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Web use and offshoring

by Aoife Hanley and Ingrid Ott

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Web Switching and Offshoring

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July 27, 2009

Abstract

Formulating a model which summarises transportation costs, uncertainty and price, we describe how a switch to ICT procurement can impact more readily procured services rather than materials. Uncertainty represents a catch-all factor describing the dovetailing of operations between two neither culturally nor geographically proximate, independent firms.

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Introduction

The prevalence of Web based outsourcing is uncontested. Also generally accepted is the fact that services, in particular Business and Computer services have experienced international outsourcing (offshoring) growth, admittedly from a low baseline (Amiti and Wei, 2005). This growth in services outsourcing has spawned much interest in the media, Amiti and Wei counting 2,634 newspaper articles in just 5 months in 2004 for the US alone.

What is not yet fully clear is the supposed impact of the Web on the *amount* and *composition* of offshoring carried out.[1] Also missing is a compelling theoretical basis grounding the debate in the experiences of offshoring executives. The transaction cost theory while useful for motivating a 'make or buy decision' is arguably less useful for informing a debate concerning: 'buy domestic or buy overseas decision'. For this we need to formulate a new and intuitively appealing model summarising the experiences of offshoring firms incorporating elements of risk, pricing and transportation.

What do we know about ICT based procurement and what remains to be explored? First there is the issue of input type: Some preliminary evidence suggests that the *composition* of offshoring matters for productivity i.e. whether inputs are service or material (see Görg, Hanley and Strobl, 2008; Görg and Hanley, 2009). Also the current policy debate articulating the fear sparked by a rise in the *value* and importantly, the *composition*, of international outsourcing. Trefler (2005) neatly summarises this as the fear that "…the ironclad law of comparative advantage does not rule out the possibility that China and India will export high-tech goods and services to us, leaving Americans to mend the socks of Chinese business executives".

Up to now, there have been three studies attempting to calculate the effect of Internet usage on increases in offshoring (Freund and Weinhold, 2002; Bartel et al., 2005, Abramovsky and Griffith, 2006). In these studies the effect of ICT on imports or offshoring is 1 to 12 percent depending on the model used, ICT proxy and aggregation level of the data. The question is this a more vexed one than on first appearances. Studies are hampered by a high degree of firm heterogeneity. There is a danger of imputing effects where none exist.

What is the contribution of our study? We first attempt to deal with firm heterogeneity by tracking what happens to Web 'switchers' in a Difference-in-differences framework. We

[1] We use the expression 'offshoring' to denote the outsourcing of inputs from foreign markets. 'Outsourcing' refers to the outsourcing of domestic inputs.

secondly motivate our study using a model which incorporates uncertainty, transportation costs and price, all key variables cited by offshoring executives. Our model summarises these stylized facts.

Using data from the EU harmonized ICT-usage and E-commence survey for Ireland for over 2,000 firms for 3 years, we find that 'switchers' increased their share of offshored services by between 1.9 and 1.6 percent. This increase is similar in magnitude to the lower bound of 2 percent reported by Abramovsky and Griffith for the UK and the approximately 3 percent value reported for the US by Bartel et al., (2005).[2] Our results are robust to different estimation techniques and formulations of the ICT response variable. Moreover, we find a 2-3 percent reduction in the level of materials offshoring following a switch to internet procurement. This difference in our findings for services and materials offshoring cautions against adopting a broadbrush approach towards offshoring.

Our findings suggest that policy makers are right to fear, at least in the short run, for the displacement of domestically produced high value added services such as Legal and Accounting or Design by foreign suppliers. Such knowledge-rich, high value services can readily be procured over the internet. However, as Amiti and Wei (2005) point out, outsourcing is a 'two-way street', a fact which tends to be forgotten. Accordingly, the net impact of ICT enabled offshoring will be codetermined by the value of insourcing.

What we see in our data is the short run shock on services offshoring induced by a switch to internet procurement. Regarding the possible long run impact of internet procurement, this is hard to state with certainty given the length of our time window. It is worth noting that evidence from offshoring business executives describes how many firms are terminating offshoring arrangements due to quality issues[3].

Our paper is structured in this way. The next section gives a brief description of offshoring models outlined in the theory and gives evidence for the elasticity of services offshoring to increased ICT use. Then follows our model. This is followed by a Methodology section describing the Difference-in-difference approach used. After this is a section describing our data.

[2] Specifically a 13 percent change in the standard deviation of offshoring in response to a 3.84 percent increase in the standard deviation of ICT intensity

[3] Bartel et al (2005) cite from independent W.E Upjohn Institute Employer Survey on Flexible Staffing policies where 31% of firms suspended outsourcing of services because of product and service quality issues

The penultimate section presents the results of our analysis and the final section concludes with some comments on the implications of our findings.

Background

ICT usage and the type of input offshored

There is a general consensus in the theory that only certain inputs lend themselves to offshoring. It follows that the switch to ICT procurement, should only affect such traded services as Accountancy rather than Building and Construction. Bartel et al. (2005) support this intuition. They argue that the adjustment costs of outsourcing services such as Buildings Repair are unlikely to be affected by the final goods producer's use of ICT and we should not expect to observe any affect of switching to internet procurement for such services. Services such as Legal and Accounting where we would expect to find an effect of ICT use on procurement belong more in the category of 'offshorable services'. According to Bartel et al;

"The plausible complementarity between the IT-level of the service and the IT level of the user implies that the reduction in user costs is larger for more IT-intensive services". [pp. 15]

Accordingly, our study focuses on offshored rather than outsourced services. Hence the defining issue is whether the service is tradable. With materials, the dichotomy between what is tradable and what is not is less clear-cut, but nonetheless there is an intuitive reason to argue that transportation costs affect the tradability of material inputs differently. Since all services (tradable and otherwise) can theoretically be outsourced, but only a subset of these cost-effectively offshored, and here we expect to see ICT procurement most effectively applied, we limit our analysis to offshored inputs. This distinction is helpful in an island economy such as Ireland, surrounded by 'shores', transportation to which involves a non-trivial cost. Given that we use Irish data, we need to be clear on this point.

There is also a growing consensus view in the literature that it is correct to impute different effects on firm performance characteristics (e.g. productivity) from offshoring service vis-à-vis material inputs. A raft of existing studies makes this distinction. It is plausible that ICT usage confers more of a boost to offshored service than material inputs, given the much vaunted idea that ICT has prompted a 'service tradability revolution' (UNCTAD, 2004). On the issue of by how much more, the literature is silent.

