EU)_{it}$			-0.089			
			[0.344]			
$Exp(WR)_{it}$			0.164			
			[0.294]			
$LnIH(R\&D)_{it}$			-0.021			0.007
			[0.057]			[0.058]
$Exp(Ratio)_{it}$		-0.209				
		[1.048]				
$R\&D(pw)_{it}$				0.001		
				[0.005]		
$Train(pw)_{it}$				-0.012		
				[0.018]		
$R\&D_{it}$					-0.000	
					[0.000]	
$IH(R\&D)_{it}$					0.000	
					[0.000]	
$Train_{it}$					0.000	
					[0.000]	
Obs	7457	7427	6668	7263	6963	7039
AR2 Test	0.7927	0.9629	0.6712	0.3691	0.3657	0.9844
Sargan−Hansen	0.9049	0.8012	0.9301	0.9515	0.8477	0.9798

Dynamic panel-data estimation, system GMM. SRI is defined as the consumption of Irish services (input) over the total input service consumption. MRI is calculated in the same way for materials. Robust standard errors and two step estimator are used. Sector and year dummies included
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

Table 15: Log of Labor Productivity System-GMM (Foreign Firms)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Prod)$_{it}$	Ln(Prod)$_{it}$	Ln(Prod)$_{it}$	Ln(Prod)$_{it}$	Ln(Prod)$_{it}$	Ln(Prod)$_{it}$
Ln(Prod)$_{it-1}$	0.455***	0.442***	0.499***	0.536***	0.631***	0.352***
	[0.154]	[0.152]	[0.137]	[0.139]	[0.122]	[0.132]
MRI$_i t$	-0.463**	-0.353*	-0.419**	-0.544**	-0.417**	-0.902
	[0.223]	[0.206]	[0.207]	[0.213]	[0.208]	[1.039]
SRI$_i t$	-0.119	-0.044	0.205	0.085	0.136	0.458
	[0.564]	[0.588]	[0.489]	[0.735]	[0.395]	[1.504]
MRI$^2{}_i t$						0.465
						[0.976]
SRI$^2{}_{it}$						-0.559
						[1.207]
Ln(W)$_i t$	0.329	0.297	0.278	0.323	0.138	0.085
	[0.398]	[0.399]	[0.280]	[0.332]	[0.378]	[0.384]
Exp(UK)$_i t$			0.538			
			[0.331]			
Exp(EU)$_i t$			-0.053			
			[0.275]			
Exp(WR)$_i t$			-0.059			
			[0.270]			
LnIH(R&D)$_i t$			-0.011			-0.023
			[0.046]			[0.044]
Exp(Ratio)$_i t$		-1.286				
		[1.311]				
R&D(pw)$_i t$				0.003*		
				[0.002]		
Train(pw)$_i t$				0.000		
				[0.002]		
R&D$_i t$					0.000*	
					[0.000]	
IH(R&D)$_i t$					-0.000***	
					[0.000]	
Train$_i t$					0.000	
					[0.000]	
Obs.	2611	2610	2423	2592	2447	2448
Sargan−Hansen	0.1433	0.3026	0.6560	0.2665	0.3509	0.7071
AR2 Test	0.1455	0.1063	0.4246	0.1529	0.3163	0.5084

Dynamic panel-data estimation, system GMM. SRI is defined as the consumption of Irish services (input) over the total input service consumption. MRI is calculated in the same way for materials. Robust standard errors and two step estimator are used. Sector and year dummies included
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

4 Conclusions

In this paper it has been illustrated the productivity pattern for a sample of Irish firms and the relation of firm's efficiency with the composition of input by origin. Three facts capture the attention. First of all I notice that the firms in the sample grows more than the average Irish economy, However some sectors grows more than others. Then comparing data I observe that foreign firms are more productive than Irish firms but they

grow with a lower rate; foreign firms in addition use more intensively imported inputs in their production process (both services and materials). Third exporters employ in their production process more imported inputs rather than domestic firms. These facts suggest a question: does input origin matter for firm's productivity? Firms which change their input structure gain in term of efficiency. Then the fundamental results are three.

1. The most efficient firms have a more diversified structure of inputs: they use more intensively foreign inputs.
2. On average the most productive firms use more intensively foreign services.
3. There is strong evidence that Irish owned firms raise their productivity if they use more intensively imported services in the production process.
4. There is weak evidence that foreign owned firms can increase their productivity using imported materials (rather than services).

