Irish firms' productivity and input's origin.*

Emanuele Forlani†

Draft: December 2009

Abstract

In this paper we analyze empirically 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. In this paper, using firm level information on imported inputs, we asses the importance both of beginning import activity and the variation in the input mix origin . Using various econometric techniques we show different results, which are robust also to additional controls. The main findings are that the most efficient firms use more intensively foreign inputs, and that the less efficient domestic firms gain when they increase the quotas of imported inputs. In addition the few firms which start importing activity raise their productivity compared to non-imprting firms. The results suggest an important policy implication: policies that favor the imports of intermediates enhance the productivty of domestic firms, in particular the less efficient.

*I am grateful to G.I.P. Ottaviano, Fergal McCann and an anonymous referee from Forfás for the useful comments. I am grateful also to Adrienne Costello for the logistic support. Finally I am grateful to Forfás for the financial support.

†Université Catholique de Louvain- CORE: Voie du Roman Pays 34, 1348 Louvain-la-Neuve, Belgium

1 Introduction

In the last decade, by creating new firm level data-set, the attention of trade economists has focused on the causal relation among trade activity and firms' efficiency; the well-established lesson says that more efficient firms tend to self-select in international markets[37] [29], but there is few evidence of learning-by-exporting effects [26] (i.e. export activity enhance firms' productivity). Nonetheless, large part of literature has forgotten to analyze another internationalization channel through which firms can face: imports.
The present paper focuses on firms' importing activity, and it tries to contribute to the debate on firms' efficiency, and internationalization process[1]. The paper describes the empirical relation among the efficiency of firms located in Ireland and the use of foreign inputs. Then the central aim is to show that the variation in the inputs' origin may have a positive effect on firms' productivity. More precisely, what we are going to estimate is both the effect due to an increase in the imports as well as the effect of starting imports. The decision to use foreign inputs may depend on fact that imported inputs may show "higher" characteristics compared to domestic ones. Then the foreign inputs have an effects on firms' efficiency through different channels, as learning, quality and variety. In addition inputs with higher features may need further "firms' internal abilities", as the know-how to use them: all these aspects have not-neglebible effects of the firms' efficiency. This issue is particularly relevant for a small open economy as Ireland, where the domestic market for inputs may not provide enough "variety/quality" necessary for the production process, while the Irish economy is one of the most opened among the developed countries(O'Toole, 2007).
The issue of efficiency is not negligible; productivity growth is a source of great concern for policy maker, media and institutions. 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) [31] 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. Closer to our case, there is 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 [35].
In addition productivity and competitiveness is relevant for firms in the global economy, in particular to face competition from low-wage countries. As cited above, only the most efficient firms remains in the market and just "superstars" become international (Bernard Jensen, 1999[11]; Bernard et al., 2007[12]; Clerides et al. 1998[14]). Therefore policy makers are interested in sustaining firms' productivity respect to international competitors.
Finally, higher efficiency can make a country an attractive 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[15]; Smarzynska-Javorcik, 2003[36]; O'Toole, 2007[33]) even if the positive spillover are quite heterogenous.
Along this debate, the paper studies the firms' productivity in Ireland, using firm level information. The research objective is to understand if the use of imported input has some effects on firms' efficiency. The aim of the paper is to analyze the effects of internationalization from an opposite point of view, the imports; does the use of foreign input, or the variation in input mix, raise productivity? Basically the paper provides three main results. First of all the most productive firms rely less on inputs purchased in the domestic market; so it means that as firm's

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

productivity increases also the consumption of foreign inputs (both services and material) increases. Second, there is evidence that foreign inputs are source of productivity growth. Third, Irish owned firms , in manufactures, benefit from the variation in the output mix, in particular if they are far way from the frontier. The paper is structured as follows. In the next section I briefly describe the past literature. Then I describe the dataset and its feature. In the fourth. section I defines the empirical analysis and the results, while in the last section I provide robustness checks analysis. Finally I provide conclusions and implications.

2 Past Literature

The relation between productivity and input origin is quite exploited in empirical analysis. Amiti and Konings(2008)[3] 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 different paper Kasahara ad Lapham (2008)[23] define a structural model where firms simultaneously choose to exports goods and import intermediates. They show as the restrictions on imports reduce the number of Chilean exporting firms; their estimations 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.
In this paper, differently from Amiti-Konings[3], I have just information about the expenditure for intermediate inputs (services and materials) and the input's value purchased from Irish or foreign producers. As introduced above, foreign seller means indistinctly firms which are located or abroad or in Ireland but are owned by foreigners. In addition, it is not possible to collect any data about quality or quantity but just cost burden: therefore the key variable will be a mix among the two. The effects that I am going to capture are two. First, as discussed above, the potential quality of foreign inputs; second the increasing variety in input mix.
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)[22] 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)[19]. 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 cost shrinks due to cheaper input a direct consequence is an increased competitiveness of domestic firms in all markets[3].
Finally, it is reasonable to claim that any benefit in term of productivity may derive from MNEs

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

[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.

and spillover effects. Ireland boosted its economic growth with foreign investment, between eighties and 2000s. However the spilloverseffects due to FDI in the Irish economy are not clear, at least at firm level. Few would doubt that the influx of FDI over the last two decades has been and import factor for the Irish growth[8], not least since MNEs, due to their being on average more productive than domestic firms, contribute to higher productivity growth in the economy. However there is little formal econometric evidence that links the presence of MNEs to productivity growth in domestic firms at the micro level. For example Ruane and Ugur (2005)[38] does not find evidence of spillover on domestic firms' labor productivity. As long as the effects are accounted at sector level, it may reflect that slipovers vary substantially across narrowly defined industry, and they cannot be detected aggregating[4]. Gorg and Strobl (2003)[21] present a different approach: due to the idea that spillovers raise productivity and consequently profitability, all other thing being equal, they test the effects of MNEs' presence on firms' survival probability. They find that multinational presence has a life enhancing effects only on firms which operates in high technology sector.

3 Data Analysis

The data used comes from Annual Business Survey Economic Impact (ABSEI) and the data-set 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 twenty industrial sectors (manufactures and services), according to NACE two digit classification. In Table 15 in Appendix 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 [5].
Foreign firms are concentrated in particular in Chemicals, Electronic and Software sectors, probably the most advanced sectors. The Table 1 below shows some descriptive statistics at sector level (Sector Nomenclature in the Appendix Table 15). It is possible to notice that foreign firms are the 25% of the sample.

[4]Also Berry et. al (2005)[9] did not find statistical evidence.
[5]Forfás defines a plant as foreign owned if 50% or more of its shares are held by foreign owners.

Table 1: Descriptive statistics: Sector Averages

Nace	Revenues	Empl	YL	LabProd	R&D	Train	Export	Ownership	Firms
10	9191.0	49.45	138.4	174.313	0.206	0.331	0.279	0.049	41
15	40060.4	140.0	240.0	339.501	0.310	0.385	0.374	0.105	620
17	5000.5	52.49	96.51	140.178	0.287	0.325	0.447	0.194	175
20	9575.1	64.42	121.7	158.648	0.319	0.408	0.354	0.054	111
22	6562.8	56.29	98.45	110.238	0.166	0.365	0.373	0.124	194
24	178168.5	158.8	557.4	716.145	0.314	0.471	0.480	0.560	259
25	6799.0	54.14	113.9	144.887	0.299	0.399	0.480	0.361	183
26	21283.8	135.5	106.3	127.127	0.228	0.314	0.320	0.150	133
27	5977.3	49.20	96.66	112.879	0.196	0.352	0.313	0.162	413
29	7195.8	56.60	107.4	129.670	0.347	0.449	0.470	0.206	272
30	93626.4	172.7	298.0	401.290	0.337	0.459	0.467	0.495	564
34	14430.3	137.8	127.0	172.577	0.302	0.445	0.492	0.418	79
36	3553.1	39.58	83.26	101.106	0.288	0.318	0.401	0.071	211
40	6984.8	72.59	105.9	85.195	0.143	0.292	0.277	0.292	65
45	26865.8	169.6	113.9	150.007	0.211	0.585	0.143	0.048	21
50	7073.7	37.29	362.1	421.816	0.132	0.250	0.298	0.118	262
65	70859.9	249.4	415.2	380.952	0.077	0.415	0.321	0.512	41
72	33779.8	66.66	192.0	183.93	0.278	0.314	0.327	0.308	929
73	1979.3	32.04	73.39	50.07	0.218	0.25	0.238	0.118	51
74	9998.57	104.5	106.8	111.34	0.186	0.43	0.392	0.251	263
Tot	37442.04	95.2905	200.7302	246.4676	0.267	0.372	0.381	0.254	4887

Source: ABSEI Datset. Revenues: delated value of revenues in Th of Euros. Empl: employment.
YL: Output per worker. LabProd: value added. R&D: expenditure in R&D in Th. of Euros per worker.
Train: training expenditure in Th. of Euros per worker.Export: % of exporter. Ownership: % of foreign firms.

