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Outsourcing Foreign Services and the Internet: Evidence from Firm Level Data

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Abstract: We analyse the link between internet use and foreign sourcing of services and materials inputs. In our empirical analysis using firm level data for Ireland we find, among firms that *a priori* all purchase inputs abroad, that those who commenced outsourcing from suppliers over the internet ("Adopters") experience significantly higher growth rates of services offshoring. This result shows in a variety of econometric methods (OLS, Propensity Scoring (Kernel, Nearest Neighbour and Caliper Matching)). Adopting the internet for outsourcing induced an increase in the share of foreign services by 3.2-4.0 per cent.

I BACKGROUND

The introduction of internet-enabled outsourcing since the turn of the century is seen by many as a breakthrough for reducing the transaction cost of outsourcing services to firms. Miroudot *et al*. (2009) demonstrate that trade in intermediate services inputs (a frequently used measure for international outsourcing) in the OECD increased between 1995 and 2006 at

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an average annual growth rate of 7 per cent. Examples of these internationally traded services include advertising, IT and logistics. An OECD (2006) report from the same period points out, however, that little has been done by researchers to investigate the full impacts of these changes for many aspects of the firms operations. The same report goes on to state that the choice of services open to outsourcers is wider than ever before:

> Rapid advances in Information and Communication Technologies (ICTs), combined with continuing efforts to liberalise international trade and investment in services, have increased the tradability of services and created new types of tradable services. (OECD, 2006, p. 4)

The menu of services available to firms is widening up to the present day. The cost of transacting these services decrease with the launch of new internet delivered platforms that enable firms to transact with suppliers. What remains to be seen is how such cost reductions arising have affected the foreign versus domestic mix of services bought in by firms. Additionally, the advances in the platforms used by firms to transact with suppliers online may have affected the choices of outsourcing firms.

It is not easy, however, to investigate empirically these changes on firms' outsourcing behaviour. This is because in a world of heterogeneous firms, firms are different from one another in terms of previous outsourcing behaviour, size, activity and other characteristics. The differences could be correlated with the changing outsourcing preferences of firms. A further problem for researchers is to identify an appropriate experimental frame. Specifically, rarely do researchers have the opportunity to compare the outsourcing patterns of outsourcing firms which apply a novel, internet-enabled outsourcing technology and outsourcing firms which do not. In other words, it is difficult to find an appropriate baseline against which to measure the impact of novel internet-enabled outsourcing tools on the outsourcing behaviour of firms.

The purpose of our paper is to investigate how the adoption of internet-enabled outsourcing technology by firms can bring about changes in the firm's outsourcing behaviour. Specifically, we investigate the change in the foreign outsourcing intensity (ratio of foreign/total outsourced services) for firms which switch to adopting an internet-enabled outsourcing technology (Adopters) versus firms choosing not to adopt such a technology (non-Adopters). To do this, our analysis applies data for more than 800 firms based in Ireland in the period 2002-2004 when international and Irish domestic service providers had commenced delivering their services to outsourcing firms using internet-based technologies – as distinct to transacting over the

telephone or using e-mail correspondence. We apply a variety of estimation procedures (OLS and various forms of propensity score matching) to estimate the link between the adoption of internet-enabled outsourcing and the choices made by outsourcers. We find that the effect of adopting the internet for outsourcing induced an increase in the share of foreign services by 3.2 to 4.0 per cent, depending on the estimation method used.

Our paper relates to a small but growing literature on the causes and effects of international outsourcing, or more generally imported inputs at the firm level (e.g., Lileeva and van Biesebroeck, 2013; Hijzen *et al*., 2010; Goldberg *et al*., 2009). Looking specifically at the case of Ireland, Görg and Hanley (2004, 2011) and Görg *et al*. (2008) show that firms which increase their level of internationally outsourced inputs can potentially raise their productivity and innovation levels. However, the impact on profitability is ambiguous. In this paper, we shift the focus away from the consequences of the foreign sourcing decision for the firm, and look at one important potential driver of outsourcing, namely, technological progress or, more specifically, the use of the internet.

The rest of the paper is structured in the following way. We outline in Section II, some key studies on the effect of the internet on the outsourcing behaviour of firms. Section III briefly describes our research methodology. In Section IV we describe the Irish data used to investigate the research question. This is followed by an analysis in Section V and our findings are summarised in Section VI.

II BACKGROUND

Many firms have traditionally relied on other firms to provide specialised legal, technical and other services. Changes in telecommunications have radically changed the interface between service buyers and service providers. Specifically, advances in how the internet helps outsourcing firms to interface with services providers, is argued to have made the provision of services cheaper. Several researchers highlight the higher visibility and tradability of international traded services (Abramovsky and Griffith, 2006; Abramovsky and Griffith, 2009; Bartel *et al*., 2014; 2012 and Sako, 2006).[1]

As a consequence of improved business-to-business internet platforms, the cut in the price of transacting with suppliers is expected to shift firms'

[1] An example of a highly specialised internationally traded service is the maritime insurance sector where a handful of London based firms have a developed specialisation over the years. Few domestic non-UK suppliers of maritime insurance could hope to compete with such a specialised supplier.

outsourcing behaviour. Jones and Kierzkowski (2001) argue that it is now easier and cheaper for (1) outsourcing firms to outsource foreign services and that (2) more services are being exchanged at arm's length than before. The UNCTAD (2004) *World Investment Report* shares this view.

