Web Switching and International Outsourcing: A Matching Approach

Aoife Hanley and Ingrid Ott

Christian Albrecht University Kiel/ Institute for the World Economy and

Karlsruhe Institute of Technology (KIT)/ Institute for the World Economy

Abstract

Formulating a model comprising transportation costs, uncertainty and price, we describe how a switch to Web-based procurement has a higher expected impact on volumes of internationally outsourced services rather than materials purchased by firms.

We find positive effects of switching to Web procurement on international *services* outsourcing of between 1.6 and 2.5 percent for fixed effects and difference-in-difference matching estimators respectively. Web switching depresses international services procurement.

Keywords: International outsourcing, heterogeneous inputs, uncertainty, price, transportation costs, propensity score matching

Acknowledgements
We would like to thank our sources at Forfás for assistance with the data. Also Eckhard Bode, Sebastian Braun, Holger Görg and Maik Heinemann for comments on earlier drafts of this paper. Of course, all remaining errors are our own.

Background

The prevalence of Web enabled international outsourcing is uncontested. Also generally accepted is the fact that international services, in particular Business and Computer services, have experienced phenomenal growth. Admittedly this growth is from a low baseline (Amiti and Wei, 2005, McCarthy, 2002) but nevertheless it has spawned much media interest, Amiti and Wei counting 2,634 newspaper articles in just 5 months in 2004 for the US alone.

The adoption of the Web use for assisting in the search of foreign partner firms and transacting of inter-firm purchasing was heralded as a breakthrough for how firms organise production. UNCTAD (2004) refer to a 'service tradability revolution', where the scope, particularly for the outsourcing of international services was predicted to be high. Bhagwati et al. (2004) using the official World Trade Organization (WTO) nomenclature to classify such transactions as 'Mode 1 services' , i.e. arm's-length services transacted over a distance, describe the pivotal role of the Web accelerating this growth:

'..new technological possibilities (..) convert previously untraded services into traded arm's-length services'. (P. 94, Bhagwati et al., 2004)

Despite the initial hubris surrounding the impact of Web enabled procurement, changes in production patterns have only been quantified by some and with varying degrees of success. The estimations are invariably dogged by problems of firm heterogeneity, imputing causation and problems with data aggregation.

Freund and Weinhold (2000) in a pioneering study using US trade data estimate the knock-on effect of Web use (proxied by number of internet host sites opened) at 0.17 percent, a value considered low in the context of later studies. Bartel et al. (2005) and Abramovsky and Griffith (2006) quantify the effects of intensifying Web use on services at between 4 and 12 percent respectively, where the 12 percent represents an upper-bound in the latter paper. Uniquely, Abramovsky and Griffith (2006) employ an instrumental framework (tax credits as instrument) to help deal with endogeneity bias and use data at the level of the individual firm.

Given the lack of consensus in existing work as to the effect of Web use on international outsourcing, a problem possibly exacerbated by data issues (endogeneity bias, firm heterogeneity, aggregation problems), it is time to re-examine the issue through a fresh perspective. This is the gap our paper sets out to fill: to quantify the effect of Web use on international outsourcing at the level of the firm (in this we resemble Abramovsky and Griffith, 2006) but uniquely in a

Matching set-up where firms can be assigned to a treatment group (firms that switch to Web use) and control group (firms that never switched) within the data window. This is the first time, to our knowledge, that a Matching design is used as a complementary technique to assess Web impact on international procurement. Another unique aspect of our analysis is the consideration of non-service inputs in the estimations, as a benchmark for comparing the responsiveness of traded services to Web use. A further unique aspect of our analysis is our formulation of the Web switching issue in terms of a simple model comprising uncertainty, transportation costs and price, all key variables cited by international outsourcing executives as determinants of international outsourcing.

Using data from the EU harmonized ICT-usage and E-commence survey for over 2,000 firms for 3 years, we show that the effect of switching to Web based international services procurement is between 1.6 and 2.5 percent for fixed effects and difference-in-difference matching estimators respectively. The latter estimator reports a decrease of 2.2 percent for internationally outsourced

Our paper is structured in this way. The next section gives a brief description of outsourcing models outlined in the theory and gives evidence for the elasticity of services outsourcing to increased Web use. Then follows our model. This is followed by a Methodology section describing the Matching approach used. After this is a section describing our data. The penultimate section presents the results of our analysis and the final section concludes with some comments on the implications of our findings.