The dataset includes information about firms revenues, employment, wage-bill, material and service consumption, plus information on export status and expenditure in R&D and training activities. The larger drawback of the data-set is the absence of any kind of information about capital stocks (tangible and intangible). It generates a methodological problem when firm's efficiency has to be calculated. The absence of capital data will impede us to estimate productivity with any parametric or semi-parametric techniques [27], [**?**]: then, productivity will be proxied with indices as output per worker or value added per worker[6]. Moreover the presence of service sectors makes reasonable the use of these indices. In the last part of the paper it will introduce two additional measures for the robustness checks analysis.
In addition the ABSEI dataset has very important characteristic, because it includes firms which receives or demand financial support in particular for R&D activity[7]. Therefore it is not possible to assume the sample is fully representative of Irish economy; it is not possible to ignore a process of self selection in the dataset, and it implies that just "good" firms are included in the ABSEI dataset. It implies that the final results will tell us which is the effects of foreign inputs on more dynamic firms.
As it is possible to observe the tables below, firms in the sample show very good performances on average. The Table 2 and Table 3 illustrates efficiency growth rates (output and value added based) both for ABSEI dataset and for the overall Irish economy (Source: EU-KLEMS)

[6]Revenues and value added are deflated with sector specific price deflators. Definition in the Appendix. In Table 18 are reported the averages across sector ownership
[7]Thanks to an anonymous referee in Forfás.

Table 2: Average growth (output based) 2001-2005

	Output Growth(pw)			Output Growth (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; pw: per worker.

Table 3: Average TFP growth(Value added based) 2001-2005

	VA Growth(pw)			VA Growth(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; pw: per worker..

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[8]The aggregated growth rates are calculated on standardized values of efficiency: it means that at time t the efficiency (output or value added per worker) of firm i which belongs sector m is divided by the average efficiency of sector m in year t. It is a standard procedure to compare values across heterogenous sectors and to generate more reasonable averages. In order to make data compatible with EU-KLEMS the average among all yearly growth rates is calculated (from 2001 to 2006).
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. Observing the data, 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.

3.1 Import data

The paper is focused on the relation among firms' efficiency and origin of input's seller. 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 and not Irish). The aim is to understand if an increase in the share of foreign inputs raises firm's efficiency. Before to continue can be useful to give some definitions. Firm's efficiency is measured as value added per worker or output per worker, as explained above above. These indices are used to proxy firm's productivity
To which regard input use, the relevance of foreign input is assed with a ratio among the foreign input use and irish input use. Both data are reported by the data-set as values, and consequently

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

they rare deflated with specific sector deflator, both for material and services. Then three ratio are constructed, one which is general and other two for material and services. The ratio as defined as follow

$$Ratio_{it} = \frac{M(F)_{it} + S(F)_{it}}{M(I)_{it} + S(I)_{it}} \tag{1}$$

where $M(j)_{it}$ and $S(j)_{it}$ are respectively for firm i at time t the consumption of material and services by origin j (I=Irish; F=Foreign). Then same ratio is constructed for services($SRatio$) and material ($MRatio$)[9].

If one of the two ratios increases it means that firm i use more intensively foreign inputs in the production process. In the Table (4)below are described the average ratios by sector.

Table 4: Average input mix ratio

	Ratio	SRatio	MRatio
Agricolture	0.443	0.136	0.851
Food Beverages & Tobacco	0.636	0.592	1.376
Textile Clothes Leather	3.637	0.741	10.01
Wood	1.040	0.289	1.916
Pulp Paper & Printing	1.414	0.123	4.757
Chemical	4.728	2.034	8.666
Rubber and Platics	2.034	0.220	8.325
Non-Metallic Minerals	1.624	0.373	3.762
Basic Metal & Fabricated Metals	3.152	0.326	5.902
Machinery n.e.c.	1.651	0.351	4.942
Electrical and Optical Equipment	3.230	0.772	12.56
Transport Equipment	2.998	0.254	7.233
Manufacturing n.e.c.	1.165	0.229	4.007
Networks	1.435	0.742	9.560
Construction	1.061	0.133	2.123
All Other Services	63.98	63.84	2.748
Financial Intermediation	0.970	0.848	0.476
Computer and Related Activities	1.521	1.218	3.065
Research and Development	0.454	0.289	4.113
Other Business Activities	0.922	0.296	2.593
Total	4.844	3.529	5.647

Clearly the ratio is higher for material rather than for services, as long as it is much more easy to import goods rather than services; while material are easily tradeable, services are more related with the place of provisions[10]. Instead across manufactures, the industry on which we are going to focus on, textiles and chemical use quite intensively imported inputs. More interesting are the next descriptive statistics, concerning manufacturing sector[11]. Table 5 compares the average ratio (1) across different class of individuals for the manufacturing sectors. It emerges that foreign-domestic firms are the ones that rely more intensively on the imports of intermediates goods (service and materials together); while domestic national firm use in large part domestic inputs. In Table 6 it is showed instead as the importers have on average higher efficiency compared to non importers; not surprisingly also exporters are more efficient than domestic firms.

[9]The inputs' import data are calculated as difference among total input and Irish input

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

[11]In the Appendix the same tables for service sectors are reported.

Table 5: Average intensity ratio (for domestic and exporting firms

		Domestic	Exporter	Total
Irish	Mean	0.99	1.36	1.27
	Std	2.58	3.59	3.37
Foreign	Mean	8.84	4.76	4.99
	Std	41.88	34.01	34.52
Total	Mean	1.63	2.44	2.29
	Std	12.39	19.47	18.33

Mean and standard deviation are calculated aggregating years sector.

Table 6: Average Log(YL) by export and importing status

Export	No-Importer	Importer	Total
Domestic	3.64	4.02	3.91
Exporter	4.66	4.74	4.74
Total	4.17	4.63	4.57

The average output per worker is reported in log i.e Log(YL).

From Table 5 it seems that the differences in term of input use is larger between foreign and Irish firms rather than domestic and exporters. However it is not possible to claim (and it is not in the paper's objectives) if the exporting activity is forcing firms to expand the variety of input used (learning by exporting for inputs) or if importing generates a process of self section in the export market. In other words speaking, we can just infer that foreign firms use more intensively foreign inputs rather than Irish firms, but not the causal relation or the optimal mix.
Finally I can conclude this section of data description with a tables of correlations. Variables Log(YL) and Log(Prod) are respectively the log of output and value added divided by number of workers. They are positively correlated both with Import dummy (equal to one if firm imports otherwise zero) as well as with the ratios (1), also for for services and materials. It may suggest that at least exists a positive correlation among the importing activity and input efficiency, even if it is still early to assert the existence of a causal relation.

Table 7: Correlation Table

	Import	Ratio	Mratio	Sratio	Log(YL)	Log(LabProd)
Import	1					
Ratio	0.151*	1				
Mratio	0.0244	0.542*	1			
Sratio	0.054*	0.464*	0.005	1		
Log(YL)	0.094*	0.248*	0.040*	0.153*	1	
Log(LabProd)	0.063*	0.338*	0.061*	0.252*	0.802*	1

All Significant at 1% confidence interval.

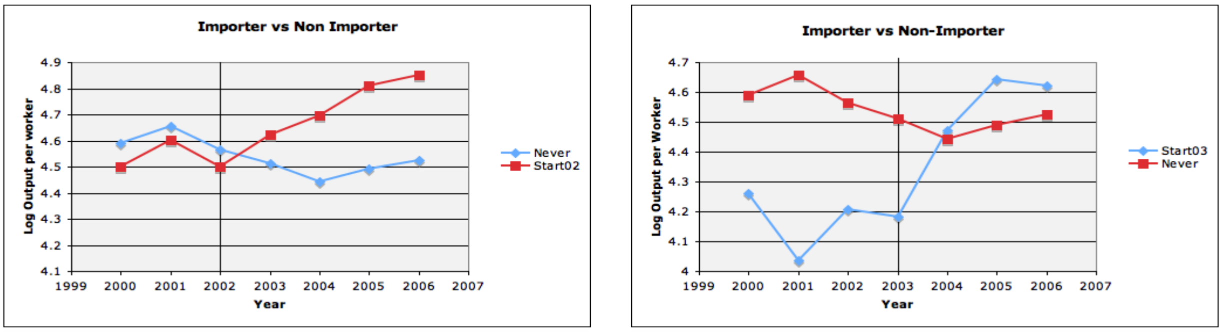
4 Empirical Analysis

In this section is devoted to explain the existence of a causal relation among firms' efficiency and importing activity. More precisely we are going to control if the decision of importing, and the variation in the input mix affects productivity, in particular focusing on the group the Irish owned manufactures. From the ABSEI dataset it is possible to observe if firms import or not input form abroad; unfortunately the mass of variety consumed nor the quality is reported. However if firms decide to start to import or to raise the quota of foreign goods, it is reasonable to assume that the quality of imported inputs is superior compared to Irish ones: even if transport or trade cost occur, foreign inputs are more convenient.

