FIW – Working Paper

FIW Working Paper N°21
January 2009

Outsourcing and Firm Productivity in Irish Manufacturing

Fergal McCann

Abstract

The causality from outsourcing, defined as the procurement of inputs from outside the boundaries of the firm, to productivity is tested for a large panel of Irish manufacturing firms. Theory suggests that as firms outsource more 'non-core' activities to specialized providers, productivity due to the firm benefiting from cheaper or higher-quality inputs and from reallocation of resources towards higher value-added activities. The international outsourcing case adds another dimension in the form of input variety, quality and technological embeddedness. I test the above hypothesis using a "System GMM" estimator to control for endogeneity in the panel and allow for a lagged dependent variable to be a regressor. International outsourcing is found to lead to productivity gains, but upon closer inspection it seems that firms' international orientation and type of industry both matter.

JEL classification: F23, L23;
Keywords: Outsourcing, Productivity, Firm Structure;

The author/s

Fergal McCann is researcher at the University College of Dublin.
E-mail: fergal.mccann@ucd.ie

The author acknowledges financial support of Science Foundation Ireland Research Frontiers Program Grant MAT 017 and a Forfas productivity research bursary 2008.

1 Introduction

In this paper I study the effects of outsourcing on productivity at the firm level. In order to contextualise this, the factors driving outsourcing's prevalence in the modern global economy and the perceptions and realities surrounding its extent and its effect on labour markets will be summarised. I will then present some theoretical reasons which explain the causality from outsourcing to productivity, and show through the estimation of Cobb-Douglas Production Functions that outsourcing does indeed influence firm-level productivity, but that this effect is small, and that it is not homogenous when we break firms down by their international orientation and their industry characteristics.

As Grossman and Helpman (2005) put it, "we live in an age of outsourcing". The extent of the proliferation of outsourcing is disucussed in Section 3.1. The reasons for the onset of this "age of outsourcing" lie in what Baldwin (2006) refers to as globalisation's "second unbundling". He defines the first unbundling as being marked by industrialisation, trade, growth, urbanisation and increasing internal inequality in the North. Movements in this first unbundling can be thought of as sitting within the Hekscher-Ohlin framework where the fortunes of sectors were aligned with the productive factors used most intensively in the sector. The firm was considered a "black box", and firm-to-firm competition was the lowest level of aggregation to be analysed. In Baldwin's "second unbundling", which began in the 1980s, that "black box" was opened up, as firms started to locate different parts of the production process in different locations. The lowest level of disaggregation was no longer the firm but the task. A German automobile firm can have a generic input manufactured in and shipped from Shenzen at a much lower cost than it could have done in Stuttgart. Similarly an employee in Dublin working for an Irish service firm now faces competition from a worker in India who can perform the task at a lower cost. There are numerous reasons for this second unbundling, which are not the focus of this paper. However I feel it constructive to briefly mention a few. The fall in tariffs and trade costs brought about by greater global integration, deregulation and market liberalisation is certainly a factor, as is the fall in transport costs due to improved facilities and technology, and competition in that sector. These factors more likely played a strong role in the proliferation of the movement of intermediate input production to foreign countries. The newest wave of the second unbundling has seen a more rapid growth in the relocation of service jobs overseas. This relocation owes less to transport and trade costs, and more to the IT and Communications revolution of the 1990s, and the huge strides made in developing countries' education systems, meaning that

more and more workers in these countries are now in direct competition with workers in developed countries for a wider range of tasks. The rise in both international material and services outsourcing can also be explained by the increased competition levels implicit in the globalisation of markets. As competition has increased, firms have had to come up with more radical solutions to stay profitable. One of these solutions has been to move certain "non-core" tasks outside the boundary of the firm and in many cases overseas.

An important clarification must be made straight away, as the terminology has often been confused in the literature and media[1]. Outsourcing is defined as the sourcing of inputs from outside the firm, regardless of whether these inputs are sourced abroad or domestically. International or offshore outsourcing, on the contrary, is the sourcing of inputs from outside the boundaries of the firm and beyond home country borders. This should not be confused with offshoring, which is the relocation of a part of the production process to another country, which can occur within the boundaries of the firm through Foreign Direct Investment (FDI) or outside those boundaries (offshore outsourcing).

While this paper deals with the subject of outsourcing's links to productivity, it must be acknowledged that international outsourcing's effects on developed country labour markets have been the focus of a large amount of (mainly negative) media and popular attention . Famous *BusinessWeek* headlines have included "The new global job shift" (Feb 3 2003), with that issue's front cover asking "Is your job next?". If we, as Baldwin (2006) recommends, think of offshore outsourcing as simply another form of trade, then we should think of its labour market effects in the same vain. What this implies is that there are both winners and losers from trade in tasks. Studies such as Falk and Wolfmayer (2008), Jensen and Kletzer (2006) and Ahn *et al* (2008) all indicate that international outsourcing, particularly to low-wage countries, has a significant negative effect on home country employment. The latter paper, for Japan, also finds that outsourcing has a positive effect on high-skilled labour demand, which indicates that the reallocation of labour into higher-value activities due to outsourcing is a reality in Japan.

A brief mention to the gap between the fear and the reality surrounding international outsourcing is also instructive. A consultancy report by Forrester (2002) predicted that 3.3 million US jobs would be lost to services

[1]For further distinguishing definitions of the fragmentation of the production process, see Olsen (2006), Section 2

offshoring by 2015. This was revised to 3.4 million by McCarthy (2004). To put this figure into context, many commentators, including Kierkegaard (2003) and Rohde (2004) refer to a quarterly job destruction rate (often referred to as "job churn")in the US of between 7-8 million jobs. Furthermore, Slaughter (2004) reports that 5.4 million jobs in the US for 2002 were attributable to outsourcing to US companies by overseas firms. This figure is larger than any estimates of jobs lost to offshoring, implying that the US is in fact a net beneficiary from the offshoring phenomenon. Kierkegaard (2003) also finds that the vast majority of jobs lost to offshoring in the US from 2000-2002 were those which would likely have been lost to technological change in the absence of offshoring. Further, Amiti and Wei (2004) find that services outsourcing leads to a positive significant effect on employment at the industry level.