Accordingly, the theory has something to say about the type of input which appropriates itself best to ICT enabled offshoring. Much of this work sits in the transactions cost literature. Here ideas of trust (read 'information leakage' in the theory) and generality of application (read 'asset specificity' in the theory), have been the subject of much theoretical research. Representative papers include Grossman and Helpman (2002), Bartel et al. (2005) and Baccara (2005). Depending on the specifics of the respective theory, the cost in question changes but there is some consensus: the costs of contracting should vary across input type because of the degree of input specificity in each case. Irrespective of whether we are dealing with material or service inputs, if a provider/ supplier is required to invest much time and effort tailoring the input, arm's length supply is not the wisest, nor most cost effective option. Therefore, generic inputs are best suited for offshored procurement. Likewise, inputs requiring a high degree of secrecy are unsuitable for offshoring (Baccara, 2005). If they are offshored, firms have to make provision to secure confidentiality, and guard against information leakage. These extra measures introduce a further source of heterogeneity in the cost of outsourcing for different firms.

ICT usage and the cost of transacting

What does the theory have to say (directly or more likely indirectly) about the predicted effect of a switch to ICT based procurement and hence reduction in transactions costs? Abramovsky and Griffith (2006), applying a standard Grossman and Helpman model of transaction costs offer general predictions on the returns to offshoring with ICT usage. They argue that outsourced services must be complementary to the firm's core activities. When we think in terms of such core, as opposed to ancillary services, demand for services must represent a fixed proportion of total output produced by the firm $S = \alpha Y$. The firm sets out to minimise production costs by choosing an optimal mix of inhouse and external services. The cost of outsourced services is made up of the market price for the service and an adjustment cost (the cost of incomplete contracts, plus monitoring and search costs). Bartel et al. (2005) elsewhere state that these adjustment costs are non-trivial.[4] As transactions costs are predicted to fall with ICT usage, the volume of these transactions is predicted to rise. Using firm level data on externally purchased services for the UK, they report that for every 1 percent increase in the proportion of firms using the internet, outsourcing should increase by 2 percent.

Using an augmented transaction cost model, Bartel et al. (2005), add the speed of technical change and fixed costs of technology adoption to their transaction cost model. Their model

[4] See Grossman and Helpman (2005) for a discussion about adjustment costs

predicts that changes in levels of technical know-how should not affect amount of services outsourced. The effect, rather, is second order (speed of change). This is due to the amortisation of fixed costs.

Bartel et al. find a significant and negative effect of ICT based services on levels of services outsourcing. Services we would consider non-tradable e.g. Janitorial Services, do not show this effect. The magnitude of the effect is a 13 percent increase for a change of 3.84 percent in ICT intensity, equivalent to a 3 percent effect for a 1 percent change in ICT intensity. This is close to the lower value observed in Abramovsky and Griffith (2006).

Freund and Weinhold (2000) apply a sunk cost model to exporting trade flows. Using aggregate trade data, they find that a 10 percent increase in their internet variable (number of internet host sites opened) is associated with a 1.7 percent increase in traded services. They do not differentiate distinguish however.

Model

Our model summarises some stylized facts that emerge from surveys of offshoring firms. We first motivate our model by outlining what the main determinants of offshoring are as gleaned from survey and anecdotal evidence. Transport costs are a main driver of offshoring. If the price of crude oil reaches $200, sending a container from Shanghai to New York costs $15,000, an increase of $12,000 since 2000.[5]

A further main determinant of whether offshoring is a viable option is the issue uncertainty. The uncertainty involved in transacting with foreign partners is cited as a key problem, in surveys of firms involved in offshoring.[6] By uncertainty, we mean the dovetailing of the domestic firm and independent foreign firm's operations with implications for the quality of intermediates, timeliness of delivery, quality of communication between the contracting firms and success in dealing with human relations, project reward and risk sharing issues within both firms. These are the uncertainties spelled out as relevant by offshoring executives today. In many ways, uncertainty is analogous to the high adjustment cost highlighted in the transaction cost literature. And yet despite uncertainty, firms are still attracted by the lure of cost savings through cheaper

[5] USA Today, 08.12.2008, 'Transport costs could alter world trade'

[6] See survey evidence cited by offshoring consultants AT Kearney: Offshore Success Study. Also the W.E Upjohn Institute Employer Survey on Flexible Staffing policies where 31% of firms suspended outsourcing of services because of product and service quality issues

intermediates. Suppliers in countries such as India possess sufficient scale and specialisation to competitively price inputs such as programming code and diagnostic tests.

Therefore, the key drivers crystallised from discussions with offshoring firms are transportation costs, uncertainty (a catch-all factor incorporating the streamlining of operations between two non-culturally nor geographically proximate, independent firms) and price. We attempt to formulate our model in the context of these key factors.

Foreign and domestic inputs

A domestic firm produces output $X(v_{ij})$ under perfect competition and sell the final product at the market price, p. In a business-to-business transaction, inputs are sourced for production by the firm. These inputs (intermediates) comprise materials, v_m, and services, v_s, either of which may be purchased either on the domestic market (subscript d) or from foreign markets (subscript f). Foreign and domestic inputs are perfect substitutes

$$v_m = v_{md} + v_{mf} \tag{1a}$$

$$v_s = v_{sd} + v_{sf} \tag{1b}$$

The firm is risk averse and maximizes its profits

$$\Pi = pX(v_{ij}) - \sum q_{ij}\, v_{ij} \tag{2}$$

with qij denoting factor prices for both inputs ($i = m, s$) that might be either purchased at the foreign or at the domestic market, $j = f, d$. Demand of materials and services (as measured by their amounts/sales) are determined by their respective price: the higher the price a firm has to pay, the lower demand. Offshoring of factors takes place whenever the foreign input acquisition is cheaper than the domestic acquisition and vice versa. We assume that factor prices of domestic inputs are well known and denoted by q_{md}, q_{sd}. In contrast, factor prices for foreign inputs incorporate uncertainty. An immediate consequence is that firms calculate a corresponding risk premium, ψ_{mf} , ψ_{sf}, for each factor bought abroad which captures all parts of uncertainty, e.g. lack of reliability and predictability (which is exacerbated with increased physical or cultural

distance) or uncertain quality (but this argument is less important if standardized inputs are used). This risk premium can be understood as the catch-all variable distilled from surveys of offshoring executives who acknowledge how uncertainty rises with increased physical/ cultural distance. Additionally, offshoring is accompanied by transportation costs, t_m, t_s, for both types of input. Hence firms that offshore factors have to consider several components determining the actual price of foreign inputs: the expected factor price, a risk premium and transportation costs. Equilibrium demand results from profit maximization of (2) and requires that the value of the marginal factor productivity equals the price of the respective factor. Then, demand for foreign inputs is determined according to

$$q_{mf} \equiv p\frac{\partial X(\cdots)}{\partial v_{mf}} = E[q_{mf}] + \psi_{mf} + t_m \quad (3a)$$

$$q_{sf} \equiv p\frac{\partial X(\cdots)}{\partial v_{ms}} = E[q_{sf}] + \psi_{sf} + t_s \quad (3b)$$

To summarize: if factor prices incorporate uncertainty, then the expected value of the firm's profits is maximized if the value of the marginal productivity of each input (services and materials) equals its expected factor price plus a risk premium and transportation costs. All these components might vary between the respective factors.