4.1 Import decision

What happens after that firms decide to import? As reported previous sections, we knows that importers are on average more productive than non-impoerts, but we do not know if this decision boosts productivity. In order to verify if importing causes productivity growth, we use for this purpose graphical analysis, rather than econometric techniques. The motivation is that just few firms change their importing behavior in the data-set; only thirty-two firms on 4887 decide to begin the importing activity, across all sector year; large part of them (twenty-five) are concentrated in year 2002 (twelve) and 2003(thirteen). The idea is to compare the productivity's evolution of that firms that never imports respect to that firms which decide to import at a certain year and continue until the end of the sample: the approach is similar to Clerides et al.(1999)[14] to test self-selection and learning-by exporting. If the productivity boosts after the decision of importing, it can suggest that foreign inputs helps firms to raise their productivity.
In figure 1 are plotted the average productivity for never importing firms (never) vs the productivity of that firms which start toi import in 2002 or 2003. It is possible to notice that in both cases the average efficiency raises after the import decision (respectively 2002 and 2003) compared to other firms[12].

Figure 1: Average Log(YL)

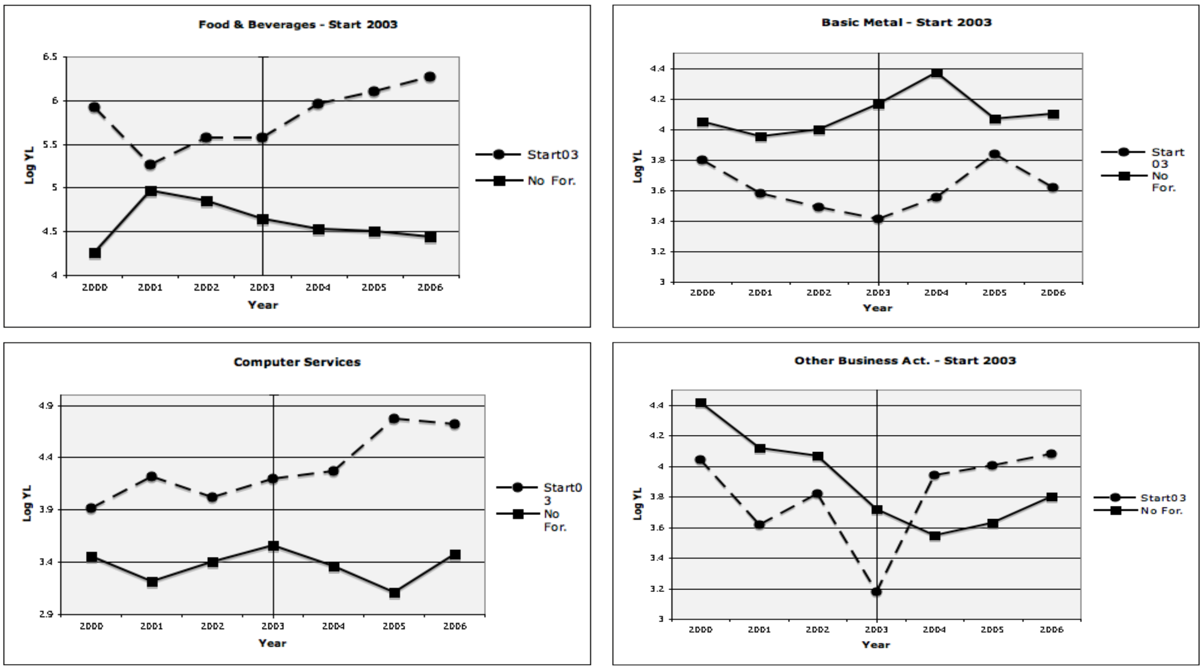


The Figure 1 shows that the decision of importing has a positive impact on efficiency, or in other words that there exists a sort of *"learning-by-importing"* process. Moreover the level of average productivity before the beginning of imports is lower compared to the non-importers firms, while at the end of the period the productivity is higher for importers; it may suggests a catch up process for importers. For a more rigorous analysis it is convenient to go further in details, disentangling sectors. Figure 2 consider four different sector in which it is possible to observe the initial activity at year 2003 (Figure 5 in the Appendix report the same data using Log(LabProd) as indicator for productivity). The sector considered are four, two from manufacture industry and two from services; they are the only sectors for which it is possible to define a group of starters and a group of non importers. The graphics show a jump after the

[12]The averages are calculated including both manufactures and services, Irish and foreign firms. In the Appendix is reported the same figure (Figure 4) using Log(LabProd) as efficiency indicator.

introduction of imported inputs for all considered sector with the exclusion of computer services. In addition, it is interesting to notice that, with exclusion of basic metal, the averages before 2003 seem to follow the same path for both groups, instead after 2003 the path diverges, with at least two year of growth for new importers. It reinforces the idea of an existing process of *"learning-by-importing"*.

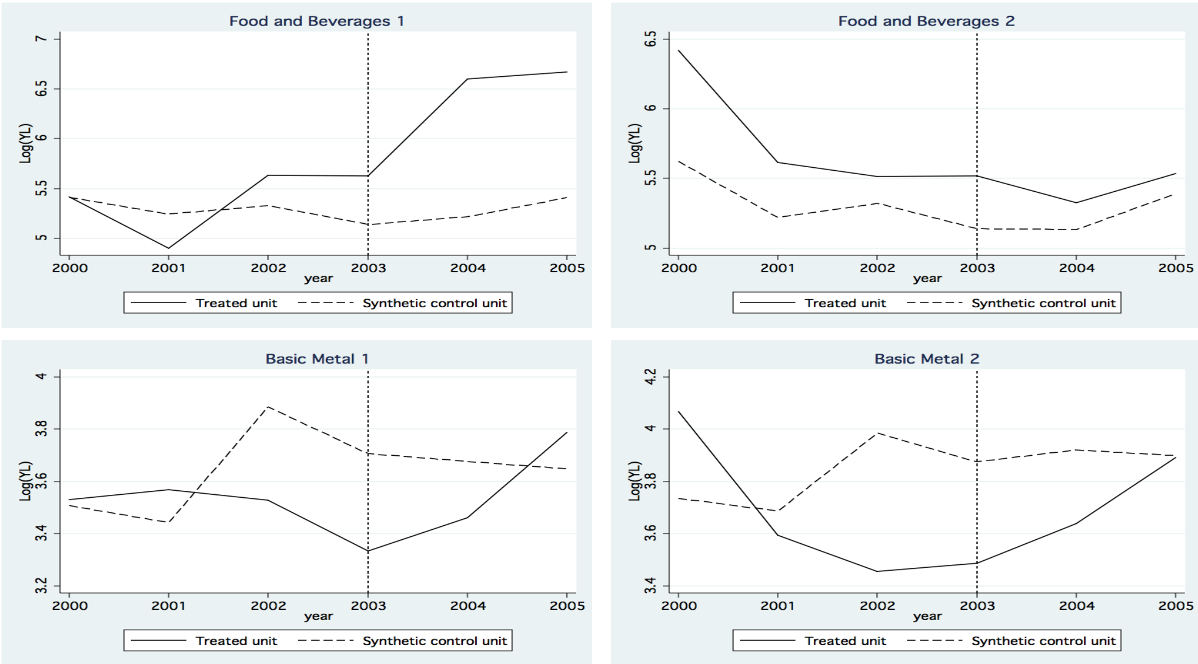
Figure 2: Average Log(YL): by sector



4.1.1 Synthetic control group

The last part of this section is devoted to a robustness checks analysis; we control if the productivity's evolution for some specific firms in manufacturing sector is robust to a different definition of "control" group; "control group" means a group of firms which never imports and belong to the same sector of analyzed firm. The firms that I am going to control are from food sector (Nace 15) and basic metal sector (Nace 27), and they start to import in 2003. The plots showed below differ from the previous ones for two reasons. First, the evolution of productivity is drawn only for the treated unit, i.e. the firm that start to import in 2003. Second, the productivity of control group is not a simple average among the productivity of non-importers, but is is a convex combination of them. The procedure used is the so called "synthetic matching estimator" developed by Abadie et al.(2009)[1], employed in the analysis of comparative case studies. The synthetic estimator constructs this an artificial control group by searching for a weighted combination of control units (non-importers): these are chosen to approximate the importer's productivity, i.e. the variable on which we are going to estimate the effect of tratemnt. The evolution of the productivity for the resulting synthetic control group is an estimate of the counterfactual of what would have been observed for the importing firm in absence of importing decision. The method, even if used in aggreted data, is very useful in the case of comparative studies and it produces informative i results regardless of the number of available comparison units and the number of available time-periods. In the figure below[13] (Figure 3) confirm the fact that the introduction of foreing input raise productivity at least in three cases on four (continuos line). In the first column of figures, in particular the treated units and synthetic control group follow the same path, but after the introduction of imported input the productivity of importers start to raise significantly, compared to non-importer[14].