As described above the input origin composition can change for three reasons:1)The price of imported input is lower given a certain level of quality. 2)The quality of foreign input is higher for a given price. 3)The mass of foreign input used in the production process increases.
Therefore these results bring to the attention some interesting facts. First of all it is important for firm's efficiency diversify as much as possible their inputs. Table 6 shows that firms in the sample use more Irish input rather than foreign ones (in particular services), while Table 11 and Table 12 tell us that firms which use more intensively foreign services are more productive. Then the use of Irish services does not affect positively, on the average, firm's efficiency. Probably this statistical relation exists because the quality of Irish services is lower than the quality imported services: as it has been illustrated by Farrell (2007), the competitiveness and productivity of service sector is an important challenge for Ireland. The aim is not only the competitiveness of services *per se* but also the potential positive effects on the efficiency of other firms which uses more intensively services as inputs: it has been demonstrated for example that for Czech Republic (Arnold et al., 2007) and France (Forlani, 2008) more competition in services brings positive effects in term of productivity for manufacturing firms. Secondly this fact is confirmed and reinforced by results in Table 14, where it is showed that Irish firms raise their productivity if they increase the burden of foreign service input in their production process. With the fact that Irish firms uses in large part national input it may suggest problems in the quality of services.
To conclude two policy advises can be given. First of all increase the competition in the input market, maybe reducing taxes on intermediates inputs imports for some sector which is intensive in R&D (Chemicals or Software Development). Secondly, and maybe more important, promote competition in service market such as the quality of services increases and sustains the efficiency of firms that use intensively services as inputs.

A further analysis will require the use of more detailed dataset which includes also the stock of capital (fixed assets) such as it will be possible to estimate production function and calculate productivity as a residual with the more advanced techniques.

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A Data description

All data on values are in thousands of Euros.

- $Ln(YL)$: Output per worker. It is calculated as the deflated value of firm's sales over the total number of employed people. Sales are deflated in order to obtain a proxy value for output produced.
- $Ln(\mathrm{Pr}\,od)$: It is labor productivity and it is calculated as value added per worker. Value added is derived from the dataset as sales minus total payroll. The value added is deflated with sector specific deflator (source:EU-KLEMS).
- $M(I)$ and $S(I)$: consumption level of material and services produced by firms in the Republic of Ireland.
- M and S: total consumption of material and services.
- $MRT_{it} = \frac{M(I)_{it}}{M_{it}+S_{itt}}$ and $MRI_{it} = \frac{M(I)_{it}}{M_{it}}$
- $SRT_{it} = \frac{S(I)_{it}}{M_{it}+S_{itt}}$ and $SRI_{it} = \frac{S(I)_{it}}{S_{it}}$
- Ln(W): Logarithm of total wage bill over the number of employees. It is the log of firm's average labor cost.
- R&D: Expenditure in research and development activity.
- Train: Total cost of all formal structured training to Management and Staff (in house and external)
- IH(R&D) and IH(R&D Work): Expenditure in R&D performed inside the firm and number of people employed in In-House R&D activity.
- Exp(Ratio): Percentage of sales from foreign markets.
- Exp(UK, EU, WR): dummy variable which is equal to one if one firm exports in UK, European Union or other countries in the world, otherwise zero.
- Status: dummy variable which is equal to one if firms is foreign owned, otherwise zero. The variable is time invariant.

B Additional tables

Table 16: Descriptive statistics (Irish Firms)

Irish Firms	Train(pw)	R&D(pw)	Exp(Ratio)	Exp(UK)	Exp(EU)	Exp(WR)
Agric./Fish./Min.	0.310	1.618	0.330	0.466	0.392	0.228
All other services	0.851	19.333	0.386	0.502	0.404	0.438
Basic/fabricated metals	0.554	2.062	0.154	0.621	0.249	0.208
Chemicals	0.467	10.921	0.510	0.858	0.621	0.555
Construction	0.397	0.710	0.074	0.098	0.110	0.098
Electronic	0.592	12.729	0.443	0.648	0.565	0.529
Food/Drink/Tob.	0.517	2.259	0.323	0.740	0.500	0.280
Machinery n.e.c.	0.590	3.738	0.298	0.765	0.521	0.419
Manuf. n.e.c.	0.759	3.028	0.250	0.754	0.222	0.217
Non-metallic Mineral	0.361	0.907	0.188	0.695	0.364	0.417
Other computer related	0.887	12.335	0.408	0.665	0.502	0.529
Print/Publish/	0.342	0.856	0.186	0.751	0.337	0.293
Professional Goods	0.913	16.892	0.565	0.689	0.701	0.630
Rubber/Plastic	0.377	2.465	0.342	0.847	0.484	0.324
Software development	0.894	25.721	0.491	0.626	0.401	0.443
Text/Cloth/Leath	0.443	2.761	0.459	0.888	0.601	0.531
Transport equip.	0.433	3.238	0.417	0.784	0.368	0.310
Wood Products	0.321	1.531	0.125	0.612	0.078	0.078
Total	0.624	9.150	0.340	0.678	0.423	0.371