In analysing outsourcing from the firm side, most attention has been given to the decision on whether to outsource or keep activity in-house, with most of this literature being theoretical. Two of the most popular strands are the property rights approach, as in Antras and Helpman (2004), and the transaction cost approach, as in McLaren (2000) and Grossman and Helpman (2003). While not the focus of this paper, this literature is relevant in that it often finds that productivity plays a part in the outsourcing decision, bringing endogeneity into play when looking at the effect of outsourcing on productivity. This will be discussed in depth in Section 5

Rather than look at the decision to outsource, I enquire as to whether outsourcing is actually of benefit to firms. Rohde (2004) references two reports which point to the dangers inherent in engaging in international service outsourcing: a 2003 Gartner report which estimated $6bn was wasted annually on failed outsourcing contracts, and a Clearview consulting report which calculated a "flop rate" of 40-50% for outsourcing contracts.

A sparsely populated existing academic literature has generally found evidence for the positive effect of outsourcing on productivity. There are a number of papers that look at the link between outsourcing and productivity at the industry level, such as Feenstra and Hanson (1996). One recent example is Amiti and Wei (2006), which focuses solely on the international outsourcing of services. They combine input-output tables with trade data to get estimates for the level of international outsourcing for 450 manufacturing industries. In regressions explaining labour productivity, they find a positive and significant coefficient on international service outsourcing, twice the magnitude of that on international material outsourcing. This method of

analysis lacks an important level of detail in that it does not model firm-level effects. Olsen (2006) gives a good overview of the literature, including studies at industry level as well as firm level. After synopsising the avenues through which outsourcing can increase firm productivity, I will briefly mention some of the firm-level studies carried out to date.

The reasons to expect a causal relationship from outsourcing (both in general and offshore) to firm-level productivity are outlined in Section 2. For now it is sufficient to briefly mention these reasons, and my empirical strategy. At the most basic level, outsourcing can be thought of as the replacement of a firm's employees and processes with an outside provider. In what follows I talk of outsourcing in general, as the procurement of an input or service from outside the boundaries of the firms, and not of international outsourcing in particular. When a process or input is outsourced, and in-house workers are replaced, the firm should see an instantaneous default increase in its labour productivity due to the fact that output should remain constant while wage costs have dropped. Further to this, there should be a productivity improvement due to the inputs being available at a higher quality or a lower cost than was the case within the boundaries of the firm. The most basic Smithian idea of specialization and division of labour can be drawn upon to explain the higher quality input coming from an outside provider. Property Rights, Transaction Cost, and Principal-Agent Theories can also help explain why work done outside the firm will be to a higher quality. This will be mentioned in more detail in Section 2, where I will also discuss reasons explaining the compounded effect that international outsourcing can have on firm-level productivity. Empirically I test for the effects of domestic and international outsourcing by allowing them to affect the technology shifter in a Cobb-Douglas Production Function framework.

Now that the factors driving outsourcing's potential effect on productivity have been explained, I move to a summary of the small amount of empirical work done so far on the issue at the firm level. Early work on outsourcing by Gorzig and Stephan (2002) and Girma and Gorg (2004) did not differentiate bewteen domestic and international outsourcing. The former paper, using German data, generally finds positive and significant effects of outsourcing on returns per employee, but negative effects of service outsourcing on firm profitability, which it uses as an alternative measure of performance in some specifications. The latter paper, using UK data, defines outsourcing as the "cost of industrial services received". Their outsourcing intensity variable is then the ratio of outsourcing to the total wage bill. It finds positive and significant effects of outsourcing on productivity, and finds that this effect

is more pronounced for foreign-owned firms. The results only hold in the chemical and engineering sectors however.
Gorg and Hanley (2005), using Irish electronics sector firm-level data from Forfas, find statistically significant positive effects of international outsourcing on productivity. International outsourcing in this case is measured as the ratio of imported inputs to total inputs. When the data is broken down, it appears that only material outsourcing leads to productivity improvements, with no effect from services outsourcing. On further inspection, the authors find that the effect only holds for plants with low export intensities. Employing a similar estimation framework to data on firms in all Irish manufacturing industries, Gorg et al (2004) conjecture that the international orientation of firms is vital in determining the benefit they can reap from outsourcing. They find evidence that foreign-owned firms' productivity increases with both materials and services outsourcing. For Irish-owned firms they find a positive significant effect for materials, but a negative effect for services. Similar results are borne out when the data is broken down by export status. Exporters have a positive sign for both types of outsourcing, while purely domestic firms have significant negative effects on their productivity due to outsourcing.
This paper contributes to the literature by including both domestic and international outsourcing intensity in the regression equation. Doing this allows us to be certain that the effect picked up by the coefficient on international outsourcing is attributable specifically to the international element and not simply to the fact that the provider is outside the boundaries of the firm. The data used here is a census rather than a survey, meaning that the sample is fully representative of the population of Irish manufacturing firms. It is also the first to my knowledge to break firms down by both international orientation and industry characteristics to analyse outsourcing at a more deeply disaggregated level than before. The rest of the paper is organised as follows: Section 2 introduces a theoretical framework in which outsourcing and international outsurcing can affect firm-level productivity. Section 3 explains the data source, the CSO Census of Industrial Production. Section 4 reports regression results, while Section 5 concludes.

2 Theoretical Framework

The productivity-enhancing effect of outsourcing can be explained theoretically through models of firms' decisions on in-house production versus outsourcing, such as principal-agent frameworks and transaction cost theory. The former suggests that outsourcing will increase productivity as it limits opportunism and self-serving behaviour on behalf of employees. In this con-

text, output can be better controlled and inefficiencies minimized through a contract than within the boundaries of the firm, so outsourcing is chosen for its productivity enhancing effects. The latter theory suggests that outsourcing is subject to certain costs such as search costs, contract incompleteness and relationship-specific investment. If these costs are outweighed by the savings from specialization which outsourcing offers, then a firm will decide to outsource. Grossman and Helpman (2003) and others point out that this characteristic of outsourcing is more easily exploitable the "thicker" the outsourcing market. The logic is that the more input suppliers there are in a given country, the higher the likelihood of finding a supplier that matches the needs of the final good producing firm. This idea brings us back to the most basic of explanations for the incentive to outsource: simple Smithian specialisation. When a firm outsources a low-value activity such as its call centre or a basic input, it can then reallocate resources into other activities at which it is better, often referred to in the management literature as its "core competencies". Outsourcing can also help firms in smoothing out seasonal fluctuations in economic activity, which means that excess spending on unnecessary labour is avoided.
Above are mentioned several reasons for which the outsourcing of a service or input should lead to labour producitvity increases. Offshore outsourcing may confer further productivity gains above and beyond those for outsourcing from within the home country. Amiti and Wei (2006) mention the majority of these productivity-driving factors. The increase in the variety of inputs acquired from international outsourcing means that, in the "market thickness" framework mentioned above, the probability of finding an input provider with the "perfect fit" increases. With an increased variety of inputs will often come an increased quality of input. Thus the firm's technology frontier also shifts through workers becoming more efficient through exposure to more sophisticated technologies embedded in these inputs. The procurement of service inputs from abroad can also lead to "learning by doing" effects for employees exposed to the new methods. All of these effects suggest that international outsourcing may have a supplementary effect beyond the general productivity-enhancing effects of sourcing an input from outside the firm mentioned in the previous paragraph. In the empirical section of this paper, I will test whether there is a productivity improvement associated with international and/or domestic outsourcing.