What does the theory have to say about the effect of internet-enabled outsourcing on changes to the mix of foreign and domestic services outsourced by firms? To our knowledge, all models assume that firms make initial investments in Information and Communications Technology (ICT) in order to use internet-enabled outsourcing. The outlay of this investment must be balanced against the reduction in the firm's marginal cost of having adopted the internet-enabled technology. Abramovsky and Griffith (2006) argue that the overall cost of adopting internet-enabled outsourcing technology is comprised of several components, such as the adjustment cost where the services provided by external suppliers will never perfectly match the services of the firm's own in-house team of dedicated staff, and a transaction cost which rises with higher input specificity. Additionally, there are the costs of monitoring/writing a service contract and the search cost incurred by the firm when searching out the most appropriate supplier. The Abramovsky and Griffith (2006) model posits that exogenous rises in ICT spending should be accompanied by a higher use of outsourced services, as the marginal cost of these outsourced services falls.

A more recent model by Bartel *et al*. (2014) frames the decision to outsource production (as opposed to producing the input in-house) as being largely conditioned by the speed of technological change. When the technological pace of change in providing a service such as internet design is fast, then the firm will outsource the service to a service provider. The Bartel *et al*. (2014) model and the accompanying analysis follows in the path of earlier work by Grossman and Helpman (2005). The latter argue that technology will modify the relative cost of in-house production versus outsourcing.

It should be clear that these papers see a role for the speed of technological change and/or technology investments in raising the attractiveness of services which are supplied from outside of the firm. None of these models considers the relative attractiveness of foreign versus domestic supplied services. Hanley and Ott (2012) attempt to address this gap in the literature by considering a model where firms can either (1) choose to remain purchasing their inputs in conventional ways or (2) elect to purchase some or all of their inputs on an online buyer/supplier interface. The model describes the effect of improvements in online technologies on the pricing of inputs and ultimate demand for inputs. For all firms (those remaining with conventional outsourcing methods and those choosing to use a buyer/supplier interface),

improvements in the internet cause a reduction in the price of services. This reduction in the price of services is largely due to a "competition" effect. This effect can be explained by increased competition among service providers as potential customers (firms) become more aware about the price and availability of services on offer and can choose the service which offers the best value for money. There is now a thicker market for services, in line with the stylised fact that the internet made many services such as professional services (auditing, legal, insurance, architecture etc.) tradable. Not all firms will continue to outsource services in conventional ways. There is a subgroup of firms that will start adopting internet-enabled outsourcing. Such firms invest in the buyer/supplier internet interface, an investment that does not guarantee a positive return. The effect on the ultimate amount of services outsourced is ambiguous due to a "dampening" effect, which captures the uncertainty of using the new method in a risk premium. Overall, the model predicts growth in the volume of foreign services transacted due to the competition effect where the market for international services is now more transparent and domestic buyers can pick and choose from a wider menu of suppliers. The growth in international traded services is in line with what other economists have observed for the period following the internet revolution (e.g., see Miroudot *et al.* 2009; Amiti and Wei, 2009).

III EMPIRICAL METHODOLOGY

The aim of this paper is to examine what happens to the intensity of foreign outsourcing when a firm adopts internet-enabled technologies for outsourcing. In doing so, we face a standard selection problem. If firms adopting internet-based tools to procure their services from suppliers ("Adopters") have, on average, different outsourcing intensities to begin with (compared with other firms which use conventional outsourcing methods), we might expect to see *ex post* differences in the intensities of foreign services for Adopters and non-Adopters even if Adopters had not started to adopt internet-based outsourcing tools. Adopting firms would then self-select into the Adopter group, in which case, the impact on the growth in foreign services would have less to do with the adoption of internet-based outsourcing and more to do with the inherent characteristics of the Adopter group.

The lack of statistically relevant and intuitively compelling instruments for online switching (factors prompting firms to switch to online outsourcing but which do not directly affect outsourcing growth) makes it difficult to deal with self-selection. The first step towards identifying an effect of switching to internet purchasing is, therefore, to define Adopters and Non-Adopters. To do

so, we drop from our sample all firms that use the internet already in 2002. Among the remaining firms we defined Adopters as those who start using the internet in 2003. As a second step, we investigate the impact on foreign outsourcing *growth* rather than *levels*, allowing us to abstract from unobserved firm effects correlated with the level of outsourcing.

Following Heckman *et al.* (1997), we can calculate the average effect of switching to online outsourcing on subsequent outsourcing growth.

$$E\{y^1 - y^0 \,|\, ADOPT_{it}^1 = 1\} = E\{y^1 \,|\, ADOPT_{it}^1 = 1\} - E\{y^0 \,|\, ADOPT_{it}^0 = 0\}$$

where the terms y^0 and y^1 represent foreign outsourcing intensities in the pre-switch and post-switch period respectively and $ADOPT^1$ and $ADOPT^0$ represent firms from the treatment and control groups respectively. The last term is needed in order to infer the foreign outsourcing intensities for the Adopters had they not switched (which is, by definition, unobserved). To get this term, we match each Adopter with a derived counterfactual, constructed over the distribution of non-Adopters.