Background

Web usage and international outsourcing

To our knowledge, three papers to quantify the impact of Web usage on volumes of services outsourced. Two of these studies use aggregate data (Freund and Weinhold, 2002; Bartel et al., 2005) and one uses firm level data (Abramovsky and Griffith, 2006). The latter two studies explore services outsourcing in general, while Freund and Weinhold (2002) specifically examine internationally traded services. None of the studies looks at the impact of Web usage on *material* (rather than *service*) input outsourcing. Table 1 summarises these studies, the different estimation methodologies used and findings reported.

[Table 1 here]

There is a general consensus in the theory that only certain types of inputs can be successfully outsourced on international markets. Specifically, the switch to Web procurement, should only affect traded services such as Accountancy (rather than non-traded services such as Building and Construction). Economists agree about this distinction (Bartel et al., 2005; Bhagwati et al., 2004). Adjustment costs of outsourcing services such as Buildings Repair are unlikely to be affected by the downstream producer's Web usage. Accordingly, the effect of switching to Web procurement is not expected to influence volumes of non-traded services. On the other hand, services such as Legal and Accounting, where we would expect to find an effect of Web use on procurement, belong in the category of traded services where impacts should be felt. If Web use is analogous to Information Technology (IT) use, firms which are most heavily involved in the application of IT are those who face the lowest costs of outsourcing international services. According to Bartel et al;

"..given the IT level of the service, more IT intensive firms face lower adjustment costs of outsourcing". [pp. 14]

There is also agreement in the literature that services outsourcing should be treated differently regarding the predicted effect of Web use. Several studies including the seminal UNCTAD (2004) report make this distinction that tradable services stand to gain most from advances in Information Technology. The theory also has something to say about the type of input which appropriates itself best to Web enabled outsourcing. The seminal models sit in the transactions cost literature (Grossman and Helpman, 2002; Bartel et al., 2005; Baccara, 2005). On the issue of *by how much* Web use has made services more tradable than materials, the literature is silent. A final issue is the reclassifying of some material inputs as service inputs in the wake of increased Web based procurement. An example illustrates this. Consider, the simple case of an employee in a firm who buys the newspaper each morning for the coffee table. With on-line newspaper access, this physical input is transformed into a service input. In aggregate data, such redefined inputs should show up in the National Accounts as services and no longer as materials.

Web 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 Web based procurement and hence the reduction in transactions costs? Abramovsky and Griffith (2006), following Bartel et al. (2005), apply a model of cost minimising firms. They predict the returns to international outsourcing to firms who procure ancillary (non-core) services over the Web. Specifically, 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 combination of in-house and external services. The cost of outsourced services is made up of the market price for the service plus 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.[1] As transactions costs are predicted to fall with Web usage, the volume of these transactions is predicted to rise. Using firm level data on externally purchased services for the UK and employing an instrumental regression design, they calculate a 12 percent increase for internally outsourced services for each 1 percent increase in the Web variable.

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 predicts that changes in levels of technical know-how should not affect the level of services outsourced. The effect, rather, is second order (speed of change) due to the amortisation of fixed costs. They find a significant and negative effect of ICT (Information and Communication Technology) based services on levels of services outsourcing. Services considered as 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 3.8 percent in ICT intensity, equivalent to a 3 percent effect for a 1 percent change in ICT intensity.[2]

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. This value is considerably lower than that obtained in the previous two studies.

[1] See Grossman and Helpman (2005) for a discussion about adjustment costs
[2] Close to the lower value observed in Abramovsky and Griffith (2006).

Generally, Web use facilitates greater access to information on foreign input prices. Since materials are already quite standardized, e.g. the ISO 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 by a significant extent. Indeed, findings by Garicano and Kaplan (2001) on Internet auction transactions for used cars are very revealing: the price of used cars transacted over the Internet when controlling for observables, e.g. car vintage and mileage, is not discounted to recompense buyers for higher uncertainty over the quality of a car when purchasing over the internet. The hypothesis being that if adverse selection is a particular issue for Internet transactions, the expectation is for a lower average car price, all things equal for cars sold over the Internet. Surprisingly, the internet price is found to be *higher* than the price obtained in an equivalent physical auction. Garicano and Kaplan conclude that transacting for second-hand cars over the Internet does not appear to reflect buyer uncertainty over quality. Unfortunately, we do not have an equivalent study for services transacted over the Internet which would allow us to draw any inferences for services. However, it is generally accepted that services are experience goods whose quality is determined ex-post. Uncertainty is arguably most acute for non-standardized services which are especially burdened with the 'experience-good-tag'.