Grossman and Rossi-Hansberg (2006), at the aggregate level, also give an explanation for the productivity-enhancing effects of offshoring. They model tasks as tradeable, claiming that before their paper the lowest level of aggregation was at the level of goods. They show that, much as was the

case previously with trade in goods, once certain tasks are offshored (those in which the home country has a comparative disadvantage), workers will have to move into tasks in which the home country has a comparative advantage. This means, in developed countries, that the workforce will be reallocated into higher-value tasks, and hence its average productivity will increase.

I posit that there are two potential causal channels from international outsourcing to productivity: firstly, a "technology effect", identical to that spelled out in Amiti and Wei (2006) and mentioned above. The second channel is one I term the "cost saving" channel. This channel is associated with the modern interpretation of international outsourcing as a cost-saving practice engaged in with firms in India, China and other developing countries. The extremely low cost of inputs along this channel means that firms make huge savings and are then able to either reallocate or make redundant workers. The latter option has led to much of the recent negative media coverage and political connotations surrounding international outsourcing. This second potential channel does not seem to fit the Irish data. A look at Table A1 will show that the vast majority of Irish firms' inputs have come from other developed nations in the EU, along with the US and UK. This allows me to claim with confidence that when I test for the productivity-enhancing effects of international outsourcing, I am indeed testing for effects such as exposure to technology and know-how, and variety and quality of inputs.

Empirically I explain the potential productivity benefits of outsourcing, as in most of the literature on the topic, within the Cobb-Douglas Production Function framework. In the first instance, I posit that only international outsourcing can have an effect on the technology shifter. In the second instance, the intensity of both domestic and international outsourcing are allowed to have an effect.

2.1 International outsourcing as a determining factor

The first regression equation is similar to that of Gorg *et al* (2004) and Gorg and Hanley (2005). A standard Cobb-Douglas firm-level Production Funtion for firm i with capital, labour and materials included as inputs, looks as follows:

$$Y_{it} = A_{it}[F(K_{it}, L_{it}, M_{it})] \tag{1}$$

Where Y_{it} is output, A_{it} is the technology shifter, K_{it} is firm capital stock,

L_{it} is labour, measured as number of employees per firm and M_{it} is material inputs. If we take logs and subtract $l_i = ln(L_i)$ from both sides, thus transforming both sides to levels per employee, we get the following expression for the log of labour productivity:

$$y_{it} - l_{it} = a_{it} + \beta_1(k_{it} - l_{it}) + \beta_2(m_{it} - l_{it}) \tag{2}$$

It is common to incorporate international outsourcing's effect on productivity into this framework through the technology factor in the production function, as outlined by Olsen (2006). This gives,

$$a_{it} = \alpha_0 + \alpha_1 FOS_{it} + \alpha_2 Z_{it} \tag{3}$$

Where FOS is a measure of the international or foreign outsourcing intensity of firm i and Z is a vector of firm characteristics that could include export status, ownership status, location, age, etc.

This means we are allowing international outsourcing, along with some other firm characteristics, to shift the intercept of the production function. This process is driven by the "technology effect" mentioned in Section 2. Adding in a dynamic element, this gives the following base regression:

$$y_{it}-l_{it} = \alpha_0+\alpha_1 FOS_{it}+\alpha_2 Z_{it}+\beta_1(k_{it}-l_{it})+\beta_2(m_{it}-l_{it})+\beta_3(y_{i,t-1}-l_{i,t-1})+\omega_i+\mu_{it}+\epsilon_{it} \tag{4}$$

Where ω refers to firm fixed effects, μ refers to the serially correlated unobservable and ϵ refers to the random error term. The assumptions on the error term are discussed in more detail in Section 4.

2.2 Outsourcing as a determining factor

Assuming that all the theoretical explanations for outsourcing affecting productivity mentioned in Sectioned 2 are plausible, expression (3) can be rewritten as

$$a_{it} = \alpha_0 + \alpha_1 FOS_{it} + \alpha_2 DOS_{it} + \alpha_3 SOS_{it} + \alpha_4 X_{it} \tag{5}$$

Where FOS is foreign outsourcing of materials, DOS is domestic outsourcing of materials and SOS is outsourcing of services, which can not be broken down into domestic of foreign in the data for this paper. The technology

shifter is now assumed to be influenced by outsourcing of inputs from outside the firm in general, and not only by the international outsourcing of inputs. The results of this regression will add robustness to the coefficients on international outsourcing intensity, as we can now be sure that the effect is purely due to the fact that the inputs are sourced abroad. Once a dynamic specification is allowed, we end up with the following:
$y_{it} - l_{it} = \alpha_0 + \alpha_1 FOS_{it} + \alpha_2 DOS_{it} + \alpha_3 SOS_{it} + \alpha_4 X_{it} + \beta_1(k_{it} - l_{it})$
$+\beta_2(m_{it} - l_{it}) + \beta_3(y_{i,t-1} - l_{i,t-1}) + \delta Z_i + \omega_i + \mu_{it} + \epsilon_{it}$ (6)

We now have two estimable equations (4) and (6), which will be the subject of regression analysis in Section 4.

3 Data

The dataset used is the Census of Industrial Production (CIP), which is collected each year by the Central Statistics Office (CSO) of Ireland. It is compulsory, giving plant and enterprise-level information on all manufacturing firms with 3 or more persons engaged in Ireland from 1991-2005. The availability of plant-level data allows the exploitation of productivity heterogeneity within industries, something which is not possible with aggregate industry-level studies. Industry breakdown at the 2, 3 and 4 digit level is given in accordance with NACE Rev 1 from 1991-2001 and NACE Rev 1.1 from 2002-2005. The panel is unbalanced, with sample size for each year outlined in Table A2. Out of 9,837 firm IDs that appear in the sample, 1564 appear in every year. All monetary variables have been deflated using the CSO's *Consumer Price Index Annual % changes* table, with 1991 used as the base year.