Source: ABSEI Datset. Pw: per worker

Table 17: Descriptive statistics (Foreign Firms)

Foreign Firms	Train(pw)	R&D(pw)	Exp(Ratio)	Exp(UK)	Exp(EU)	Exp(WR)
Agric./Fish./Min.	0.281	0.763	0.776	0.571	0.929	0.857
All other services	0.741	4.918	0.683	0.638	0.582	0.515
Basic/fabricated metals	0.423	1.412	0.656	0.757	0.784	0.495
Chemicals	0.806	33.128	0.862	0.620	0.804	0.687
Construction	0.565	0.000	0.000	0.000	0.000	0.000
Electronic	1.117	12.332	0.838	0.709	0.850	0.689
Food/Drink/Tob.	1.139	1.476	0.570	0.895	0.754	0.594
Machinery n.e.c.	0.404	2.291	0.764	0.843	0.871	0.691
Manuf. n.e.c.	0.335	0.538	0.868	0.761	0.955	0.731
Non-metallic Mineral	0.322	1.086	0.569	0.806	0.612	0.478
Other computer related	0.861	5.899	0.841	0.624	0.680	0.536
Print/Publish/	0.836	2.500	0.566	0.839	0.540	0.286
Professional Goods	0.450	7.042	0.876	0.693	0.876	0.741
Rubber/Plastic	0.383	1.173	0.759	0.778	0.859	0.579
Software development	0.963	26.091	0.850	0.655	0.731	0.664
Text/Cloth/Leath	0.386	1.061	0.808	0.659	0.773	0.443
Transport equip.	0.393	3.458	0.935	0.746	0.976	0.736
Wood Products	0.338	2.716	0.687	1.000	0.524	0.500
Total	0.739	11.235	0.784	0.706	0.773	0.624

Source: ABSEI Datset. Pw: per worker

Table 18: MRI Ratio by sector

Sectors	2000	2001	2002	2003	2004	2005	2006	Total
Agric./Fish./Min.	0.828	0.841	0.827	0.771	0.786	0.749	0.701	0.787
All other services	0.542	0.606	0.613	0.601	0.583	0.577	0.547	0.582
Basic/fabricated metals	0.480	0.489	0.498	0.508	0.489	0.458	0.430	0.480
Chemicals	0.262	0.287	0.348	0.368	0.373	0.354	0.320	0.330
Construction	0.680	0.681	0.732	0.698	0.682	0.548	0.570	0.658
Electronic	0.354	0.394	0.397	0.411	0.361	0.311	0.298	0.363
Food/Drink/Tob.	0.744	0.762	0.749	0.755	0.752	0.708	0.692	0.738
Machinery n.e.c.	0.409	0.473	0.493	0.509	0.445	0.411	0.399	0.451
Manuf. n.e.c.	0.465	0.515	0.541	0.541	0.520	0.442	0.444	0.501
Non-metallic Mineral	0.531	0.570	0.617	0.558	0.545	0.543	0.530	0.557
Other computer related	0.560	0.572	0.580	0.509	0.507	0.518	0.476	0.534
Print/Publish/	0.494	0.493	0.524	0.509	0.475	0.427	0.411	0.479
Professional Goods	0.338	0.358	0.393	0.431	0.409	0.361	0.373	0.382
Rubber/Plastic	0.285	0.326	0.398	0.420	0.354	0.326	0.309	0.345
Software development	0.573	0.568	0.610	0.663	0.607	0.571	0.566	0.594
Text/Cloth/Leath	0.288	0.291	0.300	0.268	0.250	0.249	0.238	0.274
Transport equip.	0.245	0.300	0.372	0.390	0.328	0.287	0.274	0.316
Wood Products	0.594	0.683	0.664	0.669	0.601	0.614	0.605	0.634
Total	0.476	0.509	0.531	0.539	0.514	0.482	0.469	0.503

Source: ABSEI Datset.