Figure 3: Treated vs Synthetic Control group: Food and Metal case



4.2 Variation in the input mix

This section is devoted to test the effect of a variation in the input mix, as defined in , on efficiency of manufacturing firms, namely we are testing if productivity raises as index (1) increases. 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 it is reasonable to assume that the productivity changes because of variation in the quality and number of inputs. Then we are going to assume that firms' productivity takes form[15]

$$PROD_{it} = PROD^{\alpha}_{it-1} RATIO^{\beta}_{it-1} X^{\gamma}_{it-1} A_{it} \tag{2}$$

[13]In Appendix Figure 6 are provided the same results using labor productivity as variable of interest
[14]In Table 22 in theAppendix are reported the statistics for the balance property.
[15]We assume that it takes time to observe effects due to importing input.

where it depends on past realization of productivity($PROD_{it-1}$) and past values input mix ($RATIO_{it-1}$).In addition it is reasonable to include some control variable(X_{it-1}) plus a random error term (A_{it}). Taking the logs of (2) the estimated equation is

$$Prod_{it} = \alpha Prod_{it-1} + \beta Rat_{it-1} + \gamma x_{it-1} + c_i + \varepsilon_{it} \tag{3}$$

with the error term decomposed in a firms' specific error plus and *i.i.d.* component.
What we expect is a positive sign for β coefficient, at least for Irish firms; a positive and significant coefficient means that if imported inputs grows in relation to input, it will have a positive effect on firms' productivity growth. As yet discussed in the previous section, productivity is measured with output and value added per worker (i.e. Log(YL) and Log (LabProd)), even if output per worker is preferred,; it is because value added is calculated directly from the data as a difference between revenues and production costs (material, services, and additional costs). It can create some problems of multicollinearity, and difficulties in the interpretation of interest variable on productivity. The presence of fixed effects (c_i) and control variables is necessary to avoid misspecification problems: the control variables are export dummy plus information on firms' expenditure in R&D and training. Moreover I introduce also year dummies and sector dummies(SD_i) at Nace 2-digit to control for business cycle and sector characteristics. In particular sector dummies are important because of firms' heterogeneity in the dataset. In a first moment we estimate equation (3) with OLS; the estimation method is very standard but it gives us some interesting intuition, as if there exists at least a statistical relation among the variables of interests. The coefficients tell us on average, how much productivity is higher as as higher is the ratio (1) in the past period. The results are showed in Table 8 and Table 9, where Ln(YL) Ln(Prod) are respectively the dependent variables.

Table 8: OLS Regression: Output per Worker

VAR	(1) Aggr.	(2) Aggr.	(3) Manuf.	(4) Manuf.	(5) Manuf.	(6) Serv.	(7) Serv.	(8) Serv.
$Log(YL)_{it-1}$	0.816***	0.816***	0.835***	0.834***	0.827***	0.790***	0.791***	0.786***
	(0.011)	(0.011)	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)	(0.017)
$Log(Rat)_{it-1}$	0.051***	0.051***	0.041***	0.041***	0.039***	0.071***	0.072***	0.072***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.022)	(0.022)	(0.022)
Exp_{it-1}	0.035**	0.026	0.041**	0.033*	0.026	0.031	0.025	0.011
	(0.016)	(0.017)	(0.019)	(0.019)	(0.019)	(0.034)	(0.035)	(0.035)
$D(R\&D)_{it-1}$		0.021*		0.012			0.033	
		(0.012)		(0.012)			(0.030)	
$D(Train)_{it-1}$		0.026		0.029			0.011	
		(0.017)		(0.019)			(0.035)	
$Log(R\&D)_{it-1}$					0.003			0.010*
					(0.003)			(0.005)
$Log(Train)_{it-1}$					0.020***			0.022***
					(0.005)			(0.008)
Cons	0.704***	0.680***	1.052***	1.040***	1.070***	0.472***	0.441***	0.459***
	(0.072)	(0.070)	(0.186)	(0.183)	(0.185)	(0.090)	(0.099)	(0.095)
Obs	12272	12272	8699	8699	8651	3467	3467	3429
R^2	0.760	0.760	0.772	0.772	0.772	0.724	0.724	0.724
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in barckets are robust and clusterd across individuals.
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Aggr: Aggregated industries. Manuf: Manufactures. Serv: services.

Looking at Table 8 it is possible to notice that there exists a positive and significant statistical relation among the import input burden and firms efficiency. In other words as imports raise of 1% firms' productivity will be higher in the next period between 0.04% and 0.07%. In addition

Table 9: OLS Regression: Output per Worker with Material and Service Ratio

VAR	(1) Aggr.	(2) Aggr.	(3) Manuf.	(4) Manuf.	(5) Manuf.	(6) Serv.	(7) Serv.	(8) Serv.
Log(YL)_{it-1}	0.846***	0.845***	0.857***	0.854***	0.844***	0.822***	0.823***	0.810***
	(0.015)	(0.015)	(0.019)	(0.020)	(0.022)	(0.026)	(0.026)	(0.028)
$\text{Log(MRatio)}_{it-1}$	-0.001	-0.001	0.002	0.001	-0.000	-0.015	-0.015	-0.021
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.020)	(0.020)	(0.020)
$\text{Log(SRatio)}_{it-1}$	0.059***	0.059***	0.047***	0.047***	0.043**	0.099***	0.101***	0.094***
	(0.016)	(0.016)	(0.018)	(0.018)	(0.018)	(0.034)	(0.035)	(0.034)
L.export	0.019	0.013	0.022	0.017	0.010	0.022	0.014	-0.000
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.047)	(0.049)	(0.049)
L.d_red		0.005		0.001			0.027	
		(0.012)		(0.012)			(0.046)	
L.d_train		0.035*		0.036*			0.032	
		(0.019)		(0.021)			(0.052)	
L.ln_train					0.020***			0.033**
					(0.006)			(0.013)
L.ln_red					-0.000			0.004
					(0.003)			(0.009)
Cons.	0.793***	0.781***	0.987***	0.974***	1.029***	0.389***	0.369***	0.942***
	(0.079)	(0.077)	(0.222)	(0.219)	(0.223)	(0.125)	(0.137)	(0.128)
Observations	8028	8028	6533	6533	6493	1416	1416	1403
R^2	0.776	0.777	0.783	0.783	0.783	0.747	0.747	0.747
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in barckets are robust and clusterd across individuals.
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Aggr: Aggregated industries. Manuf: Manufactures. Serv: services.

it seems from Table 9 that the imports of services is more important than the import of raw material, to determine the level of future productivity: an increase of 1% in imports of services raises the productivity of around 0.1%. It is likely that the relation is driven by the fact that multinationals are in the sample; however if we control for ownership variables the results do not change. To conclude if we exclude mutually SRatio or MRatio both are positive and significant; it can suggest multicollinearity, even if correlation is not detected, or some substitution effects among the two inputs. Finally the results are robust to a change in control variables[16].
With baseline equation I can illustrate some initial results[17]. Firm's productivity raises if the use of foreign inputs increases. The effect 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 underlying mechanism can be the same of Amiti Konings (2008)[3]. The results are reliable because they are not sensible to a variation in firm's efficiency measurement or control variables; both with output per worker and with labor productivity, the sign of coefficient does not change.
However the equation (3) suffers from some problems. First of all the import index may be endogenous, i.e. correlated with the error term. The endogeneity is caused by a simultaneity problem[18] as long as the most efficient firms may decide to use foreign inputs rather than domestic firms: it is also guessed from descriptive statistics (Table **??**). Secondly, firm's productivity is an autoregressive process, given that the present firms efficiency has to be explained with past values: the lagged values of dependent variable is endogenous too. Thirdly, it is reasonable

[16] In Table **??** in the Appendix are replied the regressions in Table **??** suing value added per worker as dependent variable

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

[18] The same issue exists for export status, because the most productive firms self-select in export market (Bernard et al., 1999).

to take into account firm's heterogeneity, with unobserved effect c_i. In order to deal with these three issue the equation (3) is estimated using a dynamic panel techniques.(Arellano Bond, 1991; Blundell Bond, 1998).

4.3 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 and Blundell and Bond (1998); in particular the "difference GMM" estimator[19][4].
This estimator first-differences each of the variables in order to eliminate the firm-specific effects (c_i), 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 **??**. 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[20]. The estimated equation is similar to (3) i.e.

$$\Delta Prod_{it} = \alpha \Delta Prod_{it-1} + \beta \Delta Rat_{it-1} + \gamma \Delta x_{it-1} + \Delta \varepsilon_{it}. \tag{4}$$

Two 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. More specifically, if $\mathbf{X}'_{it}$ is the vector of explanatory variables in equation (4) and ε_{it} is the error term, then the three conditions are:

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

$$E\left(\mathbf{X}'_{it}\varepsilon_{is}\right) = 0 \text{ for all } s \geq t \tag{6}$$

$$E\left(\varepsilon'_{it}\varepsilon_{i,t-s}\right) = 0 \text{ for all } s \geq 1 \text{ and} \tag{7}$$

The above method allow to instrument the variables in differences using the lagged values of levels. In this specific case $Prod_{it-1}$ and Rat_{it-1} are considered endogenous while the control variable predetermined. The first two assumptions (5) (6) defines respectively the orthogonality conditions (validity) to instrument purely endogenous and predetermined variables. [21]
Arellano and Bond (1991) propose two tests to control the accuracy of this estimator. First one is Sargan-Hansen test of over-identifying restrictions, which tests the null hypothesis of no correlation between the instruments and the residuals (Eq.(5)) and (Eq.(6)). Second one is a test for different-order serial correlation in the residuals. If this test is unable to reject the null

[19]The "system GMM" estimator[13] is not suitable in these case for several reasons. First the lagged dependent variable is not a random walk process ($\alpha = 1$). Second the additional initial condition assumption stated by Blundell Bond (1998) are not satisfied with proper tests: the lagged differences are not valid instruments for level equations.

[20]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.