In Table 2 the international orientation of firms in the data is outlined. We see that, in line with expectations given the fact that Ireland is well known as a hub for export-platform FDI, 90% of foreign-owned firms export. For Irish-owned firms, we see that roughly half export some of their output. A similar amount of foreign-owned firms import some of their material imports, compared with just 30% of Irish-owned firms

	Irl	For
Domestic	49.9%	10.1%
Exporter	50.1%	89.9%
Importer	30%	91%

Table 1: International orientation of firms in Ireland

The dependent variable is the log of labour productivity, where labour productivity is calculated as gross output divided by total number of employees. We see from Table 2 that the natural log of labour productivity is smallest for indigenous domestic market-serving firms (Dom in the table), larger for indigenous exporters and larger still for foreign-owned firms. This is what we would expect if we believe the strand of literature beginning with Melitz (2003), which states that a firm must overcome fixed, and then sunk, entry costs to foreign markets. The ranking found here matches that of Helpman, Melitz, Yeaple (2004)(HMY from here on), which builds on Melitz (2003) to allow firms to engage in FDI as an alternate method of penetrating overseas markets. We also see from the data that Irish firms are smaller than exporters, who are much smaller than foreign-owned firms. This same ranking holds true for capital stock, for which I have had to use a proxy due to data restrictions, and for both materials and services used. The proxy used for capital is the amount of fuel used, in line with Ruane and Ugur (2002), who use this dataset to analyse the productivity spillover effects of foreign presence in Ireland on Irish firms.

	Dom	**Ex**	**For**
logprod	10.94	11.0698	11.6855
firm size	23	43	161
l	2.508	2.857	4.216
k	6.872	6.918	7.267
m	9.951	10.211	10.68
s	5.225	5.549	5.594
Outsourcing Intensities			
Dom Mat OS	3.181	3.1	1.436
For Mat OS	0.7815	1.5962	3.1489
Serv OS	0.177	0.143	0.1668
Outsourcing, euro values ('000)			
Dom Mat OS	990	2,532	4,798
For Mat OS	290	982	16,800
Serv OS	82	108	1,027

Table 2: Summary Firm Characteristics

The CIP data allow for a much more direct and accurate measure of outsourcing than that used in older industry-level studies such as Feenstra and Hanson (1999)[2]. Table 2 outlines outsourcing, both in its intensity and in its

[2]These older measures involve calculating the share of imported intermediate inputs over total imports at the industry level.

raw figure in thousands of euro, by the HMY breakdown. The outsourcing intensity for each type of input is computed as the ratio of the purchases of that input from outside the firm to the firm's total wage bill. This approach seems sensible if we think that outsourcing is a way of replacing labour costs within a firm. A measure which relates the amount of inputs sourced from outside the firm to the amount paid in wages to those that carry out tasks within the firm can be considered a plausible measure of vertical disintegration. The materials outsourcing variable is total materials purchased[3]. The foreign/domestic outsourcing distinction is simply given by the total figure multiplied by the percentage reported as imported and as sourced within the Republic of Ireland respectively. The services outsourcing variable [4], as mentioned above, is unfortunately not separable into domestic and foreign components.

We see from Table 2 that, in terms of the raw figures, foreign firms source more of each input from outside the firm than do exporters, who in turn source more than Irish firms. This holds for domestic materials, foreign materials, and services. This is to be expected given that this ranking also holds for size, capital stock, materials used, and services used. In terms of the *intensity* with which firms outsource, however, a different picture emerges. We now see that Irish firms source domestically more intensively than exporters, who in turn source domestically more intensively than foreign-owned firms. The opposite ranking applies for Foreign Materials Outsourcing. Even when we account for firm scale by using the total wage bill as the denominator, foreign firms still source materials from abroad more than twice as intensively as exporters, who in turn source from abroad twice as intensively as domestic firms. Given that services are not broken down into a domestic-foreign dichotomy, there are no *a priori* expectations regarding which type of firm will outsource more intensively. As it turns out, it is Irish domestic firms that have the highest services outsourcing intensity. This indicates that, if the trend in materials is followed, most services outsourcing is of a domestic rather than international nature.

3.1 Outsourcing in a global context

There has been a huge growth in the level of outsourcing over the past two decades. Yeats (1998) reports that for 1995 trade in parts and components in

[3]This includes "Raw Materials, Materials for repairs, Materials purchased for the production of capital goods by your enterprise for your own use, Packaging, Office supplies"'

[4]defined as "work done on commission or contract, amounts paid for repairs and maintenance, etc"

the Machinery and Transportation (SITC 7) sector totalled roughly $550bn. This sector accounted for about half of global manufacturing trade in that year. Kimura et al (2007) show global exports of machinery parts and components to have reached $1.3trillion by 2003, which was 45% of all machinery exports and 20% of all global commodity exports. Amiti and Wei (2004) show that the top ten importers of Business and ICT services (the sectors most affected by international services outsourcing) in 2002 accounted for a mere $200bn[5], while Rohde (2004) estimates global business service outsourcing to be $160bn for 2005. From these figures it is clear that the international sourcing of parts and components has expanded massively. Another important fact emerges from these figures. This is the dominance of parts and components, or "materials" outsourcing over that of services. If one were to believe the media coverage of the last decade, one would think of outsourcing as simply the movement of IT and service jobs to countries such as India, rather than as this much more all-encompassing international fragmentation of *all* types and stages of production. To further emphasise this point, Amiti and Wei (2004) calculate average industry-level international outsourcing intensity ratios, weighted by output, for the UK and US. They find figures of 5.5 and 0.8 percent respectively for services outsourcing against 27 and 12 percent respectively for material outsourcing. They do however show that the services figures are trending upwards while the materials figures decreased in the late nineties and are roughly stagnant since. It is still clear that in terms of magnitude, materials outsourcing is much more important. This is also borne out in the data used in this paper, as will be seen in the following subsection.