We apply the STATA propensity score routine, *pscore*, based on Rosenbaum and Rubin (1983). Specifically, the first-stage probit captures the likelihood that firms switch to online outsourcing based on observable pre-switching attributes of the firm (firm size and ownership status, the firm's industry sector and lagged levels and intensity of foreign services purchased).[2] Firms from control (non-Adopters) and treatment (Adopters) groups are then assigned to strata according to the propensity score.[3] The selection probit balances firms in the treatment (Adopter) and control (non-Adopters) group on the basis of pre-existing levels of outsourced foreign services in addition to balancing on other covariates. The Adopter and non-Adopters groups are then balanced across several blocks. Figure 3 below illustrates the full continuum of switching probabilities for firms in the Adopter and non-Adopter groups on the basis of the selection probit where the area of common support is seen to be between 2.2 per cent and 26.4 per cent. In this range, the distributions of

[2] Initial levels of outsourced inputs (2002) are used to explain persistence in line with Amiti and Wei (2009). To deal with this, we include total outsourced inputs (levels) for the previous year. The positive connection between a firm's technological ability and its outsourcing intensity is captured in the R&D dummy (e.g., see Bartel *et al.*, 2014). Outsourcing intensity represents foreign factor inputs scaled by total inputs (foreign and domestic). Labour productivity and firm age were used in earlier regressions though their relative inability to explain variations in outsourcing growth led to them being subsequently dropped.

[3] The conditional independence assumption in this instance holds that firms in the control and treatment group demonstrate differing willingness/ability to continue purchasing intermediates in conventional ways versus their willingness to transact with suppliers online based on the employment size and other covariates in the selection equation.

the propensity scores for non-Adopters and Adopters overlap. There are several possible methods to implement propensity score matching. In our final analysis, we settle on three widely-used methods: Kernel Matching, Neighbourhood Matching and Caliper Matching.

The non-parametric matching estimator constructs a match for each firm that starts to outsource online using a weighted average over multiple firms which do not carry out online outsourcing. We can then estimate the growth in foreign outsourcing for firms that have begun to outsource online, and compare it to firms that decided to outsource online, subject to the standard common support assumption. Generally, we expect to see a growth in outsourced services between 2003 and 2004 as suppliers took advantage of improvements in internet speeds and coverage to set up and expand their sales.

IV DATA

4.1 *Services Outsourced over the Internet, the ABSEI and Eurostat (E-Commerce) Surveys*

We start by defining what is meant by services outsourcing. Services outsourcing are services which are supplied by an outside firm. Either the services originate from Irish-based suppliers in the data (domestic services outsourcing) or services are procured from foreign-based suppliers (foreign services outsourcing).[4] The total amount of outsourced services, therefore, corresponds to the sum of domestic and foreign outsourced services. Services could be outsourced in the conventional way, or orders for services from suppliers could be placed using internet-enabled outsourcing tools. We recall that the impact of using the internet for outsourcing on changes in the mix of foreign/domestic services forms the focus of our analysis.

Specifically, we were able to extract information on the adoption of internet-enabled outsourcing from the 2004 Eurostat *E-Commerce Survey*. Eurostat reported that by 2003, 85 per cent of firms had access to the internet. Internet penetration rates in Ireland were even higher. By 2004, 92 per cent of firms had internet access and 34 per cent of firms placed orders over the internet.[5] The Eurostat E-Commerce survey aimed to evaluate how the internet was being used within firms (Eurostat, 2005), under the reasonable

[4] Unfortunately, our measure of foreign outsourcing does not allow us to distinguish between inhouse offshore (i.e., a multinational importing services from an overseas affiliate) and outsourced offshoring.

[5] From UNCTAD aggregate statistics downloaded from the UNCTAD statistics data centre (UNCTADSTAT) at http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx

assumption that the vast majority of firms were already using the internet by the time the survey was launched. The Eurostat E-commerce survey was integrated into the *Irish Annual Business Survey of Economic Impact* (ABSEI) dataset, which we will now go on to describe.

The ABSEI data comprises a panel of Irish and foreign firms which contains, inter alia, rich information on the domestic and foreign outsourcing activities of the firms which are surveyed. The ABSEI data covers the client base of several Irish funding agencies. Client firms with 10 or more employees are captured in the data and the response rate is reasonably strong at around 60 per cent (Forfás, 2010). The ABSEI can be used to estimate the impact of adopting internet-enabled outsourcing on the subsequent growth in foreign outsourced services. The panel data can additionally be used to provide contextual information – e.g., on the economic activity of firms, their employment size and other descriptors of the firm. Specifically, we apply data on firm employment levels, NACE2 sector classification, exports and outsourcing for the period 2000 to 2004.