Table 19: SRI Ratio by sector

Sectors	2000	2001	2002	2003	2004	2005	2006	Total
Agric./Fish./Min.	0.912	0.871	0.889	0.925	0.913	0.873	0.897	0.896
All other services	0.867	0.875	0.878	0.874	0.838	0.832	0.810	0.853
Basic/fabricated metals	0.901	0.908	0.913	0.918	0.914	0.911	0.897	0.909
Chemicals	0.809	0.791	0.792	0.812	0.798	0.785	0.776	0.795
Construction	0.939	0.938	0.929	0.919	0.918	0.885	0.929	0.922
Electronic	0.837	0.836	0.824	0.824	0.805	0.806	0.777	0.817
Food/Drink/Tob.	0.900	0.906	0.908	0.899	0.899	0.886	0.880	0.897
Machinery n.e.c.	0.885	0.898	0.899	0.884	0.873	0.863	0.848	0.880
Manuf. n.e.c.	0.874	0.885	0.897	0.908	0.895	0.884	0.888	0.891
Non-metallic Mineral	0.929	0.916	0.917	0.929	0.914	0.913	0.910	0.919
Other computer related	0.837	0.841	0.832	0.805	0.789	0.785	0.785	0.811
Print/Publish/	0.934	0.913	0.901	0.897	0.924	0.928	0.893	0.914
Professional Goods	0.802	0.819	0.824	0.822	0.799	0.816	0.817	0.814
Rubber/Plastic	0.889	0.899	0.904	0.913	0.907	0.874	0.870	0.894
Software development	0.835	0.840	0.825	0.831	0.814	0.793	0.778	0.815
Text/Cloth/Leath	0.875	0.835	0.858	0.856	0.829	0.844	0.851	0.851
Transport equip.	0.885	0.873	0.866	0.866	0.860	0.876	0.885	0.873
Wood Products	0.902	0.929	0.925	0.889	0.897	0.930	0.911	0.912
Total	0.872	0.872	0.872	0.869	0.856	0.848	0.836	0.861

Source: ABSEI Datset.

C Baseline equation additional tables

Table 20: Log output per worker - Irish input overall intensity

	(1) Ln(YL)$_{it}$	(2) Ln(YL)$_{it}$	(3) Ln(YL)$_{it}$	(4) Ln(YL)$_{it}$	(5) Ln(YL)$_{it}$	(6) Ln(YL)$_{it}$
MRT$_{it}$	-0.052	-0.008	-0.000	-0.051	-0.048	-0.193
	[0.047]	[0.046]	[0.048]	[0.047]	[0.047]	[0.144]
SRT$_{it}$	-1.085***	-1.068***	-1.079***	-1.105***	-1.110***	-2.522***
	[0.070]	[0.069]	[0.071]	[0.071]	[0.071]	[0.184]
MRT$^2{}_{it}$						0.169
						[0.159]
SRT$^2{}_{it}$						1.461***
						[0.181]
Ln(W)$_{it}$	0.713***	0.707***	0.771***	0.786***	0.773***	0.782***
	[0.032]	[0.032]	[0.032]	[0.033]	[0.033]	[0.032]
Status$_i$	0.418***	0.347***	0.364***	0.401***	0.395***	0.397***
	[0.036]	[0.039]	[0.036]	[0.037]	[0.037]	[0.036]
Exp(UK)$_{it}$			0.189***			
			[0.027]			
Exp(EU)$_{it}$			0.090***			
			[0.026]			
EXP(WR)$_{it}$			0.096***			
			[0.027]			
LnIH(R&D)$_{it}$			-0.026***			-0.010**
			[0.005]			[0.005]
Exp(Ratio)$_{it}$		0.209***				
		[0.037]				
R&D(pw)$_{it}$				-0.001		
				[0.001]		
Train(pw)$_{it}$				0.010**		
				[0.004]		
R&D$_{it}$					0.000***	
					[0.000]	
IH(R&D)$_{it}$					-0.000***	
					[0.000]	
Train$_{it}$					0.000**	
					[0.000]	
Obs.	15778	15778	14330	15428	14766	14905
R^2	0.364	0.369	0.397	0.380	0.386	0.394

Standard errors are robust and clusterd across individuals. Time dummies and sector dummies are included (Nace two digits). SRT is defined as the consumption of Irish services (as input) over the sum of total input consumption (services plus materials). MRT is calculated in the same way for materials
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