[21]All lags are used as instruments. For more pratical details look Roodman (2006).

hypothesis of no second-order serial correlation the lagged dependent variable has to be lagged of a further period.

Just two final remarks for the estimation techniques. First of all the differences are calculated as "first differences" and not as orthogonal deviations (Arellano Bover, 1995): in this latter case at the observation in time t is subtracted the mean of observation from year $t + 1$ onwards. In this case we lose the last year of observation but we minimize the missing values in case of no observations between two consequent years: however the results are robust aslo to his transformations. Secondly the results do not change also using two step estimator correct for heterorskedasticity[22].

The results are showed in Table 10 and Table 11. As we can notice the significance of variable of interest disappear both if we consider ratio aggregated or disaggregated; also in the case of value added per worker (Appendix, Table**??**). The lagged dependent variable is no more significant for services while it is for manufactures: it may depend on the problematic estimation of efficiency in services (Forlani, 2008). For the moment the only puzzling coefficient is the negative sign of export in manufactures; we should expect positive and significant sign, as indicator of export premia. This coefficient can be explained by the fact that exporting activity expands the labor input, in order to satisfy the faced demand; this growth in labor input may be higher than the output growth because of rigidities in adjustment costs. Consequently it generates, at least in the short period, a reduction in the output per worker level. If we focus on the manufacturing sector or services the results do not change, both for Irish and foreign owned firms.

Table 10: Difference-GMM: Output per Worker (Aggregate Ratio)

	(1) Aggr.	(2) Manuf.	(3) Manuf.	(4) Manuf.	(5) Serv.	(6) Serv.	(7) Serv.
Log(YL)_{it-1}	0.448***	0.467***	0.463***	0.466***	0.384***	0.393***	0.384***
	(0.047)	(0.051)	(0.051)	(0.051)	(0.064)	(0.064)	(0.064)
Log(Ratio)_{it-1}	-0.015	-0.026	-0.019	-0.029	0.008	0.000	0.003
	(0.042)	(0.052)	(0.055)	(0.053)	(0.054)	(0.052)	(0.054)
L.export	-0.291***	-0.258***	-0.258***	-0.258***	-0.268***	-0.280***	-0.276***
	(0.060)	(0.077)	(0.077)	(0.077)	(0.084)	(0.086)	(0.085)
L.ln_red			0.013			0.014	
			(0.009)			(0.015)	
L.ln_train			0.002			0.016	
			(0.010)			(0.018)	
L.d_red				0.018			0.054
				(0.027)			(0.077)
L.d_train				0.006			0.024
				(0.028)			(0.059)
Obs	8722	6308	6295	6308	2346	2339	2346
Firms	2620	1815	1815	1815	779	779	779
Instruments	55	95	95	95	95	95	95
Hansen Test	0.089	0.445	0.175	0.416	0.117	0.059	0.105
AR2 Test	0.527	0.623	0.619	0.614	0.564	0.531	0.546

Dynamic panel-data estimation, Difference GMM. P-Values are showed for Hansen Test and AR2 Test
Aggr: Aggregated industries. Manuf: Manufactures. Serv: services.
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Robust standard errors are in brackets. Year dummies included

At this point we can conclude that the existence of a causal relation that move from imported input mix to firms' productivity does not exist. Nonetheless the employment of a further index for efficiency can suggest that the relation is not so straightforward. The idea is that the coefficient in equation (4), captures an average effect which disappears in first difference, when fixed effects are considered. It is plausible to believe that the benefit from importing is not the same for all

[22]Table upon request.

Table 11: Difference-GMM: Output per Worker (Disaggregated Ratio)

	(1) Aggr.	(2) Manuf.	(3) Manuf.	(4) Manuf.	(5) Serv.	(6) Serv.	(7) Serv.
Log(YL)_{it-1}	0.343***	0.393**	0.414**	0.395**	0.101	0.091	0.095
	(0.118)	(0.164)	(0.168)	(0.164)	(0.116)	(0.121)	(0.118)
$\text{Log(SRatio)}_{it-1}$	0.157	0.183	0.187	0.182	-0.125	-0.203	-0.126
	(0.207)	(0.199)	(0.192)	(0.199)	(0.119)	(0.139)	(0.120)
$\text{Log(MRatio)}_{it-1}$	0.058	0.047	0.067	0.048	-0.001	0.079	-0.007
	(0.055)	(0.054)	(0.058)	(0.053)	(0.128)	(0.131)	(0.130)
L.export	-0.140***	-0.120**	-0.127**	-0.121**	-0.012	0.021	-0.016
	(0.054)	(0.054)	(0.056)	(0.054)	(0.090)	(0.097)	(0.089)
L.ln_red			-0.004			-0.011	
			(0.005)			(0.018)	
L.ln_train			0.002			0.031	
			(0.008)			(0.023)	
L.d_red				-0.006			0.020
				(0.028)			(0.104)
L.d_train				-0.017			0.061
				(0.023)			(0.074)
Obs	5434	4525	4512	4525	861	860	861
Firms	1875	1513	1513	1513	342	342	342
Instruments	56	92	92	92	92	92	92
Hansen Tests	0.7157	0.9934	0.9925	0.9904	0.06250	0.2902	0.1335
Ar2 Test	0.1623	0.6442	0.6296	0.6335	0.2418	0.2988	0.2607

Dynamic panel-data estimation, Difference GMM. P-Values are showed for Hansen Test and AR2 Test
Aggr: Aggregated industries. Manuf: Manufactures. Serv: services.
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Robust standard errors are in brackets. Year dummies included

firms. For this purpose it is used an additional index of productivity, that takes into account the firms' distance from sector frontier. This efficiency index is similar to a Torniqvist index, and the definition below follows Aw et al.(2001).
Let $\ln Y_{it}$, S_{ift}, and $\ln X_{ift}$, be the log of firm output i, the share of input f on total revenues and the input consumption respectively, while the overbear terms are the arithmetic means in sector j (as sector are defined in the ABSEI dataset) of the corresponding firm level variables over all firms in year t. Then the TFP index for firm i at time t in sector j is

$$\begin{aligned} \ln TFP_{it}^{j} &= \left(\ln Y_{it} - \ln \bar{Y}_t\right) + \sum\nolimits_{s=2}^{t} \left(\ln \bar{Y}_s - \ln \bar{Y}_{s-1}\right) \\ &- \sum\nolimits_{f=1}^{F} \frac{1}{2} \left(S_{ift} + \bar{S}_{ft}\right) \left(\ln X_{ift} - \ln \bar{X}_{ft}\right) \\ &- \sum\nolimits_{s=2}^{t} \sum\nolimits_{f=1}^{F} \frac{1}{2} \left(\bar{S}_{fs} + \bar{S}_{fs-1}\right) \left(\ln \bar{X}_{fs} - \ln \bar{X}_{fs-1}\right). \end{aligned} \tag{8}$$

where TFP formula derives from a translog production function and the input considered are tangible fixed asset, labor (labor force) and intermediate input consumption. Finally it is constructed the variable Index as the arithmetic mean for each sector. This index is not perfectly reliable, because in its calculation we do not use information about capital stock, but it remains quite informative. In the Table 12 are presented the results. As we can see, the coefficient of Ratio variable is now positive and significant, only for the manufacturing industry ((3) (4) (5)). It can suggests that, we obtain positive effects from importing activity, when we use a productivity measure that includes also information about the relative distance of firms from sector efficiency's frontier.
In order to confirm the result we re-estimate the equation (4) introducing a new variable which

Table 12: Difference-GMM: TFP Index

	(1) Aggr.	(2) Manuf.	(3) Manuf.	(4) Manuf.	(5) Serv.	(6) Serv.	(7) Serv.
TFP_{it-1}	0.424***	0.444***	0.405***	0.448***	0.279***	0.322***	0.297***
	(0.084)	(0.062)	(0.054)	(0.062)	(0.086)	(0.090)	(0.089)
$Log(Ratio)_{it-1}$	0.006	0.056**	0.054*	0.058**	-0.050	-0.047	-0.046
	(0.026)	(0.027)	(0.028)	(0.027)	(0.051)	(0.051)	(0.051)
L.export	-0.040	0.001	0.002	0.000	-0.054	-0.055	-0.053
	(0.031)	(0.024)	(0.024)	(0.024)	(0.059)	(0.061)	(0.059)
L.ln_red			-0.004			-0.008	
			(0.004)			(0.008)	
L.ln_train			-0.009*			-0.003	
			(0.005)			(0.014)	
L.d_red				-0.021			-0.029
				(0.016)			(0.042)
L.d_train				-0.029*			-0.045
				(0.016)			(0.049)
Obs.	6280	4634	4622	4634	1595	1589	1595
Firms	2166	1548	1548	1548	598	598	598
Instruments	46	82	82	82	82	82	82
Hansen Test	0.7594	0.8533	0.7806	0.8727	0.1252	0.3189	0.09925
AR2 Test	0.1286	0.8777	0.8998	0.8551	0.1079	0.09088	0.1005

Dynamic panel-data estimation, Difference GMM. P-Values are showed for Hansen Test and AR2 Test

Aggr: Aggregated industries. Manuf: Manufactures. Serv: services.

Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value

Robust standard errors are in brackets. Year dummies included

capture the firm's distance from the sector frontier in year 2000. The distance of firm i in sector j is defined as

$$LogDist_{ij00} = Log\left(\frac{(YL)_{j00}}{max(YL)_{j00}}\right) \tag{9}$$

where the denominator is the maximum level of efficiency in year 2000 for sector j. This variable is interacted with the variable of interest in order to capture the effect of importing activity on different firms, depending on their initial value of efficiency: a similar approach is followed by Konings and Vandenbussche (2008) to estimate the effect of antidumping protection on firms' efficiency. In the table **??** are showed the results only for manufacture industries as suggested by previous results (Table 12). The sample are reduced eliminating year 2000 from the regression and a balanced panel is used in order to follow firms in their productivity evolution.

In Table **??** it is possible to notice that the effects of importing has a positive effect of firms efficiency if firms are sufficiently distant form the frontier at the begin of observation period. The effect is positive as long as distance is defined in negative value: as distance increases the distance term is farer away from the zero. Secondly, the table shows that the positive effects coming from raising imported goods is relevant for Irish owned firms rather than foreign. This result combined with the fact that Irish firms are less productive than foreign firms support the idea that the importing activity is particularly relevant for those domestic firms that are not highly efficient. If we run the same regression using value added per worker (and defining the distance in the same way) we obtain the same results[23], in Table14.

[23]In this case Log(LabProd) is lagged of two period two avoid autocorrelation in thew error term.

Table 13: Distance effect: Manufacturing Sector - Log(YL).

	(1) Irish	(2) Irish	(3) Irish	(4) Foreign.	(5) Foreign	(6) Foreign	(7)
Log(YL)$_{it}$	0.292***	0.296***	0.283***	0.023	0.092	0.105	0.298***
	(0.073)	(0.069)	(0.070)	(0.055)	(0.062)	(0.087)	(0.067)
Log(ratio)$_{it}$	-0.234**	-0.268**	-0.239**	-0.088	-0.023	-0.038	-0.120
	(0.114)	(0.116)	(0.108)	(0.117)	(0.106)	(0.113)	(0.084)
Ratio*Dist$_{it}$	-0.070*	-0.085**	-0.072*	-0.074	-0.050	-0.057	-0.051
	(0.041)	(0.042)	(0.039)	(0.049)	(0.045)	(0.048)	(0.036)
L.export	-0.061	-0.054	-0.060	0.129	0.052	0.075	-0.085*
	(0.037)	(0.037)	(0.037)	(0.150)	(0.140)	(0.149)	(0.045)
L.ln_red		0.006			0.012		
		(0.008)			(0.009)		
L.ln_train		-0.008			-0.045		
		(0.008)			(0.057)		
L.d_red			0.040			0.065	0.036
			(0.040)			(0.044)	(0.029)
L.d_train			-0.024			-0.281	-0.052
			(0.023)			(0.263)	(0.040)
Obs.	2148	2142	2148	1000	997	1000	3148
Firms	537	537	537	250	250	250	787
Instrument	52	80	80	51	79	79	80
Hansen Test	0.6217	0.9001	0.8912	0.4203	0.4083	0.6493	0.8541
AR2 Test	0.5241	0.5334	0.5673	0.4578	0.6597	0.8784	0.3440

Dynamic panel-data estimation, Difference GMM. P-Values are showed for Hansen Test and AR2 Test
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Robust standard errors are in brackets. Year dummies included

Table 14: Distance effect: Manufacturing Sector - LabProd

	(1) Irish	(2) Irish	(3) Irish	(4) Foreign.	(5) Foreign	(6) Foreign	(7)
Log(LabProd)$_{it-2}$	0.073	0.078	0.075	-0.225**	-0.227**	-0.220**	-0.107
	(0.056)	(0.055)	(0.055)	(0.093)	(0.092)	(0.094)	(0.115)
Log(Ratio)$_{it-1}$	-0.075***	-0.079***	-0.079***	-0.004	0.035	0.010	-0.012
	(0.028)	(0.027)	(0.027)	(0.057)	(0.055)	(0.054)	(0.039)
Ratio*Dist$_{it}$	-0.021**	-0.023***	-0.023***	0.014	0.026	0.018	0.005
	(0.009)	(0.008)	(0.008)	(0.023)	(0.026)	(0.025)	(0.011)
L.export	-0.007	-0.007	-0.007	0.029	0.034	0.034	-0.003
	(0.005)	(0.005)	(0.005)	(0.037)	(0.040)	(0.046)	(0.007)
L.ln_red		0.001			0.008*		
		(0.002)			(0.004)		
L.ln_train		0.000			0.014		
		(0.002)			(0.012)		
L.d_red			0.006			0.038	0.014
			(0.007)			(0.025)	(0.009)
L.d_train			0.004			-0.015	-0.001
			(0.005)			(0.034)	(0.006)
Observations	1461	1456	1461	699	696	699	2160
N_g	487	487	487	233	233	233	720
j	45	69	69	44	68	68	69
hansenp	0.1186	0.2248	0.3397	0.1121	0.05806	0.2284	0.1714
ar2p	0.3715	0.4503	0.4311	0.7479	0.7182	0.7548	0.6389

Dynamic panel-data estimation, Difference GMM. P-Values are showed for Hansen Test and AR2 Test
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Robust standard errors are in brackets. Year dummies included

5 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 importing activity boosts productivity for that firms that decide to begin to import: *learning-by-importing* effect is recognizable.
2. There is a statistical and positive relation among importing activity and firms' efficiency.
3. There no evidence that increase the imports per se raises the thew average efficiency.
4. Small irish firms benefit from increasing their ratio of imported intermediates.

As described above the composition of input mix 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. Then it is important for firm's efficiency diversify as much as possible their inputs, via imports, in particular for small domestic firms. A more differentiated input mix make raise firms' efficiency; but it is not the only case. The mechanism through which imported goods raise firms productivity may be different. It is reasonable to believe that imported inputs, substitutes R&D activity because they incorporates better characteristics. Even more reasonable is to assume that imported inputs force firms to upgrade their production process or the internal capabilities in order to use the 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.

References

[1] Abadie A., Diamaond A., Hainmueller J. (2009): Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program, *NBER Working Papers* No. 12831

[2] Ackerberg D., Benkard C.L., Berry S., Pakes A. (2005): Econometrics tools for analyzing market outcomes, *Handbook of econometrics vol.6* ed. Heckman J.J., Leamer E.E.

[3] Amiti M, Konings J (2007):Trade liberalization, intermediate inputs and productivity: evidence from Indonesia, *American Economic Review*, vol. 97(5)

[4] ArellanoM. Bond S.R. (1991): Some specification test for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies*, 58 277-298

[5] Arnold M. Javorcik B. and Mattoo A. (2006): The Productivity Effects of Services Liberalization: Evidence from the Czech Republic, CEPR Working Paper

[6] Arellano M., Bover O. (1995): Another look at the instrumental variable estimation of error-components model, *Journal of Econometrics* vol.68, pp.1-38

[7] Aw et al. (2001), Journal of Development Economics, vol. 66, pp. 51-86

[8] Barry F. (1999): *Understanding Ireland's Economic Growth*, London: MacMillan

[9] Barry F., Gorg H., Strobl E. (2005): Foreign Direct Investment and Wages in Domestic Firms in Ireland: Productivity Spillover versus Labor-market Crowding Out, *International Journal of the Economics of Business*, Vol.12(1), pp67-84

[10] Basedina E. (2008): Exporting and productivity under endogenous trade policy: theory and evidence from Ukraine, Bocconi University, mimeo

[11] Bernard A.B. Jensen B.J. (1999): Exceptional Exporter Performance: Cause, Effect or Both? Journal of International Economics, Vol. 47 (1), pp. 1-25.

[12] Bernard A.B., Redding S.J., Schott P.K. (2007): Comparative Advantage and Heterogeneous Firms, *Review of Economic Studies*, Vol. 74(1), pp. 31-66

[13] Blundell R., Bond B. (1998): Initial conditions and moent restrictions in dynamic panel model, *Journal of Econometrics* vol.87, pp. 115-143

[14] Clerides S. Lach S. Tybout J.(1998): Is 'Learning-by-Exporting' Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco, *Quarterly Journal of Economics*, Vol. 113, pp. 903-47.