The decision to offshore inputs

Web use is a necessary but not a sufficient condition for off-shoring inputs thereby indicating that firms who use the internet are not necessarily web users but that those firms that are offshoring inputs necessarily use the internet. Offshoring takes place whenever foreign acquisition is cheaper than utilizing domestic inputs. All things being equal, the following logic applies: If foreign input acquisition is cheaper than the use of domestic inputs ($q_{if} < q_{id}$), then demand for foreign inputs increases, all things equal. As a consequence the ratio of foreign inputs to total inputs increases. Analogously, if foreign inputs are more expensive ($q_{if} > q_{id}$) demand decreases and the ratio foreign inputs/total inputs also declines. The basic logic assumes that the components determining the actual factor price of foreign inputs as given in (3) differ with respect to services and to materials. As a consequence both inputs react differently to the option of offshoring and it is quite plausible to argue that demand for materials might decrease while demand for services might

increase as a consequence of web use. In doing so we compare the firm's two options 'purchasing foreign inputs' vs. 'purchasing domestic inputs' to analyze whether demand for an input increases or decreases as a consequence of offshoring. A graphical illustration is given in Figure 1.

[figure 1 here]

Explanation why demand for materials might decrease as a consequence of web use

The convex function illustrates marginal productivity of foreign materials (see Figure 1(a) for a graphical illustration). This equals the marginal productivity of domestic inputs as both are perfect substitutes. The initial situation, i.e. of no web use and hence no offshoring, is described by the domestic price of materials, q_{md}, and the corresponding amount of domestic materials, v_{md}. Web use gives the firm greater ease in procuring foreign materials. The price of foreign materials is composed of the components $E[q_{mf}]+ \psi_{mf}+t_m$ as argued in (3a). It is plausible to assume little factor price uncertainty with respect to materials and $E[q_{mf}]+\psi_{mf} \cong q_{md}$. Generally, web use facilitates greater access to information on foreign input prices. Since materials are already quite standardized, e.g. the DIN standard, it is quite plausible that there is already an equalization of factor prices among all countries irrespective of increased web use. Consequently factor prices for materials will be equalized among countries, independent of web use. Put differently, a switch to web use will not decrease the factor price to a significant extent. The decision in favor or against offshoring will then mostly be driven by transportation costs. These costs are positive for goods that have to be shipped, $t_m > 0$, and might amount to a significant component of the total factor price. Another similar intuition supporting differing elasticities to web use by input type, is the nature of services and how the quality of a service is only readily established once it has been consumed. This intuition is based on the argument that services are typically experience goods. Uncertainty is arguably most acute for non-standardised, services which are burdened with the 'experience-good- tag'.[7] A similar argument can be advanced for transacting in material inputs where there is an adjustment period as a sourcing firm gets to know its partner's quality, often building up ordering incrementally. Rauch and Watson (2003) summarize this literature in the context of asymmetric information and learning models and Watson's (1999) multi-period model with renegotiation. It makes sense that offshoring firms may attempt to reduce their risk

[7] Uncertainty between transacting partners can also be exacerbated by other issues documented in Rauch and Watson (2003) such as the technology gap between the partner countries.

exposures by establishing their partner firm's quality in a multi-period setting, with reduced first round ordering involving low fixed costs. The issue here is about the *magnitude* to which uncertainty differs for material and service inputs. The uncertainty about an input's quality is likely to be most pronounced for non-standardized service inputs. Services may well conceivably also lend themselves to small volume first time ordering in the same way as has been demonstrated for material inputs. Material inputs being standardized are less subject to this issue of quality uncertainty, however.

To summarize: due to transport costs and uncertainty, foreign materials are more expensive than domestic ones and demand for them decreases as a consequence of web use. Altogether the ratio of foreign materials to total materials declines.[8]

Explanation why demand for services might increase as consequence of web use

Analogously, the initial situation with no web use and hence no offshoring, is described by the input price for services, q_{sd}, and the corresponding quantity, v_{sd} (see Figure 1(b) for a graphical illustration). Similarly to materials, the price for foreign services includes the components $E[q_{sf}]+ \psi_{sf} + t_s$ as argued in (3b). It is plausible to assume that the price for foreign service inputs is less than that for domestic inputs, $E[q_{sf}]+ \psi_{mf} < q_{sd}$, due to the following reasoning: Usually services are knowledge intensive and the price is determined by the cheapest country at any point in time. Compared to materials, services generally are not standardized to the same extent and hence the assumption that foreign services might be provided at lower costs than domestic services is quite probable. Additionally, as a consequence of web use, any service that can be digitized can now be 'shipped' at (almost) zero cost, and $t_m \rightarrow 0$.[9] To sum up, as long as $E[q_{sf}]+ \psi_{sf} + t_s < q_{sd}$, foreign services are cheaper than domestic ones. Then demand for them increases accordingly as a consequence of web use and the ratio of foreign service inputs to overall service inputs declines.[10]

[8] It should be noted that even firms which do not switch, benefit from the decline in material prices.

[9] However, there exist services that involve high transportation costs, namely those which require lots of face-to-face contacts. Then the same reasoning as in case of materials applies and transport costs may amount to a significant determinant of the overall factor price.

[10] It should be noted that firms that do not switch, fail to benefit from the decline in service prices. This is in contrast to the case for materials.

Methodology

Our model in the previous section sets out the context for modelling the elasticity of offshoring to a shock which reduces the uncertainty in transacting with an overseas supplier. Such a shock would evidenced in the case of a firm switching to ICT procurement, having up to then never used ICT enabled supply. This decision can be framed methodologically as a 'switching' one where we look at average effects within the group of 'switchers' and 'never switchers', difference these effects for pre- and post-switch. Not only do we difference for effects *within* the groups, but also *between* the groups, hence the 'Difference-in-Difference' framework.

What are the advantages of using a Difference-in-difference methodology to augment our standard OLS framework? Meyer (1995) gives several reasons why our chosen framework improves the internal validity of our model. Continuous variables such as sales have already been deflated to reduce artificial variation in these variables over time. However, even such cleaning measures do not guarantee that omitted variables could nevertheless lead us to impute a spurious effect to the treatment variable. These omitted variables may well be events not captured in the model that have nothing to do with the treatment effect but are correlated with it. An example of where such an omitted variable would bias outcomes in our case would be where an independent Government action to raise knowledge of firms about overseas suppliers materialised at the same time that most firms switched to overseas procurement. In order to neutralise the effect of such omitted variables their implications for the joint determination of outcomes, we opt for this Difference-in-Difference approach.