The E-Commerce survey was administered in the first quarter of 2004 to the IT managers of the firms surveyed (Eurostat, 2002). The reference period was for services outsourced over the internet in 2003. Information on the adoption of internet-enabled outsourcing was also available for 2002 because the ABSEI data integrates consecutive waves of the E-commerce surveys.

We will now expand on the format and sample frame of the E-commerce survey. The Eurostat framework document stipulated that the results from the E-commerce survey should be "representative". However, it gave individual countries that participated in the survey the opportunity to include supplementary questions and exercise their own discretion over the ultimate questionnaire design. Those agencies which delivered the E-commerce questionnaire were obliged to survey firms with at least 50 employees.

It should be immediately clear that the Eurostat E-Commerce survey targeted larger firms (greater than 50 employees) than the ABSEI survey (10 or more employees) and so we expect that by focusing on firms responding to the 2004 Eurostat survey there is a bias towards larger firms. This should be kept in mind when interpreting the results below.

4.2 *Characterising "Adopters", "Non-Adopters" and Data Attrition*

The question which represents the focus of our analysis was a compulsory question in the 2004 E-Commerce survey. Participating firms were asked the following question, "Has the enterprise purchased products/services via the internet?" This question corresponded to C1* in the Eurostat framework document (See Appendix 1 which provides a screen grab for the earlier wave asking the same question).

Based on this question we calculated our measure of internet transactions. Our variable, *Internet Adopters*, indicates whether the firm had used the internet to purchase inputs.

In order to differentiate firms that used the internet for the first time in 2003 to outsource inputs from a foreign or domestic supplier, we checked in the 2004 survey whether these firms had indicated that they had used the internet to outsource inputs in 2002. Firms which did not supply information on their internet purchasing for 2002 were necessarily excluded from the final analysis because only firms providing information for both years could be considered in the analysis. This exclusion was necessary because we focus on Adopters (firms using the internet to outsource inputs for the first time in 2003) and non-Adopters (Firms never using the internet to outsource inputs in the period 2002-2004 inclusive).

Appendix 2 provides a breakdown of the combined ABSEI-Eurostat data. We have information on a total of 3,192 firms for which we had ABSEI data for 2004. In this way, we can measure E-commerce activity for 2003 and relate this to increases/decreases in international outsourcing for 2004, where information on outsourcing is extracted from the ABSEI data.

Looking at the breakdown of the ABSEI/Eurostat data, 2,287 firms were discarded from the final estimation sample because they either (1) contained no information in 2004 on outsourcing patterns nor on internet-outsourcing or (2) these firms did contain information on internet-outsourcing but had been already using the internet to conduct outsourcing since before 2003. A small number of firms (69) were further eliminated from our estimation sample because they belonged in NACE Revision 2 categories with fewer than 15 firms. The latter were excluded from our estimation sample, because due to the considerable variation in firms' outsourcing across the categories of NACE2, it is imperative to control for industry sector. Additionally, the various matching estimation techniques that we later applied perform less well with small group sizes. This is because it is difficult to balance across smaller groups. Overall, therefore, our final estimation sample accounts for around 1 in 4 of all firms in the raw ABSEI data.

We then cleaned the data in the following way. The data was first deflated by applying the Consumer Price Index (CPI) to nominal variables such as *foreign services purchased* which captures the value of foreign services outsourced over the period. Following this, we generated our foreign services intensity measure by calculating the share of foreign services in the firms total spending on external services (foreign services/(foreign services + domestic services)). We also calculated the annual growth in total services outsourced for non-missing values of this variable.

Our key variable for this analysis, *Internet Adopters* was formulated as follows. Firms responding to the 2004 E-commerce survey on internet outsourcing, which had commenced purchasing over the internet by the end of 2003, were characterised as Adopters (*Internet Adopters* = 1). Firms which responded to the survey but which had continued to purchase inputs in the conventional way over the period 2002-2004, were characterised as non-Adopters (*Internet Adopters* = 0). The fact that the E-commerce survey is biased towards larger firms (we shall see this later when we examine the data), implies that any increases in foreign outsourcing for Adopters are likely to represent a lower bound for an overall effect which is likely to be higher. Our reason for making this assumption is based on the premise that smaller firms are in general less prone to outsource inputs abroad due to high costs (Tomiura, 2005) and hence may be more responsive to a positive effect from internet based sourcing.

We now examine the key variables used in our analysis. Table 1 indicates that the median firm was an Irish domestic firm (owner = 1) and non-Adopter (*Internet Adopters* = 0). Firms were indeed large, on average comprising 100

Table 1: *Breakdown of Covariates*

Stats	*Internet Adopters*	*Foreign Firm*		
Mean	0.12	1.29		
Median	0	1		
SD	0.32	0.46		
N	836	836		
Stats	*Employment 2001*	*Employment 2002*	*Employment 2003*	*Employment 2004*
Mean	104	102	101	102
Median	38	36	36	35
SD	227	229	229	239
N	742	836	836	836
Mean	0.13	0.13	0.14	0.14
Median	0.05	0.05	0.05	0.05
SD	0.20	0.21	0.21	0.21
N	742	836	836	836
Stats	*Foreign Services Purchased 2001*	*Foreign Services Purchased 2002*	*Foreign Services Purchased 2003*	*Foreign Services Purchased 2004*
Mean	4,220	4,327	6,136	7,712
Median	14	14	17	21
SD	94,353	101,137	134,269	177,825
N	742	836	836	836

employees. Approximately 13 per cent of all services were outsourced from overseas and this amount remained reasonably constant across the years. The value of foreign services increased over the period although the high standard deviation and the sizeable difference between the average and median values for this variable, *foreign services purchased*, suggests that some firms in the estimation sample were heavy users of foreign services.