Table 21: Log Labor Productivity - Irish input overall intensity

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}	Ln(Prod)_{it}
SRT_{it}	-2.526***	-2.514***	-2.498***	-2.545***	-2.568***	-4.107***
	[0.125]	[0.125]	[0.127]	[0.126]	[0.126]	[0.323]
MRT_{it}	0.146**	0.179**	0.243***	0.120*	0.137*	0.675**
	[0.072]	[0.072]	[0.075]	[0.071]	[0.071]	[0.266]
$\text{SRT}^2{}_{it}$						1.582***
						[0.345]
$\text{MRT}^2{}_{it}$						-0.655**
						[0.285]
Ln(W)_{it}	0.341***	0.336***	0.391***	0.446***	0.391***	0.421***
	[0.054]	[0.054]	[0.056]	[0.056]	[0.058]	[0.056]
Status_i	0.703***	0.650***	0.626***	0.664***	0.670***	0.693***
	[0.063]	[0.071]	[0.064]	[0.063]	[0.063]	[0.063]
Exp(UK)_{it}			0.412***			
			[0.052]			
Exp(EU)_{it}			0.146***			
			[0.049]			
Exp(WR)_{it}			0.167***			
			[0.050]			
$\text{LnIH(R\&D)}_{it}$			-0.057***			-0.031***
			[0.010]			[0.009]
Exp(Ratio)_{it}		0.155**				
		[0.070]				
$\text{R\&D(pw)}_{it}$				-0.005**		
				[0.002]		
Train(pw)_{it}				0.013**		
				[0.006]		
$\text{R\&D}_{it}$					0.000***	
					[0.000]	
$\text{IH(R\&D)}_{it}$					-0.000**	
					[0.000]	
Train_{it}					0.000***	
					[0.000]	
Obs.	15778	15778	14330	15428	14766	14905
R^2	0.328	0.328	0.357	0.336	0.342	0.343

Standard errors are robust and clusterd across individuals. Time dummies and sector dummies are included (Nace two digits). SRT is defined as the consumption of Irish services (as input) over the sum of total input consumption (services plus materials). MRT is calculated in the same way for materials
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

D System GMM additional tables

Table 22: Log of output per worker (Full sample)

	(1)	(2)	(3)	(4)	(5)	(6)
	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$
$Ln(YL)_{it-1}$	0.251***	0.357***	0.406***	0.310***	0.456***	0.341***
	[0.055]	[0.058]	[0.058]	[0.056]	[0.067]	[0.054]
MRI_{it}	-0.018	-0.002	-0.042	-0.049	-0.025	-0.127
	[0.060]	[0.052]	[0.058]	[0.062]	[0.064]	[0.261]
SRI_{it}	-0.362**	-0.181	-0.070	-0.236	-0.073	-0.376
	[0.154]	[0.141]	[0.134]	[0.156]	[0.173]	[0.517]
${MRI_{it}}^2$						0.069
						[0.221]
${SRI^2}_{it}$						0.234
						[0.371]
$Ln(W)_{it}$	0.352*	0.451***	0.523***	0.444***	0.446**	0.523***
	[0.180]	[0.137]	[0.135]	[0.122]	[0.175]	[0.123]
$Exp(UK)_{it}$			-0.007			
			[0.105]			
$Exp(EU)_{it}$			0.124			
			[0.099]			
$Exp(WR)_{it}$			0.038			
			[0.089]			
$LnIH((R\&D)_{it}$			0.013			0.001
			[0.018]			[0.018]
$Status_i$	0.353***	0.359***	0.224***	0.299***	0.233***	0.295***
	[0.054]	[0.076]	[0.047]	[0.047]	[0.050]	[0.047]
$Exp(Ratio)_{it}$		-0.207				
		[0.359]				
$R\&D(pw)_{it}$				0.002		
				[0.002]		
$Train(pw)_{it}$				-0.001		
				[0.001]		
$R\&D_{it}$					0.000	
					[0.000]	
$IH(R\&D)_{it}$					-0.000	
					[0.000]	
$Train_{it}$					0.000	
					[0.000]	
Observations	10068	10037	9091	9855	9410	9487
Sargan−Hansen	0.5763	0.5202	0.7874	0.6466	0.6718	0.8500
AR2 Test	0.4810	0.2941	0.8415	0.4147	0.3757	0.6780

Dynamic panel-data estimation, two-step system GMM. SRI is defined as the consumption of Irish services (as input) over the total input service consumption. MRI is calculated in the same way for materials
Robust standard errors and two step estimator are used. Sector and year dummies included
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