Using this approach, the percentage of offshored to total outsourced inputs *y* is now formulated as;

$$offshoring_t^j = \alpha + \alpha_1 d_t + \alpha^1 d^j + \beta d_t^j + \varepsilon_t^j$$

where d_t are the time dummies, d^j is the firm fixed effect and d_t^j corresponds to the 'switcher' effect (j = 0, t = 0 representing 'non-switcher' pre-treatment and j = 1, t = 0 denoting 'switcher' pre-treatment) where we expect to evaluate differences once the treatment effect commences and t switches to 1. We can decompose this expression into differences in average effects as follows;

$$\hat{\beta}_{dd} = \Delta \bar{y}_0^1 - \Delta \bar{y}_0^0 = \bar{y}_0^1 - \bar{y}_0^1 - (\bar{y}_0^0 - \bar{y}_0^0)$$

Essentially, this method involvese subtracting pre- and post treatment period average effects for firms in the treatment and control group.[11] These differences are then in turn further differenced in order to calculate the pure effect on the response variable induced when 'switcher' firms start to offshore using the web.

To summarise, the key idea with this approach is that time specific problems, e.g. Government support for offshoring initiatives, are screened out. α_1 summarizes how both treatment and control groups are affected such an outside shock. Any time invariant difference in overall means between the two groups is captured in the coefficient α^1.

As well as capturing the switching phenomenon, we control for several other covariates in order to reduce the amount of inter-firm heterogeneity. Similar to Abramovsky and Griffith (2006), the most similar study to ours, we include a foreign ownership dummy as well as a control for employment size. Similar to the former, we also include a full set of industry and time dummies.

Data

We use plant level information from data collected by Forfás, the Irish policy and advisory board with responsibility for enterprise, trade, science, and technology in Ireland. Specifically, our data source is the Annual Business Survey of Economic Impact (ABSEI), covering the period from 2000 until 2004. This survey extracts information on many dimensions of firm performance. Importantly for this study, the survey also included questions on ICT usage for the period 2002 to 2004. These ICT questions were harmonized across the EU for comparability and some recent work is now emerging for other EU member states using this data.[12]

[11] Averages are calculated as the average within firm effect i.e. fixed effect

[12] See 'Information society: ICT impact assessment by linking data from different sources', Eurostat Report, August 2008 with contributions for Sweden and Italy by Hagsten and Svanberg (2008) and de Panizza (2008) respectively.

Since the ICT variables were covered only in the period from 2002 (although we had data from as early as 2000), we had 3 years of ICT coverage data in our sample frame.[13] The ABSEI survey is an annual survey of plants in Irish manufacturing with at least 10 employees, although a plant, once it is included, is generally still surveyed even if its employment level falls below the 10 employee cut-off point. The response rate is estimated by Forfás to be around 55 to 60 percent of the targeted population per year. This data contains information on services purchased, distinguishing between imported and domestic service inputs. Further data available from this source that is relevant to the current paper are total sales (as a measure of output), employment, exports, nationality of ownership and the four digit sector of production.

Data cleaning and variable generation

We started with the initial balanced panel comprising 3 years of data (2002 – 2004) where we have information about the ICT activities of the firms surveyed. All continuous variables in our data containing nominal values such as sales were deflated by multiplying by the appropriate index in each case.

Some variables used in our analysis had to be generated from the raw data. Our most important generated variable, 'any_web_trans' denotes whether a firm used the internet to carry out either sales or purchases. One novelty of our paper is the ability of our data to identify 'switchers'.

To identify 'switchers', we needed to identify 3 groups of firms. The first was the set of firms who had always used the internet from the beginning of our records. The second set of firms was those who had never used the internet at any stage within our records. The final set of firms, a subset of whom we identified as switchers, moved to internet procurement during the 3-year time window. We see from Table 1, that 45-49 percent of our sample (firms using the Web for any transactions or purchases respectively) needed to be discarded on the basis of always continuously using the internet during the sample period. Our control sample comprising the 'never switchers' form a group of 45-49 percent of the sample population. These were retained as

[13] Similar data is available for other European member countries. See 'Information society: ICT impact assessment by linking data from different sources', Eurostat Report, August 2008 with contributions for Sweden and Italy by Hagsten and Svanberg (2008) and de Panizza (2008) respectively.

a benchmark against which to compare our 'switchers'. 'Switchers' comprised 9-10 percent of the firms surveyed. The criteria for categorisation as a 'switcher' was non-use of the internet for the ICT activity in the first year of our analysis window (2002) followed by a move to the ICT activity in either of the following 2 years, 2003 and 2004 respectively.

[Table 1 here]

We now report some breakdowns for the firms which were used in our subsequent regressions. In Table 2, we examine whether the composition of services and materials offshoring respectively varies across the 'switcher' and 'never switcher' group. What we see from the table is very little difference between the test and control group. In terms of the average level of services offshoring, the 'switcher' sample registers slightly higher levels (14 percent viz. 13 percent) but this is unlikely to be statistically significant given the high standard deviation in these levels. Another aspect of the services offshoring breakdown worth noting is that there is a large difference between the median and mean offshoring levels. This hints at some firms being heavily involved in services offshoring, their high offshoring intensity driving up the average value. There is more homogeneity within the materials offshoring data where we observe a close correspondence between mean and median levels. As we will note in the next section when commenting on the sectoral breakdown of the data, far more firms are involved in materials as opposed to services offshoring. This aspect of offshoring is not new and is consistent with other studies. Despite the relatively low levels of services offshoring compared to materials offshoring, these levels reported for the Irish data are high in an international context. Amiti and Wei (2005) point out that Ireland is ranked number one on the list of *industrialised* countries outsourcing business services.[14]

[Table 2 here]

From Appendix 1a and 1b we see that there is considerable sectoral variation in the amount of service and material offshoring carried out in Ireland where we report values for offshored intermediates (as a proportion of total outsourced intermediates) for the pre-switch year of 2000. The Chemicals sector heads the list for imported services with on average 22 percent of all bought-in services procured from foreign markets (Appendix 1a). This mean value is inflated by some large values and so the median value of 10 percent gives a truer reading of the average firm's procurement from foreign markets. A much higher proportion of materials is offshored with the median firm in the Textiles sector offshoring as much as 80 percent of its total materials

[14] Compare this with 1.03 percent for the UK and 0.39 percent for the US (Amiti and Wei, 2005).