The ultimate decision in favour of (or against) international outsourcing, in the absence of quality considerations, will most likely be driven by transportation costs. These costs are positive for goods that have to be physically shipped and might amount to a significant component of the total factor price.

Theory

We focus on a continuum of risk adverse firms that produce a certain good using foreign and domestic inputs. Profit maximization (which implies cost minimization) dictates both the optimal amount of output and the composition of inputs given the assumption of an exogenous and constant product price that, for the sake of simplicity, is normalized to unity.

Web use allows firms to outsource, at least some of their inputs, internationally. A firm decides to outsource on international markets if it expects decreasing factor costs as a consequence. Factor prices also affect the composition of domestic and foreign inputs according to the following logic:

A factor price reduction increases demand for the corresponding factor. Hence international outsourcing leads to an increase in the ratio between foreign and domestic inputs outsourced.

In addition to reduced pure factor prices, Web enabled outsourcing is also impacted by the issues of transportation costs and uncertainty: (i) the need to transport goods or services in order to overcome physical distance; and (ii) the uncertainty of the finally resulting factor price notwithstanding known input quality. This uncertainty goes hand in hand with a risk premium i.e. firms have make outsourcing decisions based on expected rather than actual factor prices.[3]

To formalize these considerations we formulate a model that captures both the individual and aggregate dimensions to outsourcing by focussing on a continuum of firms. This is for the following reason: At an individual level, the decision in favour of (or against) international outsourcing takes place by comparing domestic factor prices, on the one hand, and the expected overall cost of outsourcing inputs, on the other hand. Hence it is natural to assume that at an individual level, the decision will be either to outsource the entire factor demand or nothing. However, at an aggregate level where we consider the entire demand of all firms, these decisions are heterogeneous in the sense that some firms opt to outsource on international markets while others opt against international outsourcing. Thence, it is natural to assume that at an aggregate level, inputs are in part domestic and in part foreign. Since the basic argumentation is similar for materials and services, we do not differentiate between the two inputs in order to derive the optimality conditions that determine factor demand. However, after deriving the various components of factor demand, the discussion then differentiates between the two inputs services and materials on this basis: Overall, the cost of an internationally outsourced input which must be paid by a firm comprises components of factor price, transportation and uncertainty. These components differ between services and materials. Even if we were to observe similar changes in the volumes of outsourced service and material inputs respectively on international markets, we would still expect the elasticity of outsourced services to be higher than the elasticity for materials for firms switching to Web enable procurement.

[3] The model is thus based on the work of Batra/Ullah (1974), Stewart (1978) or Perrakis (1980) who analyze input demand under price uncertainty.

Model

Each firm produces the homogenous good, *x*, thereby utilizing domestic and foreign inputs, v_d and v_f, respectively.[4] Factor prices are denoted by q_d and q_f and *tc* reflect transportation costs of the internationally outsourced input. Factor price uncertainty arises in the context of international outsourcing, hence we assume q_f to be stochastic with $E[q_f]>0$ whereas q_d as well as tc are well-known to the firms. Expected profits are given by

and the following optimality conditions result[5]

$$\frac{\partial x}{\partial v_d} = q_d$$

$$\frac{\partial x}{\partial v_f} = E^*[q_f] + \psi + tc$$

The parameter ψ denotes the risk premium associated with factor price uncertainty of the internationally outsourced input. The first optimality condition describes the usual relationship in a deterministic setting between the value of the marginal product of the factor and its price in the case of inputs that are not internationally outsourced. The second optimality condition captures the fact of uncertainty and hence considers additional components: Optimal demand for the internationally outsourced input is given when its value of marginal product is equated with the sum of expected factor price, $E[q_f]$, a corresponding risk premium, ψ, and transportation costs, tc. Only if the sum of all three components falls short of the domestic factor price, will Web use cause an increase in v_f.

This argumentation holds for both services and materials. Moreover, since Web use opens up efficiency gains in that inputs may now be purchased at the cheapest location, decreasing factor costs will lead to an increase in the volume of internationally outsourced inputs. The crucial question now is what the differential impact of Web enabled outsourcing will be for service and material inputs respectively. We argue that demand for internationally outsourced inputs will increase for both types of input. However, the effect is expected to be more pronounced for services than for materials. This is due to the following reasoning:

[4] Note that the relationship between the two inputs formally depends on the sign of the cross derivative. Complementarity arises, when an increase in the price of one factor is accompanied by a decrease in demand for both factors. The cross derivative would then be positive whereas a negative sign arises in the case of substitutes. Throughout the following argumentation we assume that both inputs are not perfect substitutes.