Table 23: Log of output per worker (Irish Firms)

	(1)	(2)	(3)	(4)	(5)	(6)
	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$
$Ln(YL)_{it-1}$	0.307***	0.430***	0.436***	0.329***	0.367***	0.305***
	[0.054]	[0.070]	[0.057]	[0.048]	[0.060]	[0.054]
MRI_{it}	-0.029	0.039	0.038	0.095	0.053	-0.226
	[0.082]	[0.071]	[0.092]	[0.093]	[0.092]	[0.393]
SRI_{it}	-0.354*	-0.142	-0.419**	-0.364*	-0.380*	-2.642***
	[0.205]	[0.165]	[0.203]	[0.197]	[0.208]	[0.947]
$MRI^2{}_{it}$						0.147
						[0.310]
$SRI^2{}_{it}$						1.886***
						[0.677]
$Ln(W)_{it}$	0.709***	0.642***	0.938***	0.540***	0.770***	0.768***
	[0.234]	[0.159]	[0.170]	[0.204]	[0.179]	[0.193]
$Exp(UK)_{it}$			-0.020			
			[0.126]			
$Exp(EU)_{it}$			0.054			
			[0.129]			
$Exp(WR)_{it}$			0.217*			
			[0.120]			
$LnIH(R\&D)_{it}$			0.028			0.040
			[0.026]			[0.026]
$Exp(Ratio)_{it}$		-0.061				
		[0.356]				
$R\&D(pw)_{it}$				0.002		
				[0.002]		
$Train(pw)_{it}$				-0.011		
				[0.016]		
$R\&D_{it}$					-0.000	
					[0.000]	
$IH(R\&D)_{it}$					0.000	
					[0.000]	
$Train_{it}$					-0.000	
					[0.000]	
Observations	7457	7427	6668	7263	6963	7039
Sargan−Hansen	0.6920	0.6007	0.8420	0.9262	0.6892	0.6251
AR2 Test	0.6175	0.3538	0.9575	0.6064	0.5653	0.9272

Dynamic panel-data estimation, system GMM. SRI is defined as the consumption of Irish services (input) over the total input service consumption. MRI is calculated in the same way for materials. Robust standard errors and two step estimator are used. Sector and year dummies included
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

Table 24: Log of output per worker (Foreign Firms)

	(1)	(2)	(3)	(4)	(5)	(6)
	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$	$Ln(YL)_{it}$
$Ln(YL)_{it-1}$	0.334**	0.330***	0.451***	0.506***	0.537***	0.321**
	[0.132]	[0.124]	[0.138]	[0.145]	[0.123]	[0.127]
MRI_{it}	-0.276*	-0.220	-0.277**	-0.301**	-0.221	-0.621
	[0.150]	[0.140]	[0.137]	[0.136]	[0.137]	[0.804]
SRI_{it}	-0.154	-0.039	-0.016	-0.139	0.051	0.583
	[0.299]	[0.295]	[0.261]	[0.307]	[0.239]	[0.996]
$MRI^2{}_{it}$						0.269
						[0.726]
$SRI^2{}_{it}$						-0.485
						[0.780]
$Ln(W)_{it}$	0.635***	0.644***	0.721***	0.591***	0.544**	0.533**
	[0.225]	[0.220]	[0.168]	[0.209]	[0.211]	[0.211]
$Exp(UK)_{it}$			0.341*			
			[0.189]			
$Exp(EU)_{it}$			0.104			
			[0.196]			
$Exp(WR)_{it}$			-0.096			
			[0.179]			
$LnIH(R\&D)_{it}$			-0.006			0.003
			[0.035]			[0.028]
$Exp(Ratio)_{it}$		-0.570				
		[0.642]				
$R\&D(pw)_{it}$				0.002		
				[0.001]		
$Train(pw)_{it}$				0.000		
				[0.001]		
$R\&D)_{it}$					0.000*	
					[0.000]	
$IH(R\&D)_{it}$					-0.000**	
					[0.000]	
$Train_{it}$					0.000	
					[0.000]	
Observations	2611	2610	2423	2592	2447	2448
Sargan−Hansen	0.1912	0.3677	0.8554	0.3102	0.2597	0
AR2 Test	0.2648	0.1957	0.9443	0.2368	0.7949	0.8883

Dynamic panel-data estimation, system GMM. SRI is defined as the consumption of Irish services (input) over the total input service consumption. MRI is calculated in the same way for materials. Robust standard errors and two step estimator are used. Sector and year dummies included
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value