[15] Coe D.T., Helpman H.(1995): International R&D spillovers, *European Economic Review*, vol.39(5) pp.859-887

[16] Eaton J., Kortum S., Kramrz F. (2004): Dissecting trade: firms, industries and export destinations,*American Economic Review* vol.94(2), pp.150-154

[17] Farell D. (2007): Service sector productivity: The tigers next challenge? *in Perspectives on Irish Productivity* ed. by Aylward C. and O'Toole R., Forfás

[18] Forlani E. (2008): Competition in service sector and performances of manufacturing firms: does liberalization matter, *mimeo Université Catholique de Louvain*

[19] Fugazza M., Robert-Nicoud F.(2005) Can South-South trade liberalization stimulate North-South trade? CEPR Discussion Papers 5699

[20] Gorg H., Strobl E (2001): Multinational Companies an Productivity Spillovers: A Meta-Analysis, "Economic Journal, Vol.111(475), pp.723-739

[21] Gorg H., Strobl E (2003): Multinational Companies Tehcnology Spillovers and Plant Survival, *Scandinavian Journal of Economics*, Vol.105(4), pp. 581-595

[22] Grossman G.M., Helpman H. (1991): Innovation and Growth in the Global Economy, ed. MIT Press

[23] Kasahara, Lapham B. (2008): Productivity and the Decision to Import and Export: Theory and Evidence, *CESifo Working Paper No*

[24] Konings J. (2001): The Effects of Foreign Direct Investments on Domestic Firms: Evidence form Firm Level Panel Data in Emerging Economies, *Economics of Transition*, Vol.9(3), pp.619-633

[25] Konigs J., Vandenbussche H. (2008): Heterogenous responses of firms to trade protection r*Journal of International Economics*,

[26] De Leocker I. (2007): Do Exports Generate Higher Productivity? Evidence from Slovenia, *Journal of International Economics*, Vol.73, 6998

[27] Levinshon J., and Petrin A. (2003): Estimating Production Functions Using Inputs to Control for Unobservable., *Review of Economic Studies*, Vol. 70, pp. 317-342.

[28] Melitz M. (2003): The impact of trade on intra-industry reallocations and aggregate industry productivity, *Econometrica* 71(6) 1695-1725

[29] Melitz M., Ottaviano G.I.P (2008): Market size trade and productivity, *Review of Economic Studies*, Vol. 75, pp.295-316

[30] Monfort P., Vandenbussche H., Forlani E. (2008): Chinese Competition and Skill-Upgrading in European Textiles: Firm-level Evidence, *Licos DP 198/2008*

[31] Oliner S.D., Sichel D.E. (2000): The resurgence of growth in the late 1990s: is the information technology the story? Proceedings, Federal Reserve Bank of San Francisco

[32] Olley S., and Pakes A. (1996): The Dynamics of Productivity in the Telecommunications Equipment Industry, Econometrica, Vol 64 (6), 1263-98

[33] O'Toole R. (2007): Outward direct investment and productivity *in Perspectives on Irish Productivity* ed. by Aylward C. and O'Toole R., Forfás

[34] Roodman D. (2006): How to do xtabond2: an introduction to "Difference" and "System" GMM in Stata, *Working paper 103, Center for Global Development,* Washington

[35] Sexton J.J. (2007): Trends in output, employment and productivity in Ireland, 1995-2005 *in Prespectives on Irish Productivity* ed. by Aylward C. and O'Toole R., Forfás

[36] Smarzynska-Javorcik B.(2003): Does Foreign Direct Investments increase the productivity of domestic firms? In search of spillover towards backward linkages, American Economic Review, vol.94(3) pp. 605-627

[37] Roberts M.J., Tybout J.R. (1997): The decision to export to Colombia: an empirical model of entry with sunk costs, American Economic Review 87(4) pp.545-564

[38] Ruane F., Ugur A. (2005): Foreign DIrect Investments and Productivity Spillovers in Irish Manufacturing Industry: Evidence from Firm Level Panel Data, *International Journal of the Economics of Business*, Vol.11(3), pp.53-66

Table 15: Dataset description: Firms

Sector	Nace Sector	Firms	Domestic	Foreign
Agricolture	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 Platics	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

All data on values are in thousands of Euros.

- Material: Total cost of material and components used directly in the production of goods and provision of services.
- Irish material: Material produced in the Republic of Ireland.
- : Services: Total costs of all bought in services, e.g. advertising, transport, fuel, power repairs royalties telephone postage stationery computing services, professional fee, etc.
- Irish Services: Services sourced in Republic of Ireland.
- $Ln(YL)$: 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.
- $Ln(Prod)$: 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).
- 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.

Table 16: Average intensity ratios for domestic and exporting firms: Services

		Domestic	Exporter	Total
Irish	Mean	0.39	0.73	0.63
	Std	1.31	2.81	2.49
Foreign	Mean	1.60	45.75	40.58
	Std	8.99	837.97	787.47
Total	Mean	0.55	14.45	11.17
	Std	3.49	462.96	404.72

Table 17: Average Output per worker by export and importing status: Services

	No-Importer	Importer	Total
Domestic	2.74	3.26	3.05
Exporter	4.11	4.42	4.34
Total	3.61	4.18	4.02

Table 18: Average Productivity by sector/ownership.

	Log(YL)			Log(LabProd)		
Nace Code	Irish	Foregin	Total	Irish	Foreign	Total
10	4.615	4.374	4.605	6.888	6.792	6.884
15	4.815	5.519	4.903	6.968	7.157	6.992
17	4.163	4.334	4.189	6.815	6.938	6.833
20	4.458	5.294	4.538	6.858	7.005	6.872
22	4.352	4.711	4.398	6.819	6.879	6.827
24	4.340	5.651	5.157	6.867	7.254	7.109
25	4.434	4.619	4.500	6.850	6.877	6.860
26	4.154	5.168	4.326	6.799	7.007	6.834
27	4.231	4.525	4.277	6.813	6.870	6.822
29	4.317	4.848	4.423	6.827	6.901	6.842
30	4.161	5.095	4.647	6.826	7.073	6.955
34	4.436	4.699	4.545	6.879	6.868	6.874
36	4.160	4.709	4.203	6.809	6.898	6.816
40	3.837	4.304	4.022	6.776	6.817	6.792
45	4.391	4.352	4.389	6.870	6.770	6.863
50	4.270	4.873	4.384	6.892	7.106	6.933
65	4.749	4.849	4.813	6.919	7.001	6.972
72	3.557	4.714	3.865	6.748	7.030	6.823
73	3.088	4.132	3.306	6.757	6.737	6.753
74	4.149	3.959	4.103	6.805	6.806	6.805
Total	4.220	4.938	4.411	6.837	7.029	6.888

Source: ABSEI Data-set. Averages calculated across years.

Table 19: Correlation Table (b)

	R&D(pw)	Train(pw)	IH(R&D)	IH(R&D Work)	Log(YL)	Log(LabProd)
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		
Log(YL)	-0.0272*	0.0270*	0.0483*	0.0672*	1	
Log(LabProd)	-0.0579*	0.007	-0.0506*	0.0204	0.8716*	1

Table 20: Correlation Table (c)

	Exp	Exp(UK)	Exp(EU)	Exp(WR)	Exp(Ratio)	Log(YL)	Log(LabProd)
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		
Log(YL)	0.1633*	0.2677*	0.2885*	0.2318*	0.2147*	1	
Log(LabProd)	0.1071*	0.2606*	0.2294*	0.1533*	0.0816*	0.8716*	1