3.2 Outsourcing in Ireland

Ireland, as one of the world's most globalised countries, seems an interesting country in which to study the effects of outsourcing on firms' performance. Table 3 gives an indication of the evolution of outsourcing in Irish manufacturing across the time period. Figures quoted are the mean per firm, in thousands of euro. We see a clear trend emerge - firms in Ireland started in the early 90's relying to a greater degree on Irish material inputs. As the 90's progressed foreign outsourcing became more and more prevalent, with domestic sourcing dwindling, to the point where by 2004 almost twice as much material inputs were being sourced abroad. Both this, and the

[5]Unfortunately the authors do not give a figure for total global service imports. From eyeballing the data, however, it does not appear that the countries outside the top ten account for much more than another $100bn, leaving global Business and ICT Service imports lying between $200bn-$300bn

steady rise in services outsourcing, indicate that Ireland has followed the global trend mentioned in 3.1 above. The fact that material sourcing still far outweighs services sourcing[6], stressed in Section 3.1 above, is also borne out in Table 3. This statement admittedly comes with a caveat, as only the manufacturing sector is analysed here, resulting in an obvious bias towards material outsourcing over that of services.

Outsourcing	1992	1996	2000	2004
Foreign Mat	1,612	2,590	3,478	3,008
Domestic Mat	2,229	2,467	2,144	1,670
Service	101	147	239	303

Table 3: Evolution of outsourcing ('000 EUR)

Table 4 moves on to another pertinent empirical question: who outsources? To answer this question, I break the data down by a number of different criteria to see what type of firms source materials from where. Findings are similar to those in Girma and Gorg (2004). Figures report the mean amount, in thousands of euro, of each outsourcing activity. Outsourcing intensity is reported in parentheses. The first breakdown is between high-wage firms (those that pay an average adjusted wage below EUR 18,000), versus low-wage. This threshold roughly splits the data in half. We see that high-wage firms source domestically with three times the magnitude of low-wage firms, and source from abroad with roughly 8 times the magnitude. In terms of relative sourcing, we see that low-wage firms rely more heavily on Irish inputs (1.37:1) than high-wage firms (0.65:1). The figures in parentheses are the mean outsourcing intensities for each group. Both high and low-wage firms are found on average to have a higher domestic than foreign outsourcing intensity.

"Large firms" are defined to be those that employ more than 20 employees. This threshold again splits the data roughly in half. Under this dichotomy we see striking differences. Large firms source domestically with sixteen times the magnitude of small firms, and source from abroad with fourty-two times the magnitude. Again when we look at the outsourcing intensities, we see that both types of firms on average source more intensively from Ireland than from abroad, and that large firms source from abroad more intensively than small firms. These findings are in line with Wakasugi et al (2008), who show

[6]the data only allows the domestic-international distinction to be made for materials outsourcing.

that for Japanese firms, the extent of offshore outsourcing increases with firm size. 10% of firms employing 99 or less employees engaged in offshore outsourcing, with that figure rising to 20%, 50% and 65% for firms under 300 employees, less than 1,000 and over 1,000 respectively.
The most relevant dichotomy in Table 4 is that between high and low-productivity firms. Splitting the sample in half, with the threshold level being a natural log of labour productivity of 11, we see that high-productivity firms source more intensively than low-productivity firms in both categories. In terms of magnitudes, high-productivity firms source 20 times as much foreign material and 13 times as much domestic material. This correlation between productivity and outsourcing leads me to the crucial conundrum of this paper - the potential endogeneity of outsourcing and productivity. This endogeneity problem is particularly severe in the case of international outsourcing. If we believe that the logic of Melitz (2003)and HMY (2004) applies on the input side as well as the final good sales side, we then have the conjecture that only the most productive firms will overcome the entry costs of sourcing inputs from abroad, and hence causality in both directions. This endogeneity issue is dealt with in Section 4.

	Domestic OS	Foreign OS
High wage	3,529 (2.264)	5,347 (1.633)
Low wage	1,006 (3.470)	729 (1.293)
Large firms	4,815 (2.538)	6,691 (1.766)
Small firms	288 (3.180)	157(1.240)
High Productivity	4,013 (3.753)	5,415 (2.175)
Low Productivity	292 (2.025)	274 (0.726)
Breakdown by HMY(04)		
Domestic Firms	990 (3.181)	289 (0.785)
Exporters	2,531 (3.100)	981 (1.596)
Foreign Firms	4,797 (1.436)	16,800 (3.149)
Breakdown by Peneder		
Mainstream Manuf	771 (1.612)	1,214 (1.394)
Labour-intensive	494 (1.885)	593(1.091)
Capital-intensive	1,970 (2.092)	8,745(3.789)
Marketing-driven	4,581 (5.646)	1,105(1.163)
Technology-intensive	3,439 (1.319)	19,400 (3.223)

Table 4: Who outsources materials?

Table 4 also reports outsourcing figures for the Helpman, Melitz, Yeaple

breakdown, which have already been discussed in Section 3. Foreign firms source more than exporters, who source more than domestic firms, both for domestic and foreign materials. Foreign firms are the only grouping in Table 4 that source from abroad more intensively than they source from Ireland, suggesting that linkages to and knowledge of international markets are extremely important for international outsourcing.
The last breakdown is by the Peneder (2002) classification of NACE 4-digit industries. Peneder claims his classification to be novel in that it tracks both comparative cost advantages stemming from exogenous location dependent factors such as relative endowments of capital and labour, as well as firm-specific advantages stemming from intangible investment in R&D and advertising. He uses statistical cluster analysis to group all industries into one of the five groups in Table 4. The labels "labour-intensive", "capital-intensive", "marketing-driven", and "technology-driven" are self-explanatory. "Mainstream manufacturing" comprises industries that did not fit neatly into one of the other four groupings, and it therefore has less analytical use. We see that international outsourcing is most common in the capital and technology-intensive sectors, which we would expect at this point. Marketing-driven industries, which include food and beverages, have the highest levels of domestic sourcing. For an overview of how the Peneder and Helpman, Melitz, Yeaple groupings interact, see Table A3. From this we see that foreign firms have by far the greatest share technology-intensive intensive (31%, versus 7% and 3% for exporters and domestic firms respectively). The same holds for capital-intensive firms (8% versus 3% for both exporters and domestic), but at a smaller magnitude. Irish firms have the highest share of labour-intensive firms. These are results that we would expect to hold given what we know about productivity rankings from Table 2. An interesting finding is that the Peneder breakdown by exporters and domestic firms is almost identical. This may indicate that Irish exporters are not at the level of "sophistication" that we would expect given international evidence. This idea also gains weight when we look back at Table 2 and see that exporters are far closer to domestic firms than to foreign firms in terms of productivity, size and capital intensity.