In our next section, we begin our econometric analysis by applying a simple OLS regression to the data to reveal whether the start of purchasing services over the internet, was associated with higher levels of foreign outsourced services in the following year.

V ANALYSIS

We begin in Table 2 by regressing the growth in foreign services intensity (change in foreign services/total services), on the firm's employment size, ownership status, lagged foreign services intensity, lagged volume of outsourced services and NACE rev. 2-sector category.[6] For the lagged values we use values for the year 2002. We find that the adoption of the internet for outsourcing was significantly correlated with the growth in the intensity of foreign services in the subsequent year. We also find that firms with lower intensities of foreign to total services are significantly more likely to report higher growth in the intensity of foreign outsourced services. One possibility is that there is some convergence in the optimal amount of foreign services outsourced where firms with *ex ante* rates of foreign outsourced to total outsourced services show reduced growth in this measure the following year.

In estimation (2) we estimate whether the volume of foreign services increases between the two periods. The coefficient on internet adoption is positive but statistically insignificant. We also note that larger firms consume increasing volumes of foreign outsourced services. Generally, therefore, it is harder to show a link between the adoption of internet-based outsourcing and a growth in the overall volume of internationally outsourced services. The adoption of online-outsourcing appears to affect the mix of foreign to domestic outsourcing rather than the total volume of outsourced services.

The simple regression of internet adoption on the changing intensity of foreign outsourced services in the following year reveals a strong and significant association between the two variables. But is this positive

[6] In earlier versions of this paper we included a measure for export growth. This variable added little to the overall model fit, caused considerable attrition in the sample due to firms not reporting their exporting each year and was accordingly dropped from the estimations.

Table 2: *Adoption of Internet-enabled Outsourcing and Foreign Services Outsourced (OLS)*

	(1) *y:* Δ *Foreign Services Intensity*	*(2)* *y:* Δ *Foreign Services Purchased*
Internet Adopter $_{t-1}$	0.033**	0.072
	(0.014)	(0.082)
Employment $_{t-1}$	–0.004	0.039*
	(0.003)	(0.024)
Foreign firm	0.007	–0.027
	(0.007)	(0.039)
Foreign Services Intensity $_{t-1}$	–0.078***	0.095
	(0.020)	(0.107)
Foreign Services Purchased $_{(t-1)}$	0.005**	-0.055
	(0.002)	(0.023)
Sector dummies	yes	yes
Observations	836	833
R^2	0.068	0.045
Adjusted. R^2	0.0406	0.0168
Root mse	0.0940	0.540

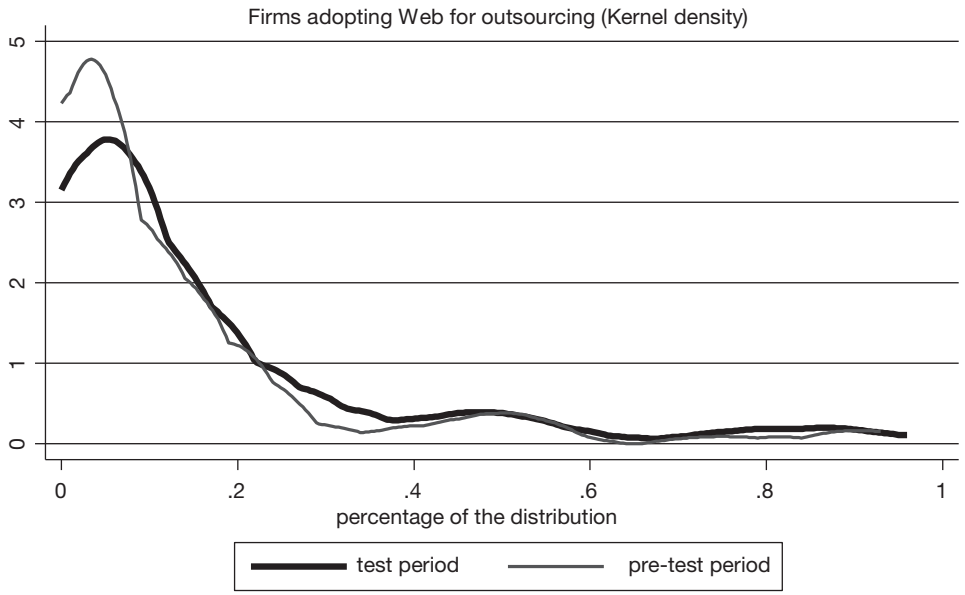
Notes: Robust standard errors in parentheses. Employment and foreign services amount logged. ***p<0.01, **p<0.05, *p<0.10. Sector dummies at NACE2 aggregation.

relationship a consequence of selection bias? In the latter case, we would expect that Adopters are *ex ante* different from non-Adopters and that these *ex ante* differences are what drive the perceived relationship. For example, what if those firms which started to use the internet to place orders with suppliers did so because the transaction costs of conventional methods were prohibitive? If this were the case, we might observe that the adoption of internet-based foreign outsourcing was a pattern seen most often in firms with low starting rates of foreign services.