Table 21: Starters by year sector

Nace Code	Start 2002	Start 2003	Control
15	1	2	12
27	1	2	4
72	4	4	5
74	3	2	6

Figure 4: Average Log(LabProd): by sector

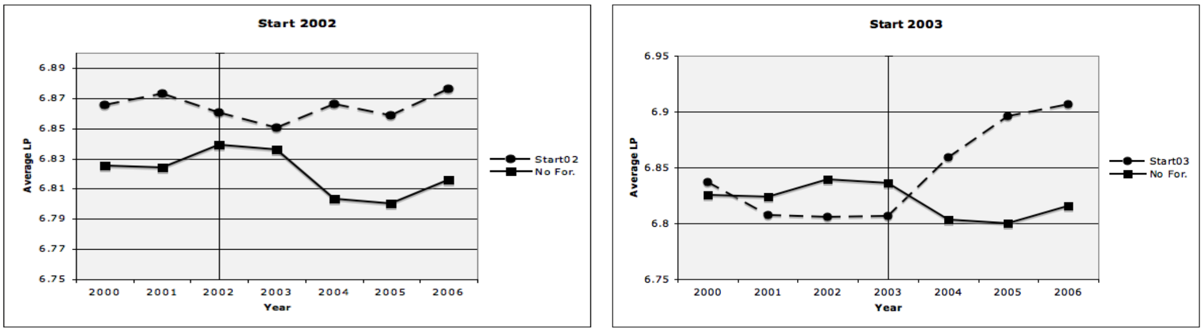


Figure 5: Average Log(LabProd): by sector

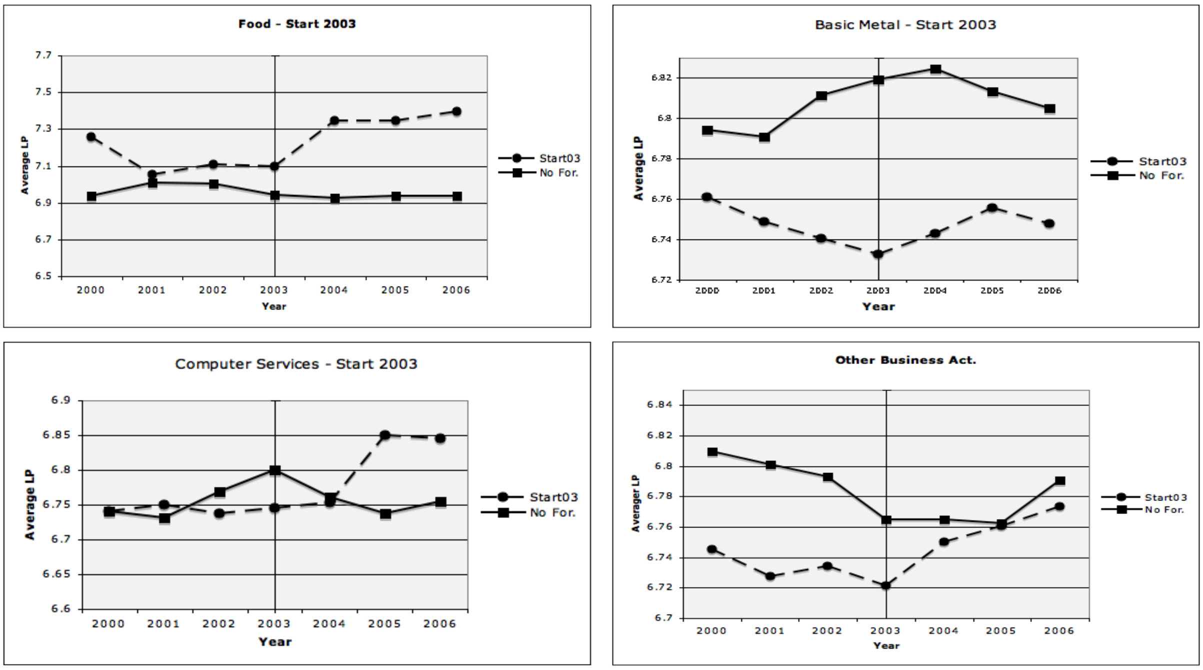


Figure 6: Treated vs Synthetic Control group: Food and Metal case

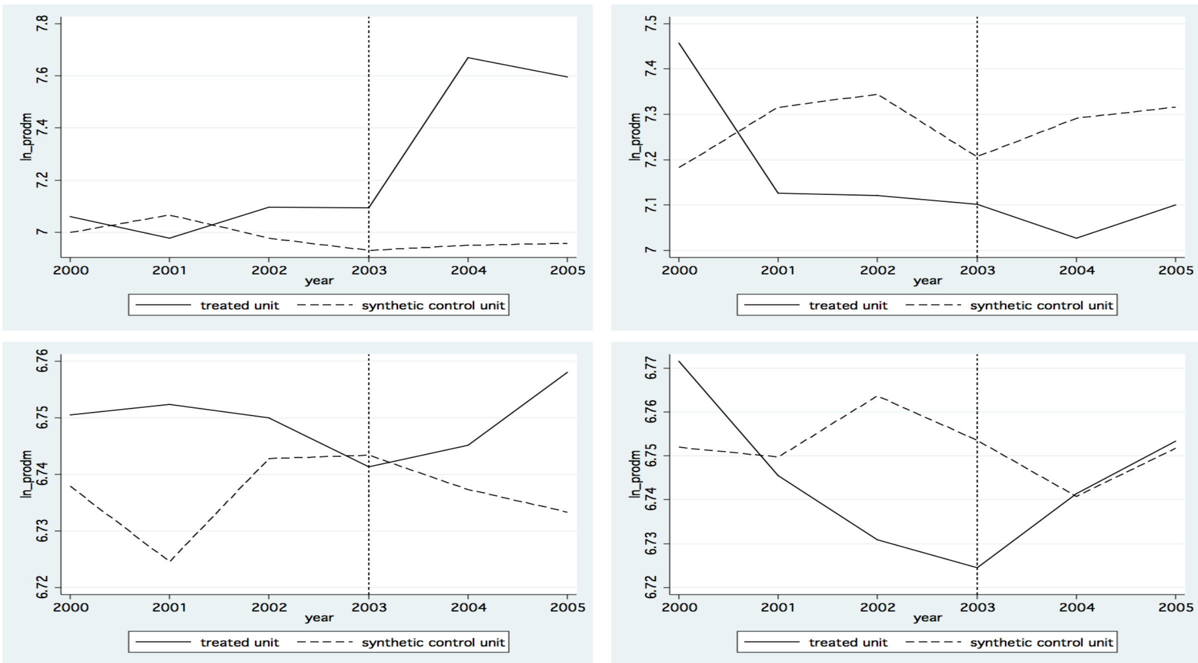


Table 22: Synthetic control group

multicolumn 5—c—Basic Metal				
	RMSPE	0.2186432	RMSPE	0.36438
	Control Unit	Unit Weight	Control Unit	Unit Weight
	5265	0.115	5265	0.337
	14489	0.885	14489	0.663
	16209	0	16209	0
	124811	0	124811	0
Predictor Balance	Treated	Synthetic	Treated	Synthetic
Log(YL) in 2000	3.5310	3.5072	4.0674	3.7352
Av. Log W in 2000 and 2001	2.0892	2.5840	2.7477	2.8526
Av. LogS in 2000 and 2001	4.0005	4.7487	3.6177	5.1322
Av. LogM in 2000 and 2001	5.1674	4.8848	5.2758	5.7571

Food and Beverages				
	RMSPE	0.2637	RMSPE	0.5248
	Control Unit	Unit Weight	Control Unit	Unit Weight
	311	0.135	311	0
	2123	0	2123	0
	13563	0	13563	0
	15576	0.379	15576	0.629
	19102	0	19102	0
	22532	0	22532	0
	23335	0	23335	0
	24528	0	24528	0
	24756	0	24756	0.047
	25723	0.487	25723	0.324
	34151	0	34151	0
	110760	0	110760	0
Predictor Balance	Treated	Synthetic	Treated	Synthetic
Log(YL) in 2000	5.4160	5.4116	6.4194	5.6237
Av. LogWin 2000 and 2001	3.0363	2.8947	2.5614	2.8464
Av. LogS in 2000 and 2001	6.7632	6.7770	4.8024	6.3897
Av. LogMin 2000 and 2001	8.6905	8.5028	7.1021	7.9129
hline				

Table 23: OLS Regression: Value Added per Worker

VAR	(1) Aggr.	(2) Aggr.	(3) Manuf.	(4) Manuf.	(5) Manuf.	(6) Serv.	(7) Serv.	(8) Serv.
Log(LabProd)$_{it-1}$	0.857***	0.856***	0.921***	0.920***	0.913***	0.757***	0.755***	0.752***
	(0.048)	(0.048)	(0.034)	(0.034)	(0.036)	(0.101)	(0.102)	(0.102)
Log(Ratio)$_{it-1}$	0.015**	0.015**	0.008**	0.007**	0.007**	0.033	0.033	0.033
	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.020)	(0.020)	(0.020)
L.export	0.006**	0.005*	0.006*	0.006*	0.004	0.007	0.006	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)
L.d_red		-0.004		-0.001			-0.014	
		(0.004)		(0.003)			(0.012)	
L.d_train		0.010**		0.005			0.015**	
		(0.004)		(0.005)			(0.007)	
L.ln_train					0.004**			0.008***
					(0.002)			(0.003)
L.ln_red					-0.001			-0.001
					(0.001)			(0.002)
Constant	0.970***	0.970***	0.565**	0.566**	0.614**	1.579**	1.610**	1.623**
	(0.326)	(0.327)	(0.234)	(0.234)	(0.249)	(0.683)	(0.701)	(0.696)
Observations	12272	12272	8699	8699	8651	3467	3467	3429
R^2	0.809	0.809	0.853	0.853	0.851	0.731	0.732	0.732
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in barckets are robust and clusterd across individuals.
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Aggr: Aggregated industries. Manuf: Manufactures. Serv: services.

Table 24: Difference-GMM: Value added per worker (Aggregate Ratio)

	(1) Aggr.	(2) Manuf.	(3) Manuf.	(4) Manuf.	(5) Serv.	(6) Serv.	(7) Serv.
Log(LabProd)$_{it-1}$	0.479***	0.460***	0.465***	0.459***	0.369**	0.355**	0.367**
	(0.123)	(0.097)	(0.093)	(0.097)	(0.149)	(0.144)	(0.149)
Log(Ratio)$_{it-1}$	-0.000	-0.007	-0.004	-0.007	0.010	0.009	0.010
	(0.011)	(0.013)	(0.013)	(0.013)	(0.016)	(0.016)	(0.016)
L.export	-0.023**	-0.025*	-0.026*	-0.025*	-0.013	-0.013	-0.014*
	(0.009)	(0.014)	(0.014)	(0.014)	(0.008)	(0.008)	(0.008)
L.ln_red			0.001			0.001	
			(0.002)			(0.003)	
L.ln_train			0.000			0.003	
			(0.002)			(0.004)	
L.d_red				0.004			-0.000
				(0.005)			(0.014)
L.d_train				-0.003			0.011
				(0.004)			(0.010)
Obs	8722	6308	6295	6308	2346	2339	2346
FIrms	2620	1815	1815	1815	779	779	779
Instruments	55	95	95	95	95	95	95
Hansen Test	0.6733	0.8099	0.6634	0.7779	0.05794	0.1032	0.06196
Ar2 Test	0.7526	0.4721	0.4753	0.4699	0.4970	0.5487	0.4965

Dynamic panel-data estimation, Difference GMM. P-Values are showed for Hansen Test and AR2 Test
Aggr: Aggregated industries. Manuf: Manufactures. Serv: services.
Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value
Robust standard errors are in brackets. Year dummies included