[5] See the appendix for a formal derivation of the results.

- Transportation costs are higher for materials than for services.[6]

- The risk premium is arguably lower for materials than for services for two reasons: Ongoing international product standardization results in homogenous products fulfilling clearly defined quality requirements. This allows applies to certified generic services (e.g. ISO certified) though to a lesser extent than in case of materials. Besides, in contrast to materials, services are experience goods. Hence, altogether we assume that ψ is quite low for both input types but lowest in the case of materials.

- Hence the remaining question is how much the expected factor price with Web enabled international outsourcing falls short of factor costs in the absence of Web enabled outsourcing. In this context, Web use can facilitate partner search thereby leading to a reduction in factor price uncertainty. The search for international materials suppliers is especially helped by Web enabled searching. Here international standardization processes are already quite advanced and Web enabled searching helps locate the cheapest supplier of the non-differentiated input. This is not necessarily true for services: Volumes of internationally outsourced services are still at a relatively low level, there is less product standardization and fewer possibilities to realize learning effects in order to more accurately calculate the expected factor price.

To conclude: Firms will only outsource inputs on international markets when they expect the entire factor cost of outsourcing these inputs to decrease. This cost comprises the expected factor price, a risk premium, and transportation costs. Accordingly, demand for internationally outsourced services and materials rises with the expectation of reduced total factor costs. What is still unclear is the strength of these effects and how they differ between the two input types (materials and services). Expected factor price cuts are lower for services than for materials.

Ingrid: why are factor price cuts lower for services than for materials? Are you saying that materials become better value than services because of higher expected factor price cuts? Recall, our new results show a decline in materials intensity, not just reduced increase compared to services. Can we account for this?

[6] Note that also in case of services, transportation costs might play a role. This is especially true if the production process requires frequent face-of-face contacts which which is quite costly. One might quite well drop these kinds of services from our consideration since we mostly refer to standardized services. Whenever face-to-face contacts are important, the relationship between proximity and productivity is of special importance thereby representing an agglomeration force working against international outsourcing (see the discussion within New Economic Geography, e.g. Brakman et al. (2009) for an overview on agglomeration and dispersion forces).

In contrast, risk premia are probably higher in the case of services than for materials. Assuming that the combination of risk premiums and expected factor price cuts produce nearly identical effects for volumes of internationally outsourced materials and services, it is the additional consideration of transportation costs that explains remaining differences in responses to Web enabled outsourcing. It is natural to assume that transportation costs for materials inputs exceed those for service inputs. As a consequence, although Web enabled outsourcing can induce increases in the volumes of many international inputs, the overall effect is expected to be higher in case of services.

Methodology

The aim of our paper is to investigate whether there is a causal relationship from switching to Web based procurement on the amount of internationally procured services and materials inputs. Our model in the previous section describes the context for modelling the elasticity of international outsourcing to an event (switching to Web-based procurement). The advent of Web use helps reduce the uncertainty in transacting with an overseas supplier. This event can be framed methodologically as a 'switching' one where we look at average effects within the group of 'switchers' and 'never switchers', and difference these effects for pre- and post-switch.

Let $\text{switch}_{it} \in \{0,1\}$ be an indicator of whether a firm i switches to Web based procurement in time t and let $\text{serv\_os}^{1}_{it+s}$ be the proportion of internationally procured services (international/ total service inputs) following the switch. Also denote $\text{serv\_os}^{0}_{it+s}$ as the proportion of internationally procured services if the switch had not taken place. The causal effect of switching to Web based procurement on the proportion of internationally procured services is then expressed as:

$$\text{serv\_os}^{1}_{it+s} - \text{serv\_os}^{0}_{it+s}$$

A problem arises here. The counterfactual, $\text{serv\_os}^{0}_{it+s}$ cannot be observed if a firm makes the choice to switch to Web based procurement. The analysis can be viewed as confronting a missing-data problem. The microeconomic literature since Heckman et al. (1997) is equipped to

deal with this missing counterfactual by defining the average effect of switching on the proportion of internationally procured services as follows:

$$\begin{aligned} &E\left\{serv\_os^{1}_{t+s} - serv\_os^{0}_{t+s} \mid switch_{it} = 1\right\} \\ &= E\left\{serv\_os^{1}_{t+s} \mid switch_{it} = 1\right\} - E\left\{serv\_os^{0}_{t+s} \mid switch_{it} = 1\right\} \end{aligned}$$

where the counterfactual in the last term is inferred. This inferred causal estimate is the proportion of internationally outsourced services the firms would have exhibited, on average, had they not made the switch to Web based procurement.