(Appendix 2b). What is interesting when comparing the proportions of offshored to total outsourced inputs, is the much higher ratio reported for materials offshoring. It is clear that Ireland is a small, open economy, very much dependent on overseas markets for material intermediates. What is also clear is that the provision of services is largely dominated by domestic providers. Of course, other studies have similarly shown that services offshoring is largely a minor activity, albeit a fast growing one (See Amiti and Wei, 2005).

Analysis

In this section we estimate offshoring of services and materials, applying in turn random and fixed effect estimators. We then check for whether there are a priori differences between the 'switcher' and 'non-switcher' group in terms of average differences in offshoring year in the year cross-section before the two year test window commenced. The third part of this section reports the predicted percentage differences in offshoring for both groups, test and control on the basis of our regressions.

In Table 3 we report our findings for the impact of switching to internet use for offshoring of services and materials respectively. Columns 1 and 2 report the results for firms citing internet use for any (sales or purchase) transactions and columns 3 and 4 for firms citing internet as exclusively a purchasing tool. Irrespective of the purpose for which the internet is used ('any transactions' or 'purchases'), the result is the same: switching to the internet is associated with an increase in the level of services offshoring. The same cannot be said for materials offshoring, where the sign on the 'switch' coefficient is negative and insignificant.

[Table 3 here]

We now comment briefly on the remaining covariates. All behave in line with expectations, where firms with higher labour productivity, higher international sales ratios, larger and foreign owned firms registering significantly higher offshoring for both services and materials inputs.

Table 4 reports our findings using the fixed effects estimator, again including the 'switch' variable. As described earlier, this formulation of the model is equivalent to a Difference-in-difference approach summarised in the Methodology section. It estimates the within firm change

of a move to internet procurement, all other things held constant. As is typical in the case of fixed effect estimations, the fixed effect estimator tends to neutralise all other dummy variables such as foreign ownership. This is because there is no variation within each firm of variables such as sector and foreign ownership.[15] In general, the fixed effect estimator has a moderating effect on all the covariates, due to the low levels of intra-firm variation within covariates such as international exports, as opposed to the high inter-firm variation witnessed earlier in the random effects estimator.

[Table 4 here]

Predicted effect of switching on offshoring and comparisons with literature

Notwithstanding these qualifications, the switch variable remains robust to the fixed effect estimator. Similar to the earlier results for the random effects estimator, the effect of switching to the internet on offshoring of services is between 1.9 and 1.6 percent, depending on the stated purpose of the internet (all transactions or purchase transactions only). We recall that Abramovsky and Griffith (2006) reported an approximately 1.3 percent increase offshored service inputs following a switch for UK data in their OLS estimations. In Bartel et al. (2005), the magnitude of the effect is approximately 3 percent for outsourced services (13 percent change in standard deviation / 3.84 percent change in internet intensity). Our reported values are much more in line with Abramovsky and Griffith (2006) and Bartel et al. (2005) than the 0.17 percent increase reported in Freund and Weinhold (2000).[16] The corresponding effects for materials offshoring show not only a fall, as seen earlier in the estimations with random effects, but this time the decrease is significant.

Finally, we summarise what our regressions predict for the average effects on offshoring brought about by switching to internet based procurement. Table 5 reports the findings for services offshoring. The results for the fixed effects estimator are more pronounced than those reported

[15] For longer periods of data, arguably this assumption would no longer hold because we would observe some within firm variation in the indicator variables as firms get taken over or even migrate to different sectors

[16] The latter find that a 10 percent increase in their internet variable (number of internet host sites opened) is associated with a 1.7 percent increase in traded services

for the random effects estimator. In all, a 1-2 percent increase in services offshoring is predicted depending on the estimator used.

[Table 5 here]

Figures 2 to 5 illustrate graphically what is happening in terms of the distributions of the predicted values (kernel density estimates). The peak of the distribution in Figure 2 which charts the predicted distribution for the switch to internet for services offshoring (any transactions motive), migrates from below 10 percent (red arrow) to above 10 percent (green arrow). Similarly, the remaining figures show to what extent the population peak moves to the right as a firm switches to internet based procurement for internationally traded services.

[figures 2 to 5 here]

Table 5 reports the corresponding predicted effects for materials offshoring. In all a 2-3 percent decrease in materials offshoring is predicted, again dependent on the estimator used.

Are 'switchers' laggards to begin with?

It is worthwhile to conclude by commenting on how different were 'switchers' and 'non-switchers' to begin with in terms of starting levels of offshoring. In Table 7 we estimate an OLS for the 2002 cross-section. From the results, it is apparent that 'switchers' were laggards in terms of their initial services offshoring. Therefore perhaps, any improvements which are induced by switching to internet procurement may serve to bring about convergence rather than confer any advantage. There is some evidence that 'switchers' offshore materials more intensively than their counterparts in the control group.

Conclusion

Building a model which summarises key offshoring drivers as reported in surveys of offshoring firms (i.e. transportation costs, uncertainty and price), we describe how the elasticities for offshored services to web use may differ from the elasticities for offshored material inputs to web use. Uncertainty represents a catch-all factor which describes the dovetailing of operations between two non-culturally nor geographically proximate, independent firms.

We then apply our model to a balanced panel of data for 'switchers' and 'non-switchers'. We use data from the EU harmonized ICT-usage and E-commence survey for Ireland, and find that 'switcher' firms report increases in services offshored by between 1.9 and 1.6 percent, depending on the estimation technique. This increase is reassuringly similar in size to the predicted increases of approximately 2 and 3 percent reported for the UK and US respectively. Our results are robust to different estimation techniques and formulations of the web response variable. Unlike other work which is confined to offshored services only, we additionally report a 2-3 percent *reduction* in the level of materials offshoring following a switch to internet procurement.

Our difference in results for services and materials offshoring cautions against a 'one model fits all' approach to inputs procurement and suggests instead that if we want to ultimately make predictions as to the hollowing out of production, we should instead estimate separate models for different input types. It underscores the model predictions that we expect different elasticities to ICT use for offshored service and material inputs. Much of this difference in results may be due to the role of uncertainty, (streamlining of operations between two neither culturally nor geographically proximate, independent firms), which is less acute as ICT enabled communications between partners improve.