We can check this possibility visually by examining the distribution of foreign outsourced services for internet-Adopters and non-Adopters for 2002 and 2004.

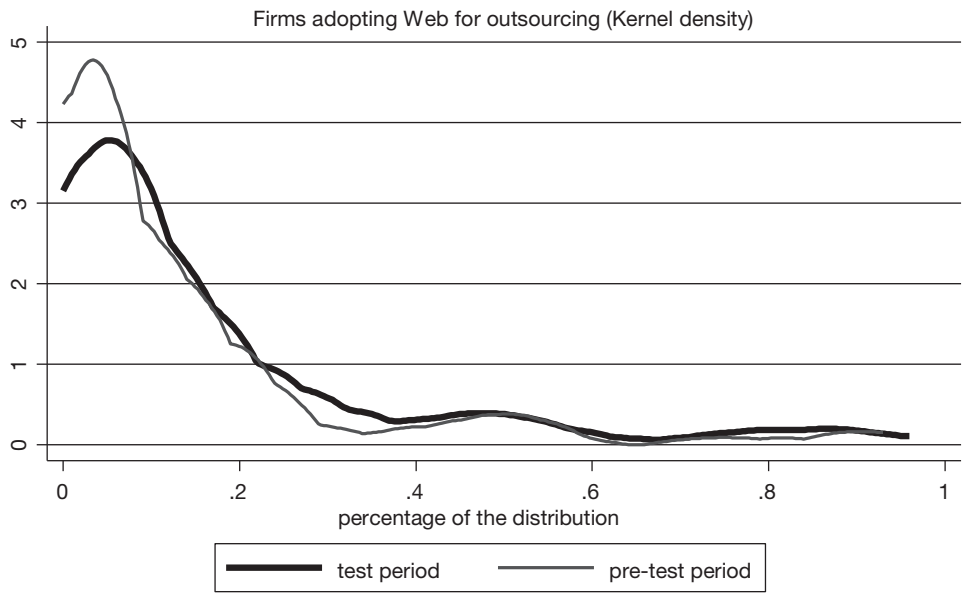
What is evident from comparing Figure 1 and Figure 2 is that firms which adopt the internet for services outsourcing have, on average, lower foreign services intensities (Figure 1) to begin with than firms which never use the internet for outsourcing. Our graphs of the foreign services distributions (kernel density) for the pre- and post-treatment period show that non-Adopters had observationally similar foreign outsourcing intensities in both periods (15.4 per cent versus 15.5 per cent) but for Adopters, the percentage

Figure 1: *Distribution of Foreign Services Outsourcing*



Note: Mean services outsourced pre-test = 11.9 per cent; post-test = 15.2 per cent.

Figure 2: *Distribution of Foreign Services Outsourcing*



Note: Mean services outsourced pre-test = 15.4 per cent; test = 15.5 per cent.

was seen to rise (11.9 per cent versus 15.2 per cent) between the pre-treatment and post-treatment periods. Therefore, it makes sense to initially model the firm's choice of internet-based outsourcing conditional on the firm's pre-test foreign outsourced services intensity because Adopters and non-Adopters exhibit *ex ante* differences in the ratio of foreign to total outsourced services. This exercise of selecting firms on the basis of their *ex ante* outsourcing behaviour (along with other attributes such as size and sector) leaves us with a more valid basis for comparing any ultimate differences in foreign services outsourcing.

Accordingly, the next step is to estimate a selection Probit regression which estimates the move to adopt the internet to outsource services (*Internet Adopter* = 0 in time t–1 and *Internet Adopter* = 1 in time t). The response variable is conditioned on the lagged share of foreign outsourced to total outsourced services and other variables which are standard in the literature such as firm size and sector. The probit regression in Table 3 shows that there is indeed a significantly negative relationship between the two variables. In other words, firms with a low starting share of foreign outsourced services in their overall basket of outsourced services are significantly more likely to