Of course, it is imperative to base the estimated counterfactual by using a valid control group. If there are missing covariates in the model which are correlated with the variable *switch*, the analysis will suffer from endogeneity and simultaneity bias. This is where the matching process can help. The idea behind matching is to pair each firm that switches to Web based procurement with a firm that never made such a switch. The selection of the paired control is performed on the basis of some observable variables e.g. size or foreign ownership. We apply the matching procedure (propensity score matching) pioneered by Rosenbaum and Rubin (1983) which applies a calculation of the probability of being in the treatment sample (making the switch to Web based procurement in our analysis) conditional on these controlling covariates such as firm size. Accordingly, in a first step, we compute the probability (propensity score) of a firm making the switch to Web based procurement in a probit model.

$$P\left(switch_{it} = 1\right) = F\left(X_{it-1}\right)$$

where X is a vector of covariates observed in the period before the firm made the transition to Web based procurement. Included in this vector is a foreign ownership measure, an industry measure, year dummies, similar to Bartel et al. (2005). a skills proxy, *wages_pw*, a measure of firm size (logged employment) and a productivity measure (sales per worker). The intuition for including a foreign ownership measure is that foreign firms are more likely to have more advanced IT by default, being embedded into international production networks. Therefore, similar to Abramovsky and Griffith (2006), the most similar study to ours, we include a foreign ownership dummy as well as a controlling for employment size. Finally, larger or more productive firms may have the critical mass or accumulated capital to pay for such procurement systems. Similar to Abramovsky and Griffith (2006), we also include a full set of industry and

time dummies. Finally, the intuition behind the inclusion of a skills measure is that the application of Web based procurement requires some component of worker skill.

A conventional matching estimation of the causal effect of switching on the proportion of internationally outsourced services is expressed

$$\mu = \sum_{i \in A} (serv\_os_i) - \sum_{j \in c} g(p_i, p_j) \Delta serv\_os$$

where $g(p_i, p_j)$ is a function assigning the weights to be given to the comparison firm j in constructing the counterfactual for the switching firm i. For g, we employ a Gaussian kernel in this paper which applies diminished weight to firms in the control group further away in the propensity score distribution. Essentially, however, the full distribution of non-treatment firms is used in constructing the averaged effect for the counterfactual.

What are the advantages of using a matching 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. Despite such efforts to clean data, the presence of omitted variables could still lead us to impute a spurious effect to the treatment variable. These omitted variables may be events not captured in the model but which are correlated with the treatment effect. To give an example of where such an omitted variable would bias outcomes, consider where a Government drive to raise firms' awareness of overseas suppliers coincided with the time that most firms switched to overseas procurement. In order to neutralise the effect of such omitted variables and in order to reduce the joint determination of outcomes, we opt for matching.

To summarise, the key idea with matching is that time specific problems, e.g. Government support for outsourcing initiatives, are screened out. Both treatment and non-treatment groups are affected by the same contemporaneous effects.

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.[7]

Since the Web usage variables were covered only in the period from 2002 (although we had data from as early as 2000), we had 3 years of Web coverage data in our sample frame. 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 unbalanced 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.

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. This variable is analogous to the Web measure used in the Abramovsky and Griffith (2006) paper, also from the ICT survey but in the latter case for a UK sample.

A main novelty of our paper, enabling us to apply a Matching design, is the identification of 'switchers': firms that during the 3-year time window switched from non-Web procurement to Web-procurements. To identify 'switchers', we needed to distinguish 3 groups of firms. The first were firms who had always used the internet from the beginning of our records. The second were firms who had never used the internet at any stage in the data. The final were firms, a subset of whom we identified as switchers, switched to Web procurement during the 3-year time window. We end up with an unbalanced panel of 343 firms who switched to Web procurement

[7] See 'Information society: ICT impact assessment by linking data from different sources', Eurostat Report, August 2008

during the 3-year time window. We also have information on 1,424 non-switchers for the 3 years of the panel. Looking at the transition probabilities for the sample of switchers, we see that 202 switches took place in 2002 and 141 switches took place in 2004 (Table 2).