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Table 1 Breakdown of EU harmonized ICT-usage and E-commence survey for Ireland

	Year				
	2002	**2003**	**2004**	**Total**	**% sample**
Firms that used web for transactions					
Never switched to web	1,452	1,452	1,452	4,356	45%
Switched to web during the time period	326	326	326	978	10%
Had switched from before start of data				4,299	45%
Firms that used web for purchases					
Never switched to web	1,587	1,587	1,587	4,761	49%
Switched to web during the time period	297	297	297	891	9%
Had switched from before start of data				3,981	41%

Note: Data provided by Forfás

Table 2 **Descriptive statistics for 'Switchers' and 'Never Switchers'**

	Services offshoring						Materials offshoring					
	'Never switchers'			**'Switchers'**			**'Never switchers'**			**'Switchers'**		
	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004
mean	13%	13%	13%	N/A	14%	14%	48%	47%	48%	N/A	50%	50%
median	5%	5%	5%	N/A	5%	5%	50%	50%	50%	N/A	56%	50%
Standard dev.	21%	21%	22%	N/A	22%	21%	38%	38%	38%	N/A	39%	37%
Number of obs.	1,463	1,505	1,166	N/A	183	303	1,265	1,286	999	N/A	158	265

Note: Offshoring defined as % international input/ total outsourced input

Table 3: Effect of Switching on Offshoring: Panel OLS with Random Effects

	Web used for any transactions		**Web used for purchases**	
	(1) Offshored services	(2) Offshored materials	(3) Offshored services	(4) Offshored materials
Impact following switch	0.019**	-0.020	0.015*	-0.017
	(0.008)	(0.015)	(0.008)	(0.015)
Productivity (sales_pw)	0.011***	0.007	0.011***	0.009
	(0.003)	(0.008)	(0.003)	(0.007)
Logged employment size	0.012***	0.011*	0.013***	0.012*
	(0.004)	(0.007)	(0.004)	(0.006)
ROW exports to sales	0.004***	0.008***	0.004***	0.008***
	(0.001)	(0.002)	(0.001)	(0.002)
Foreign owned firm	0.086***	0.153***	0.090***	0.148***
	(0.013)	(0.024)	(0.013)	(0.023)
Sector dummies	yes	yes	yes	yes
Time dummies	yes	yes	yes	yes
Constant	0.055	-0.004	-0.111**	0.259
	(0.108)	(0.036)	(0.043)	(0.225)
Observations	4622	4010	4891	4224
Number of firms	1717	1507	1818	1589

Notes: Robust standard errors in parentheses. Errors clustered within firm. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4 Effect of Switching on Offshoring: Panel OLS with Fixed Effects

	Web used for any transactions		**Web used for purchases**	
	(1) Offshored services	(2) Offshored materials	(3) Offshored services	(4) Offshored materials
Impact following switch	0.019**	-0.029*	0.016**	-0.027*
	(0.008)	(0.016)	(0.008)	(0.015)
Labour productivity	0.002	0.011	0.002	0.015
	(0.003)	(0.012)	(0.003)	(0.012)
Logged employment size	-0.003	0.015	0.000	0.020
	(0.009)	(0.014)	(0.008)	(0.014)
ROW exports to sales	-0.003	0.007*	-0.003	0.006*
	(0.002)	(0.004)	(0.002)	(0.003)
Foreign owned firm	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Sector dummies	yes	yes	yes	yes
Time dummies	yes	yes	yes	yes
r^2				
Wald $\chi 2$				
Pr > Wald $\chi 2$				
Constant	0.116***	0.410***	0.107***	0.369***
	(0.039)	(0.083)	(0.037)	(0.086)
Observations	4623	4011	4898	4230
Number of firms	1717	1507	1820	1591

Notes: Robust standard errors in parentheses. Errors clustered within firm. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5 T-tests for regression generated means: services offshoring

	All transactions motive							
	Random effects				Fixed effects			
	Obs	Mean	Std. Err	Std. Dev	Obs	Mean	Std. Err	Std. Dev
Never switched	4,212	0.13	0.001	0.0628	4,212	0.13	0.0002	0.0104
Switched	493	0.14	0.0027	0.0601	493	0.15	0.0004	0.0099
combined	4,705	0.13	0.0009	0.0626	4,705	0.13	0.0002	0.0118
difference		-0.01	0.003			-0.02	0.0005	
	Test statistic: -4.1923				Test statistic: -36.5710			
T-tests	Ha: diff < 0 = 0.00				Ha: diff < 0 = 0.00			

	Purchasing only motive							
	Random effects				Fixed effects			
	Obs	Mean	Std. Err	Std. Dev	Obs	Mean	Std. Err	Std. Dev
Never switched	4534	0.13	0.001	0.0661	4534	0.13	0.0002	0.0104
Switched	449	0.14	0.0029	0.0608	449	0.15	0.0005	0.0102
combined	4983	0.13	0.0009	0.0657	4983	0.13	0.0002	0.0113
difference		-0.01	0.0032			-0.02	0.0005	

Table 6 T-tests for regression generated means: materials offshoring

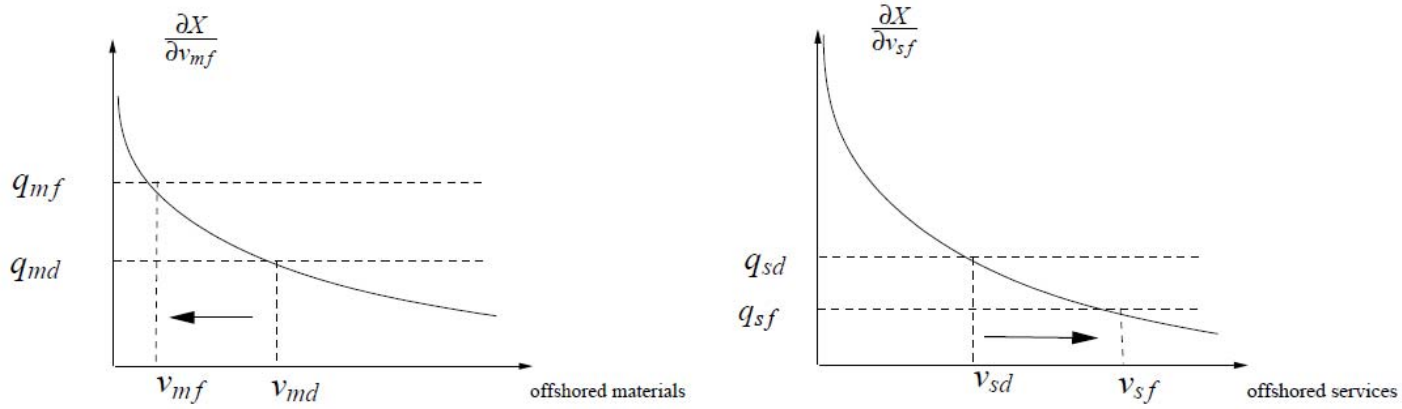
	All transactions motive							
	Random effects				Fixed effects			
	Obs	Mean	Std. Err	Std. Dev	Obs	Mean	Std. Err	Std. Dev
Never switched	4216	0.47	0.00	0.16	4216	0.48	0.00	0.03
Switched	494	0.45	0.01	0.14	494	0.45	0.00	0.03
combined	4710	0.47	0.00	0.16	4710	0.48	0.00	0.04
difference		0.02	0.01			0.03	0.00	
	Test statistic: 2.9706				Test statistic: 16.8290			
T-tests	Ha: diff > 0 = 0.0015				Ha: diff > 0 = 0.00			

	Purchasing only motive							
	Random effects				Fixed effects			
	Obs	Mean	Std. Err	Std. Dev	Obs	Mean	Std. Err	Std. Dev
Never switched	4539	0.47	0.00	0.16	4539	0.48	0.00	0.04
Switched	449	0.45	0.01	0.14	449	0.45	0.00	0.04
combined	4988	0.47	0.00	0.16	4988	0.48	0.00	0.04
difference		0.02	0.01			0.03	0.00	

Table 7 Are switchers different to begin with?