Table 3: *Decision to Adopt Internet-enabled Outsourcing (Selection Probit)*

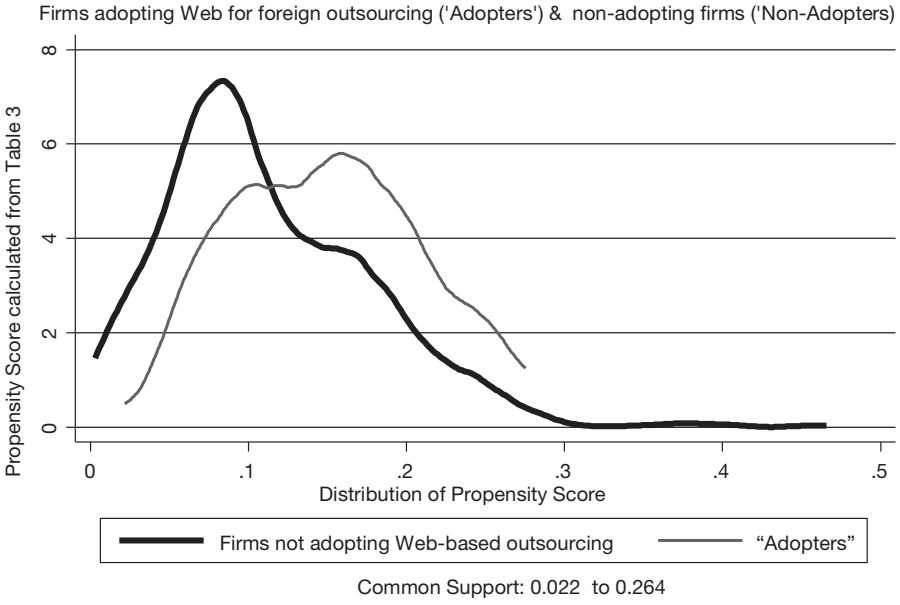
	y: Internet Adopter
Foreign Services Intensity $_{t-1}$	–0.87***
	(–2.38)
Employment $_{(t-1)}$	–0.02
	(–0.31)
Foreign firm	–0.10
	(–0.63)
Foreign Services purchased $_{(t-1)}$	–0.018
	(–0.35)
Constant	–0.29
	(–0.41)
Sector dummies	yes
Observations	836
LR chi^2(23)	29.94
Prob > chi^2	0.15
Pseudo R^2	0.05
Balanced propensity score[1]	yes

Notes: [1]Full balancing output, including for individual variables available from authors on request. Standard errors in brackets.

become Adopters. The Probit regression generates a propensity score for Adopters and non-Adopters whose distribution we can examine in Figure 3.[7]

Figure 3 illustrates the balanced propensity score for firms which do not adopt internet-based outsourcing and the group of firms which choose to adopt this practice. The area within the graph corresponding to the common support area is for the propensity score within the range 0.022 to 0.264. We subsequently estimate that only 24 firms were excluded on the basis of falling outside the common support region (See also Appendix 2), leaving a total of 812 firms for the estimation sample. We can also visually see the matching process at work in Figure 3. Here we see the largely overlapping distributions for firms which do not adopt the internet to outsource from supplier firms and those that choose to do so. We can also observe the portion of the distribution falling outside of the common support area.

Figure 3: *Distribution of Balanced Propensity Score*



Our next step is to estimate the impact of a firm's adoption of internet-based services outsourcing on the subsequent growth in the firm's share of outsourced foreign services. Table 4 applies the data to this question using a variety of propensity score matching methods. In the first estimation model we

[7] See Appendix 4 on more detail of the balancing. A full description of the balancing tests is available from the authors on request.

use Kernel Matching (KM), followed by Nearest Neighbour Matching (NN) and finally by Caliper Matching (CM). It should be noted that the number of observations in the estimation sample varies according to the method used. KM applies all observations in the estimation sample, weighted by their distance to matched firms along the Gaussian continuum. Nearest Neighbours cuts the sample down to individual Treatment group firms (100 Adopters) and picks the most statistically similar nearest neighbor. Finally, CM uses as its criteria the set of neighbouring firms which fall within a pre-specified radius.

Table 4: *Impact of Internet-Enabled Outsourcing on Foreign Outsourcing*

	Δ *Foreign Services Intensity*			
	Kernel Matching	*Kernel Matching (Blocks 2-4 only)*	*Nearest Neighbour*	*Caliper Matching*
	(1)	*(2)*	*(3)*	*(4)*
Internet adopter	0.032***	0.034**	0.040***	0.033**
	(2.253)	(1.807)	(2.35)	(2.10)
Observations	812	417	185	836
Firms that adopt (Treatment)	100	72	100	100
Firms that do not adopt (Control)	712	345	85	736

Notes: t-values in brackets. STATA procedure *attk* (Kernel matching) with common support assumption used in estimation (1). Balanced blocks (4) at propensity score cut-offs 0-9 per cent; 10-15 per cent; 15-20 per cent; >20 per cent (See Appendix 4). Common support 2.2-26.4 per cent. STATA procedure *attnd* (Nearest Neighbourhood matching) with common support assumption, random draw and 100 bootstrap repetitions used in (2). Random draw used for NN. 10 neighbours with replacement used in (3) and 50 repetitions.