4 Empirics

4.1 Estimation Procedure

My empirical analysis comprises the testing of equations (4) and (6). In dealing with production functions, there are a number of econometric issues

which can compromise the standard Panel Data approach. Firstly, it is reasonable to believe that a production function can be characterised as having a dynamic element. This means that there will be serial correlation in the dependent variable, so that lagged labour productivity is an important explanatory variable. Secondly, the endogeneity of factor inputs must be dealt with. It may be that more productive firms can choose to purchase more capital or materials or services, or hire more labour, rather than it simply being the case that causality only runs from inputs to productivity. Further to these problems common to all production functions, in this study there is also the possibility that international outsourcing decisions may be endogenous, i.e. more productive firms may be more likely to outsource. The reasoning behind this endogeneity can be thought of in the Melitz (2003) framework, applying his ideas on exporting to the importing of inputs. It may be the case that more productive firms are the only ones capable of entering into international markets for inputs, due to the higher fixed costs involved in entering these markets. If this were the case, any causal effect from international outsourcing to productivity would be endogenous. This thought line may also even apply to domestic outsourcing, if we think that there are search costs involved in finding an outsourcing partner, as in the theoretical work of Grossman and Helpman (2004) and others.

Given these possible channels of endogeneity, the "System" GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998) seems a sensible way to estimate equations (4) and (6). To quote Roodman (2006):

> (These estimators were both designed for) situations with "large N, small T"' panels ...; independent variables that are not strictly exogenous, meaning correlated with past and possibly current realizations of the error; fixed effects; heteroskedasticity and autocorrelation within individuals

Take the composite error term, ϕ_{it} to be composed of a time-invariant fixed effect ω_i, a firm-specific unobservable μ_{it} and a random error term ϵ_{it}. The fact that ϕ can include both a fixed effect and a serially correlated error component is deemed by Ackerberg et al (2006) to be the greatest advantage that this estimator has over structural models in the tradition of Olley-Pakes (1996). It also makes less strict assumptions on the random error component ϵ_{it}. The following assumptions are made on the elements comprising ϕ_{it}. It allows correlation between the ω_i and the inputs. It assumes that the ϵ_{it} is i.i.d and uncorrelated with the inputs. It further assumes, as do structural

models such as Olley-Pakes (1996), that while the μ_{it} are correlated with inputs at time t, the *innovations* in μ_{it} occur between $t-1$ and t. This means they are uncorrelated with inputs at $t-1$ and earlier.
Arellano-Bond (1991) differences equations which are then instrumented by lagged levels. This straight away purges the ω_i. However these untransformed lags are considered to be poor instruments, particularly when the dependent variable is close to a random walk. To improve on this, the "System GMM" estimator keeps these equations but adds another stack for every observation, by taking the equations in levels and instrumenting them with lags of the differences. These lagged diferences must be orthoganal to the fixed effects, ω_i. Standard treatment of an endogenous regressor is to start instrumenting with the second lag. This is because the first lagged level, $x_{i,t-1}$ will be endogenous and correlated with the $\mu_{i,t-1}$ in the $\mu_{it} - \mu_{i,t-1}$. Validity of instruments also depends on the errors not being serially correlated. If there is serial correlation of order 1 in the errors, $x_{i,t-2}$ is endogenous to the $\Delta\mu_{i,t-1}$ term in the error term in differences, $\mu_{it} - \mu_{i,t-1}$, so the second lag is not a valid instrument. To overcome this, we simply start instrumenting with a third lag. At times it may be necessary to start with even deeper lags. Arellano-Bond test statistics for second-order autocorrelation in differences, and Hansen test statistics for instrument validity are reported for all regressions. The depth and range of lags used as instruments are reported under the heading "laglimits".

4.2 Regression Results

In initial regressions, I estimate Equation (4) using the "System GMM" estimator. A positive significant coefficient on the international outsourcing variable indicates that it does indeed have an effect on the firm's technology shifter, and hence on firm productivity. The results of the regressions on the full sample of firms are reported in column (1) of Table 5 below. A result that fails the Arellano-Bond test, implying autocorrelation cannot be rejected at the 5% level, is reported in bold. If avoidable, a second lag of the dependent variable is not included as a regressor. In any instance that it is included, I have done so where autocorrelation was unavoidable without including the second lag. *Hansen* reports the coefficient from a test for instrument validity, with a value above .05 indicating instrument validity. *Laglimits* reports the range of the instrument matirx, where (3 5) means that the 3rd, 4th and 5th lags were used as instruments. Looking at the results, we find the expected positive significant coefficients on the lagged dependent variable and on the Cobb-Douglas inputs. Export status does not have a significant effect

however. This is surprising, but may be expected given the facts mentioned at the end of 3.2 regarding Irish indigenous exporters. Foreign ownership does have a positive significant coefficient. The parameter of interest, international material outsourcing intensity has a positive, small coefficient, but is statistically insignificant for the full sample.

Given the huge level of heterogeneity across firms, the above results do not tell us a whole lot. Breaking the data down into the three HMY subgroups, to allow international outsourcing's effect on productivity to differ by international orientation. Equation (4) is then run on these three subsamples with the results shown in columns (2), (3) and (4). From this breakdown we can see that the effect of international outsourcing on firm productivity does depend on the international orientation of the firm. All other variables have the same sign and significance as the full sample, apart from capital stock in the foreign subsample, indicating the proxy may not be perfect. Foreign-owned firms get the largest increase from international outsourcing, and the only statically significant effect. A one-unit increase in international outsourcing intensity leads to a 1% increase in labour productivity. If we believe that the exposure to international markets, a knowledge of global production processes, an embeddedness in international production networks and easier access to more advanced technologies are associated with international orientation, then these results sit well. The lack of an effect for exporters, on the other hand, is something that is less easily explained. Perhaps it is the case that, as alluded to earlier, indigenous Irish exporters are simply not exceptional performers.