	All transactions motive		Purchasing only motive	
	(1) Offshored services	(2) Offshored materials	(3) Offshored services	(4) Offshored materials
Firm is a switcher	-0.026**	0.032	-0.027**	0.052**
	(0.012)	(0.024)	(0.012)	(0.024)
	0.020***	0.018*	0.022***	0.019**
Labour productivity	(0.006)	(0.010)	(0.005)	(0.010)
	0.011**	0.012	0.012**	0.010
	(0.006)	(0.009)	(0.006)	(0.008)
Logged employment size	0.007***	0.006**	0.007***	0.007**
	(0.002)	(0.003)	(0.002)	(0.003)
	0.081***	0.139***	0.082***	0.140***
ROW exports to sales	(0.014)	(0.025)	(0.014)	(0.025)
	-0.026**	0.032	-0.027**	0.052**
	(0.012)	(0.024)	(0.012)	(0.024)
Foreign owned firm	0.020***	0.018*	0.022***	0.019**
	(0.006)	(0.010)	(0.005)	(0.010)
Sector dummies	yes	yes	yes	yes
Constant	0.029	-0.067	0.013	0.379
	(0.039)	(0.047)	(0.035)	(0.256)
Number of firms	1468	1287	1555	1361

Notes: significant at 10%; ** significant at 5%; *** significant at 1%; 2002 is the pre-switch control year; Cross-section OLS: year is 2002



(a) offshoring materials (b) offshoring services

Figure 1: offshoring materials and services

Figure 2 Effect of switching (all transactions motive: re)

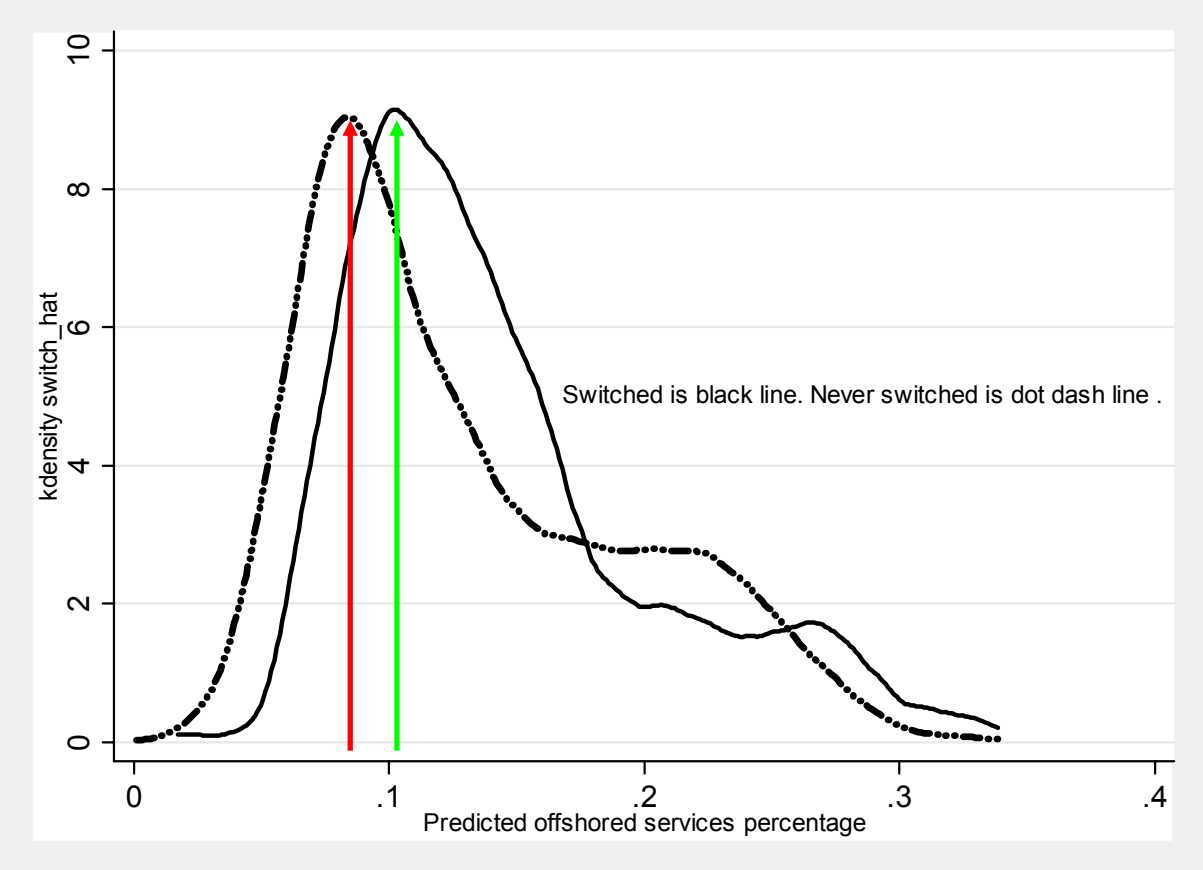


Figure 3 Effect of switching (purchasing only motive: re)