We can see from Table 4 that the impact of adopting internet-based outsourcing on the subsequent growth in the intensity of foreign services outsourced is 3.2 per cent for Model (1) when we apply Kernel Matching to the full sample across the common support area. These estimates are based on the matched propensity scores that were obtained over 4 blocks (See Appendix 4 for balancing score output). One could argue that the propensity score values for the first block are different, at least at the 5 per cent level of statistical significance. Therefore, Model (2) re-estimates the output for the Kernel Matching method taking only the observations for blocks 2-3 inclusive where the tests for balancing scores pass at the 0.01 level of significance. The estimates for Model (2) reveal that the effects are much the same as before – 3.4 per cent for Model (2) versus 3.2 per cent for Model (1) – although the

t-value decreases somewhat. The t-value may have decreased in line with our exclusion of 395 firms from the estimation sample used in Model (2). Because there is such little difference between the results obtained over Models (1) and (2), we continue to estimate Models (3-4) using the full sample for the common support region 2.2 to 26.4 per cent.

The results are reassuringly similar across the different matching methods used. Summarising, the effect is 3.2 to 3.4 per cent for KM, 4.0 per cent for NN respectively and 3.3 per cent for CM. In all cases the effect is statistically significant. A further point worth noting is that the effects documented in Table 4 which are obtained from using a variety of matching methods are relatively similar to the effects obtained when using the straightforward OLS regression (3.3 per cent) method in Table 2.

VI CONCLUSION

What can we conclude from our examination of the adoption of internet-based outsourcing on the intensity of foreign outsourced services? The early years after the Millennium represented a period when firms generally explored new ways of exploiting advances in internet technology to transact with other firms. Even in 2014, the delivery of services to businesses over the internet has improved even further. For example, Blur plc. is a recently floated firm on London's Alternative Investment Market (AIM) which developed a proprietary platform (blur 4.0). This platform allows small businesses to more cost effectively outsource services from suppliers.[8]

It would be interesting, whether the usage of more recent advances in services provision, platforms such as those offered by Blur plc. further increase the competitiveness of foreign services providers versus their domestic competitors. A possible direction for future work is to examine the possible erosion of the domestic services advantage within a cross-country framework taking the size, orientation and importance of the domestic services sector into account. Ideally, data would include information on actual volumes transacted, rather than price amounts, to allow researchers to calculate the changing volumes in the amount outsourced from overseas versus from domestic suppliers.

What our results suggest is that a firm's adoption of internet enabled outsourcing slightly favoured foreign services providers, at least in the sense of increasing their share in the mix of overall outsourced services. This revealed bias towards foreign services providers makes sense if Irish

[8] http://www.ft.com/cms/s/0/6e2a9108-a12f-11e2-990c-00144feabdc0.html#axzz38HLh4kcS

outsourcers faced potentially higher costs when transacting with foreign suppliers and that the use of internet-based outsourcing technologies reduced these transaction costs. If this were the case, the adoption of internet-enabled outsourcing would have disproportionally reduced the marginal cost for outsourcers of transacting with a foreign supplier compared with the cost of transacting with a domestic supplier. In sum, the economic significance of internet-enabled outsourcing for foreign services (3.2-4.0 per cent) is non-trivial and this effect is robust to a variety of estimation methods.

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APPENDIX 1

Screengrab for the EUROSTAT E-Commerce Survey

The questions are defined in the framework document "EUROSTAT: Community survey on ICT usage (e-commerce)" as follows:

Purchases via Internet				
C1*	Has the enterprise purchased products/services via the internet during 2002 (at least 1 per cent of total purchases)? (Filter question)	Yes?	No ?	Do not know

From EUROSTAT: "Community survey on ICT usage (e-commerce) of enterprises 2003", Version of 6.11.2002, final. www.unctad.org/ecommerce/

APPENDIX 2

Breakdown of the Data

ABSEI Raw Data and Eurostat E-Commerce Survey (2004 wave)		
Total number of firms	3,192	
Exclusions:		
Missing values for outsourcing and internet-usage[1]	2,287	
NACE Revision 2: < 15 firms in industrial group	69	
Estimation sample:		
[s]"Adopters"	100	
[sn]"non-Adopters"	712	
Firms outside common support region	24	
Total estimation sample[s+ns]	812	25.4%

Notes: "Community Survey on ICT usage in enterprises (E-Commerce)", 2004 Wave.
[1] Firms which were contained in the ABSEI survey but not surveyed under the Eurostat criteria. Also firms where we have missing values in the 3-year period 2002-2004.

APPENDIX 3

Variable Definitions

Label	*Description*
Foreign Services Intensity	Total foreign outsourced services/ Total outsourced foreign and domestic services
Internet adopter	Firm adopted internet for purchasing inputs in 2003
Foreign Services purchased	Value of foreign services outsourced
employment	Number of FTE employees in firm
foreign firm	Owner is foreign (coded 2 for foreign; 1 for domestic)
s_*	NACE Revision 2, 2-digit sector dummies (manufacturing)

APPENDIX 4

Propensity Score Balancing

Block #				*Ha: diff ! = 0*	*Block Balances*
1	non-Adopters	372	0.067	0.034	yes
	Adopters	28	0.077		
2	non-Adopters	154	0.122	0.200	yes
	Adopters	19	0.126		
3	non-Adopters	127	0.177	0.753	yes
	Adopters	33	0.178		
4	non-Adopters	83	0.227	0.985	yes
	Adopters	20	0.227		