Dependent variable: log of labour productivity				
Subsample	(1) Full Sample	(2) Indigenous Domestic	(3) Indigenous Exporter	(4) Foreign Owned
L1.Logprod	.5357***	.3089***	.3538***	.6757***
L2.logprod	.1188[20]	.1211**	.2215**	n/a
k	.0579**	.1184**	.1022[20]	.0238
m	.1409***	.2276**	.2670***	.1288***
export	-.0428	n/a	n/a	.4019
ctry	.3869[20]	n/a	n/a	n/a
ForMatOS	.0018	.0053	-.0002	.0106**
laglimits	(3 5)	(3 5)	(3 5)	(3 5)
A-B stat	.572	*.028*	.143	*.013*
Hansen	.722	.781	.461	.653
Obs	47,029	20,658	19,328	7,043

*** - statistical significance at 1%
**- statistical significance at the 5%
* - statistical significance at the 10%
x^{20} - statistical significance at the 20%
Table 5: Estimation of Equation (1)

Equation (6) tests whether the intensity of domestic material and service, as well as international material, outsourcing has an effect on the technology shifter. Column (5) reports results for the full sample, while Columns (6) to (8) report the results for the HMY groups. The significance of international material outsourcing remains for foreign firms when these two extra variables are included. A point of note is the ranking of the international outsourcing coefficients: foreign firms have the largest effect, which one would expect *a priori*, but domestic firms (with a coefficient of effectively zero) have a larger coefficient than Irish exporters. Given the lack of a significant effect from domestic outsourcing to productivity, it seems that unless inputs are sourced from beyond the borders of the firm's home nation, their outsourcing does not increase productivity.
On the subject of services outsourcing, we see that only foreign firms gain. One cannot say a whole lot about this finding given that we cannot break down the data into Irish and foreign services. One can however imagine that perhaps only foreign firms have the know-how or resources to ensure that a service outsourcing contract is the right "fit", as in Grossman and Helpman (2005).

Dependent variable: log of labour productivity				
	(5)	(6)	(7)	(8)
Subsample	Full	Dom	Exp	For
L1.Logprod	.5146***	.4420***	.338***	.4329***
L2.logprod	.0692	.0190	.1922**	.1859**
k	.0804**	.1850***	.0907*	.0945*
m	.1762***	.2362***	.3493***	.1788***
export	-.1537	n/a	n/a	.448
ctry	.5297***	n/a	n/a	n/a
ForMatOS	.0056**	-.0003	-.0011	.0076*
DomMatOS	-.0015**	.002	-.0011	.0071
ServOS	.0186[20]	.023	.0575	.0420**
laglimits	(3 5)	(3 3)	(3 5)	(3 5)
A-B stat	.934	.785	.045	.227
Hansen	.476	.079	.276	.475
Obs	47,029	20,658	19,328	7,043

Table 6: Estimation of Equation (2)

4.3 Further disaggregation

Section 4.2 has established the instances in which the interaction between international orientation of the firm and the origin and type of input sourced matter for the productivity effects of outsourcing. To delve a little further beneath the surface of these figures, each HMY category is broken down by the five Peneder (2002) industry types, to see if there is heterogeneity within groups with heterogeneous international orientation. To this end, Equation (6) is run on each of the fifteen subgroups.

For the sake of brevity, I simply report the coefficients for the foreign material, domestic material and service outsourcing intensities[7]. Tables 5 and 6 showed that domestic firms were more likely to experience a productivity gain from international outsourcing than indigenous exporters, although neither had a significant effect. In Table 7 we see that this effect is driven

[7]The coefficients on the lagged dependent variable, capital and materials all come in positive and significant for each specification, with three exceptions

completely by firms in capital-intensive. This again shows the importance of recognising firm heterogeneity. Among exporters, who were shown in the previous subsection to benefit the least from international outsourcing, we similarly see that in the labour, capital and technology-intensive industries, exporters have a positive coefficient for international outsourcing. While Irish exporters in general have been shown not to be exceptional performers throughout this paper, it seems that within the exporting sector there are subsectors in which a "learning by outsourcing" effect does exist. Among foreign firms we see that in all Peneder sectors there is a positive significant coefficient on international outsourcing, albeit at only the 20% level in capital intensive industries. We also see that in three of the sectors there is a positive effect from domestic sourcing to foreign firm productivity, indicating that the result in Table 6 may be misleading. The results here indicate that the majority of foreign firms do in fact experience productivity gains from domestic sourcing in Ireland, which is tantamount to implying that there exist productivity-enhancing vertical linkages between multinationals and indigenous suppliers in marketing-driven, technology-driven and mainstream manufacturing industries.

Dependent variable: log of labour productivity							
Subgroup							
HMY	Peneder	For Mat	Dom Mat	Ser	A-B	Hansen	Obs
Dom	Manuf	.0027	.0105	.0213	.315	.659	4,654
Dom	Labour	.0112	-.0055	.384***	.174	.893	7,135
Dom	Capital	.0072**	-.0088**	.1647**	.725	.08	481
Dom	Marketing	.0067	.0055***	-.1064***	.327	.411	6,454
Dom	Technology	.0345	.0027	.1278**	.837	.249	658
Exp	Manuf.	-.0131	-.0183	-.0237	.057	.815	5,436
Exp	Labour	.037**	-.0033	.1729**	.133	.347	5,363
Exp	Capital	.0089**	.0077	.165**	.115	.092	645
Exp	Marketing	0	-.002	.0127	.18	.245	6,247
Exp	Technology	.015[20]	−.0157[20]	.318[20]	**.031**	.288	1,402
For	Manuf.	.0243***	.0243***	.0884	**.032**	**0**	2,131
For	Labour	.007*	-.042**	.0629***	.858	1	725
For	Capital	.0069[20]	.0187	-.0189	.333	1	584
For	Marketing	.0484*	.0124[20]	.0163**	.851	.742	1,364
For	Technology	.0094***	.0133[20]	.1094[20]	.043	.565	2,151

Table 7: Equation 2 for each HMY-Peneder subgroup

5 Conclusions

The outsourcing of inputs to the production process can lead to productivity gains at the firm level. These gains can arise through cost savings, higher quality products from specialised providers, reallocation of workers and resources to "core competence" activities, and in the case of international outsourcing, higher quality or variety of inputs, exposure to new technologies and know-how and learning-by-doing effects for workers. After having theoretically explained how outsourcing can affect productivity in a Cobb-Douglas production function framework, I go on to test the hypothesis using a "System GMM" estimator on data for Irish manufacturing firms. This estimator allows for a lagged dependent variable and endogenous regressors. In initial estimations on the full sample a positive significant effect of international outsurcing of material inputs on firm productivity is found. Upon further inspection I find that this effect is strongest for foreign firms, indicating that a knowledge of, and embeddedness in, international production networks is important. Notable at this level of disaggregation is the lack of an effect for indigenous exporters. Upon further disaggregation of the data along the lines suggested by Peneder (2002), I find that the positive coefficient on international outsourcing for domestic firms is specific to firms operating in capital-intensive industries (which are a small proportion of total domestic firms), exporters in three subgroups have positive coefficients, while foreign firms in all subgroups have a positive coefficient. This suggests that Irish firms are in the majority not increasing their productivity as a result of international sourcing of inputs, but that being an exporter can be complementary to gains from outsourcing in certain industries. The positive sign on domestic outsourcing intensity for three of the five subgroups of foreign firms is heartening from an Irish policymaker's point of view. The key message to take from the paper is that international outsourcing of materials is shown to have a more consistent and larger impact on firm level productivity than domestic outsourcing, and that it is vital that heterogeneity in international orientation and industry type are taken into account before drawing any conclusions.