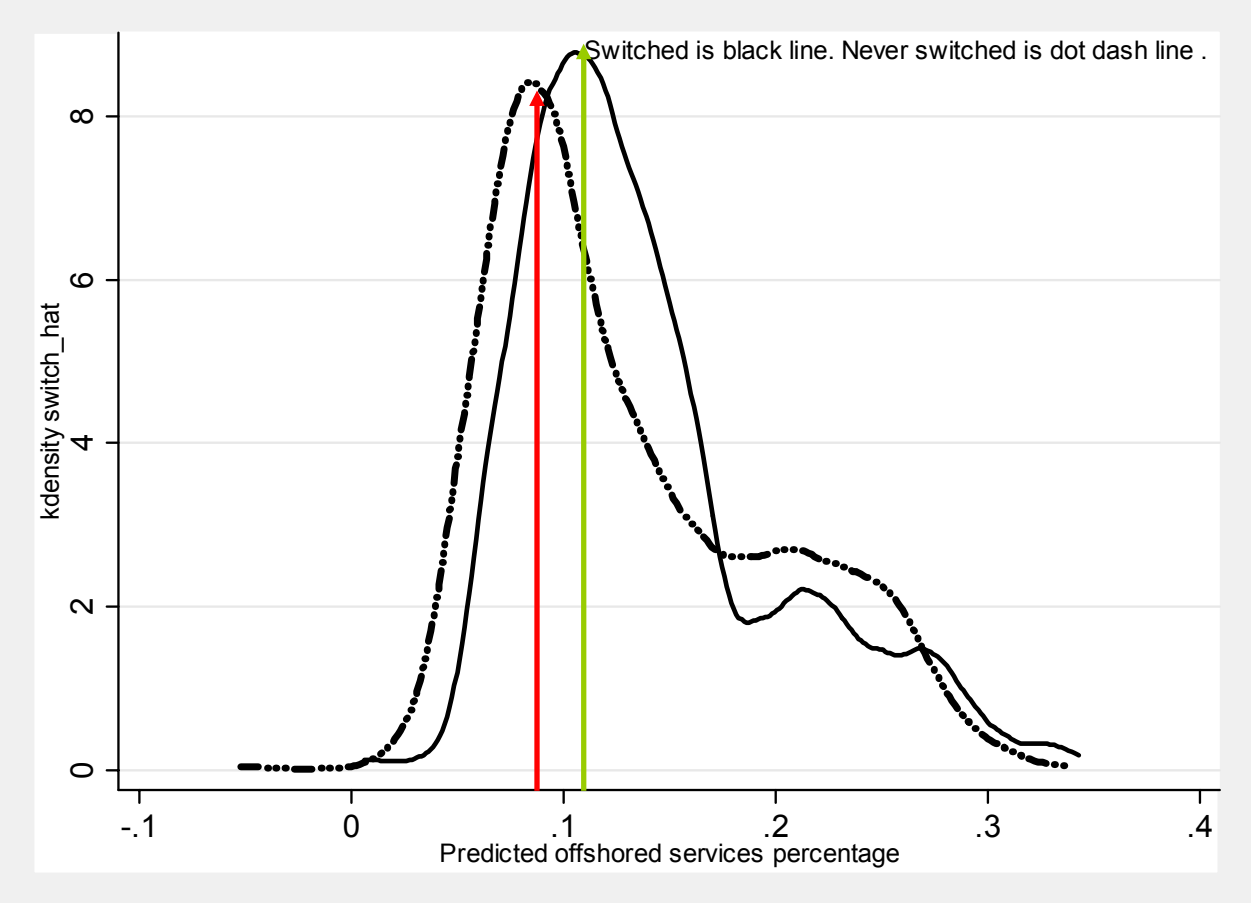


Figure 4 Effect of switching (all transactions motive: fe)

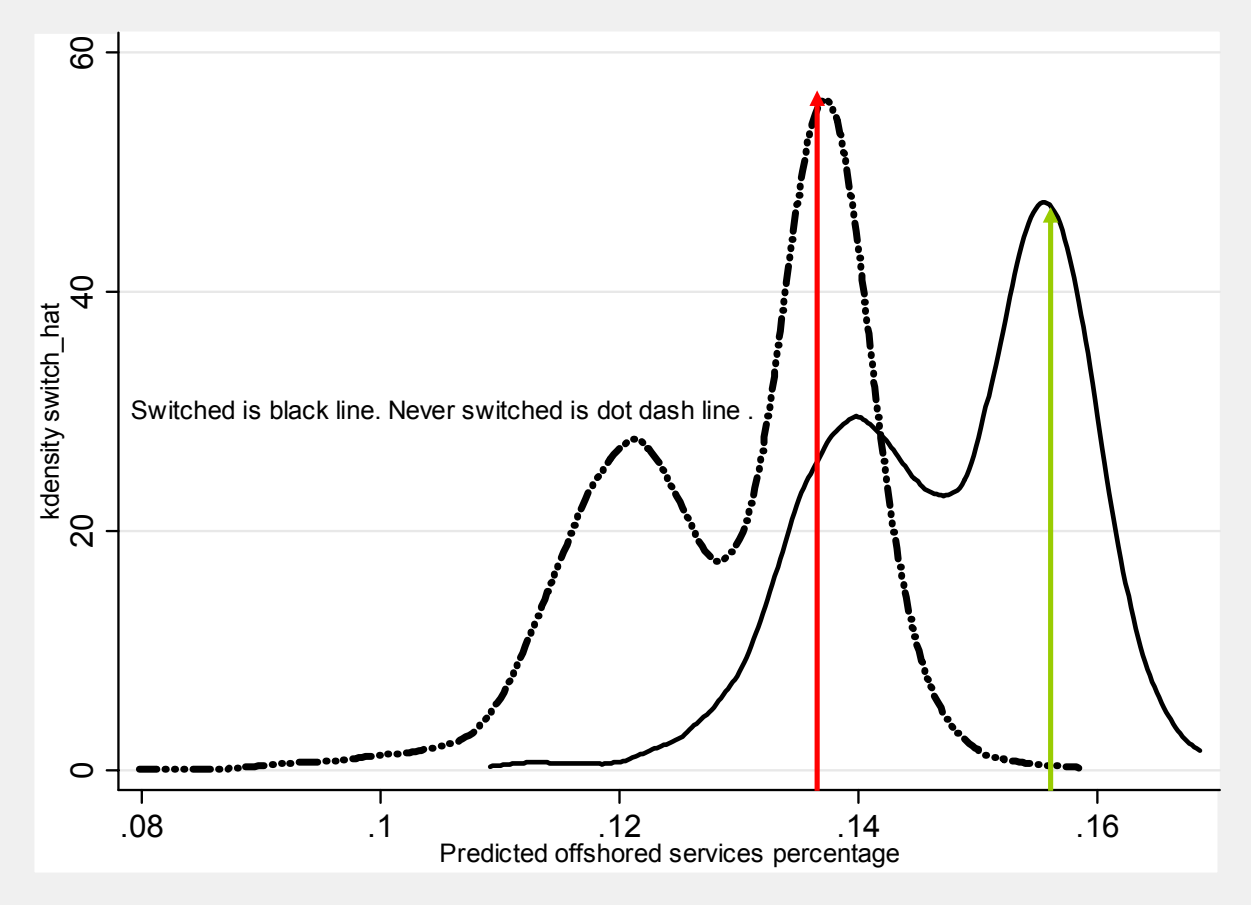


Figure 5 Effect of switching (purchasing only motive: fe)