[Table 2 here]

The core idea in our analysis is to investigate, if any, the effect of Web procurement on the intensity of overseas intermediates. Accordingly, Table 3 documents the breakdown between Switchers and Non-Switchers for the intensity of overseas service and material inputs. To net out the effect of switching, we compare pre-switch values only. Switchers have lower ex-ante intensities of overseas service inputs and higher ex-ante intensities of material inputs. These differences are mostly insignificant however (except for service inputs in 2003). Therefore, for the most part, the treatment and control groups have comparable overseas outsourcing intensities.

[Table 3 here]

Finally, since we will at a later stage match firms based on characteristics such as foreign ownership and industry sector, it is interesting to see what the composition of these variables is for Switchers and Non-switchers. The pre-switch values for Switchers reveal them to be less productive than their Non-Switcher peers and also more likely to be domestically owned. They report higher export intensities, although this effect is only marginally significant. On the basis of these preliminary statistics, it is plausible that Non-Switchers are more internationalised (higher foreign ownership, lower exporting intensities suggesting that overseas procurement is internalised i.e. through vertical integration) than Switchers. However, this is merely a conjecture.

[Table 4 here]

Analysis

In this section we estimate international outsourcing of services and materials, applying in turn random and fixed effect estimators. As a further robustness check, we estimate the effect of Web enabled procurement on proportions of internationally outsourced service and material inputs using the propensity score matching technique outlined in the methodology section.

In Table 5 we report our initial findings for the standard panel regressions with fixed effects and random effects respectively. Columns 1 and 2 report the impact on the proportion of internationally outsourced services, $serv\_os$, for firms citing Web use for as a procurement tool. Columns 3 and 4 report the corresponding impacts for internationally outsourced materials. Overall, the average effect is about 1.7 percent for internationally outsourced service inputs (1.6% and 1.8% for FE and RE respectively). This effect is significant at the 5 percent level. The signs on the other covariates are as expected: more productive, larger and higher-skill firms have higher intensities of internationally traded service intensities.

The results for internationally outsourced materials are negative for both the and RE estimators. Here, switching to Web procurement is associated with a 3 – 3.3% decrease in the intensity of internationally traded services, depending on the estimator used..

[Table 5 here]

Figure 1 illustrates what is happening in terms of the distributions of the predicted values (kernel density estimates) from the FE regressions. The peak of the distribution in Figure 1 which charts the predicted distribution for the switch to Web use for international services outsourcing, migrates from below 10 percent to above 10 percent once firms adopt Web procurement.

[Figure 1 here]

However, these panel-regressions are unsatisfactory in the sense of not controlling for the shock induced by switching to Web based procurement. Other omitted variables possibly correlated with the variable 'any_Web_trans' could similarly have produced the impacts witnessed in Table 5. One option is to address this problem within a Matching framework as described in the Methodology section.

We first calculate the Propensity Scores for the treatment (Web switchers pre- and post-switch) and non-treatment group based on criteria. Firms are matched based on skills profile, size, productivity, ownership status and sector. Figure 2 shows the distribution of the resulting propensity scores, where treatment firms have higher likelihoods (propensities) of scoring high on these dimensions.

[Figure 2 here]

Notwithstanding these ex ante differences between treatment and control sample, the balancing test conditions are satisfied and we can proceed to the Gaussian matching estimation. Table 6 presents these results for levels of and within-firm differences (comparable to the FE estimator reported earlier) in traded services and materials respectively.

[Table 6 here]

Looking first at levels of traded service intensities, the marginal effect of switching to Web based procurement is 2.2 percent. The accompanying bootstrapped standard errors show this result to be statistically significant. The corresponding statistic for international materials outsourcing is insignificant.

Arguably, it is insufficient to use levels as an appropriate yardstick to complement the results from the FE estimations earlier. Accordingly, we expressed the response variable, intensity of international inputs in first differences and reran the estimations. The result is reassuringly similar to the FE estimations reported in Table 5 earlier. Switching to Web procurement induces a 2.5 percent increase and 2.2 percent decrease for service and materials inputs respectively. These changes are statistically significant. (In comparison, the FE values were a 1.6 percent increase and 3.7 percent decrease for services and materials).