References

Ackerberg, D., Caves, K. and G. Frazer (2006). "Structural Identification of Production Functions". Submitted to *Econometrica*.

Ahn, S., Fukao, K. and K. Ito (2008). "Outsourcing in East Asia and its

impact on the Japanese and Korean Labour Markets". *OECD Trade Policy Working Paper*, No. 65.

Amiti, M. and J. Konings (2007). "Trade Liberalization, intermediate inputs and productivity: Evidence from Indonesia"', *American Economic Review*

Amiti, M. and S.J. Wei (2004). "Fear of service outsourcing: is it justified?", NBER Working Papers, 10808.
Antras, P. and E. Helpman (2004). "Global Sourcing," *Journal of Political Economy*, University of Chicago Press, vol. 112(3), pages 552-580.

Baldwin, R. (2006). "Globalisation: the great unbundling". Contribution to the project *Globalisation Challenges for Europe and Finland*, Secretariat of the Economic Council of Finland.

Baltagi, B.H. (2001). *Econometric Analysis of Panel Data*, 2nd Edition, John Wiley.

Bartelsman, E.J., and M. Doms (2000). "Understanding productivity: Lessons from Longitudinal Microdata"', *Journal of Economic Literature*, No.3, pp569-594.

Bhagwati, J., Panagariya, A. and T.N. Srinavasan (2004). "The Muddles Over Outsourcing", *Journal of Economic Perspectives*, 18:4, pp 93-114.

Branstetter, L., and C.F Foley (2007). "Facts and Fallacies about US FDI in China", *NBER Working Papers*, No. W13470.

Criscuolo, C. and M. Leaver (2005). "Offshore Outsourcing and Productivity", OECD and Office of National Statistics.

Falk, M. and Y. Wolfmayer (2008). "Services and Materials Outsourcing to low-wage countries and employment: Empirical evidence from EU countries". *Structural Change and Economic Dynamics*, Vol. 19, pp38-52.

Girma, S. and H. Gorg (2004). "Outsourcing, Foreign Ownership, and Productivity: Evidence from UK Establishment-level Data"', *Review of International Economics*, Vol. 12, Iss. 5.

Gorg, H. and A. Hanley (2005). "International Outsourcing and productivity: evidence from the Irish electronics industry", *North American Journal*

of Economics and Finance, 16, pp 255-269.

Gorg, H., Hanley, A. and E. Strobl (2004). "Outsourcing, Foreign Ownership, Exporting and Productivity: An Empirical Investigation with Plant-Level Data", *Globalisation, Productivity and Technology Research Paper*,No. 8, University of Nottingham.

Gorzig, B. and A. Stephan (2002). "Outsourcing and Firm-level Performance"', German Institute for Economic Research, *Discussion Paper 309*.

Grossman, G. and E. Helpman (2003). "Outsourcing and FDI in Industry Equilibrium", *Journal of the European Economic Association*, 1(2-3):317-327.

Grossman, G. and E. Helpman (2005). "Outsourcing in a Global Economy", *Review of Economic Studies*, 72, 135-159.

Helpman, E., Melitz, M.J. & S.R. Yeaple (2004). "Export versus FDI with Heterogeneous Firms". *American Economic Review*, Vol. 94(1), pp 300-316.

Kierkegaard, J.F. (2003). "Outsourcing: Stains on the White Collar?". *Institute for International Economics*

Kimura, F., Takahashi, Y. and K. Hayakawa (2007). "Fragmentation and parts and components trade: Comparisons between East Asia and Europe", *North American Journal of Economics and Finance*, 18, pp23-40.

Mann, C. (2003). "Globalization of IT Services and White-Collar Jobs: The Next Wave of Productivity Growth". *International Economics Policy Briefs*, PB03-11.

McLaren , J. (2000). "Globalization and Vertical Structure", *American Economic Review*, XC, 1239-1254.

Melitz, M.J., 2003 , The impact of trade on intra-industry reallocations and aggregate industry productivity, Econometrica 71 (2003), pp. 1695-1725.

Olsen, K.B. (2006). "Productivity Impacts of Offshoring and Outsourcing: A Review"', *OECD STI Working Paper*, 2006/1.

Peneder, M. (2002). "Intangible Investment and Human Resources". *Journal of Evolutionary Economics*, 12(1-2), pp.107-134.

Rohde, G. (2004). "Global Sourcing: The Employee Perspective", *European E-Skills Conference, 20-21 September 2004, Thessalonica, Greece.*

Roodman, D. (2006). "How to do xtabond2: An introduction to "Difference" and 'System" GMM in Stata"', *Center for Global Development Working Paper Series*, No. 103.

Yeats, A.J. (1998). "Just how big is global production sharing?", *World Bank Policy Research Working Paper* No. 1871.

appendix

Source	2001	2002	2003	2004	2005
UK	18.24	18.58	13.96	12.6	14.37
EU	11.28	10.27	7.96	9.92	10.94
US	3.12	3.43	3.82	3.78	3.48
RofW	3.35	3.5	3.99	3.69	3.85
Imports/Materials	37%	36%	31%	32%	36%

Table A1: Irish Input Imports by Provenance. Figures report percentage of total material input purchases accounted for by imports from that country or region.

year	No. of firms
1992	4473
1993	4459
1994	4541
1995	4586
1996	4605
1997	4740
1998	4713
1999	4799
2000	5051
2001	4948
2002	5189
2003	5169
2004	4885
2005	4508

Table A2: Sample Size by Year, Census of Industrial Production, (CSO)

Table A3: HMY by Peneder			
	Dom	Exp	For
Mainstream Manuf	6,266 (24)	7,690 (27)	2,736 (30)
Labour-intensive	9,712 (36)	8,292 (29)	956 (10)
Capital-intensive	743 (3)	913 (3)	753 (8)
Marketing-driven	8,873 (33)	9,236 (32)	1,859 (20)
Technology-intensive	960 (3)	2,169 (7)	2,862(31)
Total	26,554	28,300	9,166

Number of firms, with percentage of total HMY category accounted for by each Peneder category reported in parentheses