Predicted effect of switching on international outsourcing and comparisons with literature

How do our computed effects compare with those observed in the literature? Abramovsky and Griffith (2006) reported an increase of circa 3 percent increase in outsourced service inputs associated with Web procurement in their panel 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 (FE and D-in-D matching) are 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).[8] This is the first study to

[8] 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

document however, the decline in international materials outsourcing in the wake of a switch to Web procurement.

XX reason for decline in materials outsourcing. Ingrid. We need to recap how our model ties in with our results here.

A further possible reason for this decline in international material inputs may be the reclassification of certain physical inputs as services once they are procured on-line.

Conclusion

Building a model which summarises key drivers of international outsourcing as reported in surveys of outsourcing firms (i.e. transportation costs, uncertainty and price), we describe how the impact of Web use on proportions of internationally outsourced services differs from the impact on materials. This difference is mainly due to uncertainty where uncertainty represents a catch-all factor describing the dovetailing of production between two geographically and culturally distant firms.

We then apply a fixed effects, random effects and D-in-D propensity score matching to a sample of firms that switch to Web based procurement and a sample of firms that do not. Using data from the EU harmonized ICT-usage and E-commence survey we find that Web switchers report increases in international traded services 1.6 percent and 2.5 percent depending on the estimation technique. These values are comparable for XXX: compare to literature

The decrease for traded materials is 2.2 percent and 3.7 percent, again depending on the estimation technique. Unique to this study & reasons

Need longer time window
Need to capture substitution between sectors: migration of categories etc.
Policy: effects small as per literature: not an abyss (quote from Bhaghati)

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 be readily 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 Web enabled international outsourcing will be codetermined by the value of insourcing. Furthermore, as Bhagwati et al. (2004) point out, while increases international services outsourcing may prompt short-term job

losses, workers do not fall ‘off the edge of an abyss into prolonged unemployment and re-employment only at low wages’. In time, one expects newly created high-value jobs to make good the attrition.

References

Abramovsky, L. and R. Griffith, 2006, 'Outsourcing and Offshoring of Business Services: How Important is ICT?' Journal of the European Economic Association, April-May 2006, v4, n2-3, pp.594-601

Amiti, M. and S.J. Wei, 2005, 'Fear of Service Outsourcing: Is it Justified?' Economic Policy, Vol. 20, pp. 308-347

Baccara, M., 2007, 'Outsourcing, Information Leakage and Consulting Firms', RAND Journal of Economics, v38, n1, pp.269-289

Bhagwati, J., A. Panagariya and T. Srinivasan, 2004, 'The Muddles over Outsourcing', Journal of Economic Perspectives, v18, n4, pp.93-114

Bartel, A., S. Lach and N. Sicherman, 2005, 'Outsourcing and Technological Change', Centre for Economic Policy Research, Discussion Paper Series No. 5082

Batra, R. N. and Amann Ullah, 1974, Competitive Firm and the Theory of Input Demand under Price Uncertainty, Journal of Political Economy, v82, n3, 537-548.

Brakman, S., Garretsen, H. and C. van Marrewijk, 2009, The New Introduction to Geographical Economics, Cambridge University Press, Cambridge UK

Eurostat Report (as yet unpublished), 'Information society: ICT impact assessment by linking data from different sources', August 2008 draft

Freund, C. and D. Weinhold, 2002, 'The Internet and the international trade in services', American Economic Review, v92, n2, pp.236-40

Garicano, L. And S. Kaplan, 2001, 'The Effect of Business-to-Business E-Commerce on Transaction Costs', The Journal of Industrial Economics, v49, n4, pp.463-485

Görg, H. and A. Hanley, 2009, Services outsourcing and innovation: an empirical investigation, Economic Inquiry (forthcoming 2010)

Grossman, G. And E. Helpman, 2002, 'Integration versus outsourcing in industrial equilibrium', Quarterly Journal of Economics, v117, n1, pp. 85-120

Grossman, G. And E. Helpman, 2005, 'Outsourcing in a global economy', Review of Economic Studies, v72, n1, pp. 135-159

Heckman, J., H. Ichimura, J. Smith and P. Todd, 1997, 'Matching as an econometric evaluation estimator: evidence from evaluating a job training programme', Review of Economic Studies, 64, 605-654

McCarthy, J., 2002, '3.3 Million Jobs to Go Offshore', Cam. Mass., Forrester Research Inc., Nov 11

Perrakis, S., 1980, Factor-Price Uncertainty with Variable Proportions: Note, American Economic Review, v70, n5, 1083-1088

Rosenbaum P. and D. Rubin, 1983, 'The central role of the propensity score in observational studies for causal effects', Biometrika, v79, n1, pp 41-55

Stewart, M., 1978, Factor-Price Uncertainty with Variable Proportions, American Economic Review, v68, n3, 468-473

UNCTAD, 2004, World Investment Report: Shift Towards Services

Mathematical appendix

Given the profit function of the representative firm

$$E^*[Z] = E[Z(p \cdot x(v_d, v_f) - v_d q_d - v_f \cdot (q_f + tc))]$$

the following first-order conditions that determine optimal factor demand for both domestic and foreign inputs may be derived

$$\frac{\partial E^*}{\partial v_d} = E^*\left[Z'\left(\frac{\partial x}{\partial v_d} - q_d \right)\right] = 0$$
$$\frac{\partial E^*}{\partial v_f} = E^*\left[Z'\left(\frac{\partial x}{\partial v_f} - q_f - tc \right)\right] = 0$$

Due to uncertainty, the following relationship concerning the internationally outsourced input holds

$$\frac{\partial E^*}{\partial v_f} = E^*\left[Z'\left(\frac{\partial x}{\partial v_f} - q_f - tc \right)\right]$$
$$= E^*[Z'] \cdot E^*\left[\frac{\partial x}{\partial v_f} - q_f - tc \right] + \operatorname{cov}\left[Z', \frac{\partial x}{\partial v_f} - q_f - tc \right]$$
$$= E^*[Z'] \cdot \left[\frac{\partial x}{\partial v_f} - E^*\left[q_f \right] - tc \right] + \operatorname{cov}\left[Z', \frac{\partial x}{\partial v_f} - q_f - tc \right]$$
$$= E^*[Z'] \cdot E^*\left[\frac{\partial x}{\partial v_f} - q_f - tc \right] - \operatorname{cov}\left[Z', q_f \right]$$

since $\operatorname{cov}\left[Z', \frac{\partial x}{\partial v_f} - q_f - tc \right] = \operatorname{cov}\left[Z', -q_f \right] = -\operatorname{cov}\left[Z', q_f \right]$

Define the risk premium, ψ, as

$$\psi = \frac{\mathrm{cov}[Z', q_f]}{E^*[Z']}$$

Then demand for v_f results according to the optimality condition

$$\frac{\partial x}{\partial v_f} = E^*[q_f] + \psi + tc$$

Tables and Figures

Table 1 **Previous findings on Web use and outsourcing**

Study	Model	Data	Impact
Freund, C. and D. Weinhold, 2002. AER	Gravity trade equation	Aggregate (56 countries)	10% increase in Web hosts increases total trade by 1 percent
Bartel, A., S. Lach and N. Sicherman, 2005, CEPR WP	OLS	Aggregate (4-digit SIC) IT investment/TOTAL investment Spend on purchased services (e.g. Machinery repair)	3.84% increase in IT ratio increases accounting/software services by 8%
Abramovsky and Griffith (2006), JEEA	OLS & IV	Firm level (E-commerce survey) outsourcing =int. services / sales Internet dummy Intensity at sector level: % firms using internet in sector	Firms using Web have 6% higher Pr. of purchasing services (upper bound 12%)
This paper	OLS (FE & RE) PS Matching	Firm level (E-commerce survey) Int. outsourcing =int. services / total purchases Internet dummy	Firms switching to Web, increase amount of international services by 13%

Table 2 Transition Matrix for Switchers

		Status in 2003					Status in 2004		
Status in 2002		No Web procurement	Web procurement	Total	Status in 2003		No Web procurement	Web procurement	Total
	No Web procurement	126	202	328		No Web procurement	0	141	141
	Web procurement	NA	NA	NA		Web procurement	28	280	308
	Total	126	202	328		Total	28	421	449

Table 3 Differences in Means for Switchers (Pre-Switch) and Non-Switchers

International services outsourced (serv_os)	**2003**			**2004**		
	Obs	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
Firm Never switched to Web sales and purchases	1259	13%	21%	1407	13%	21%
Firm Switched to Web purchases [PSV]	342	11%	18%	146	11%	17%
difference	1601	13%	21%	1553	12%	20%
		2%			2%	
Significance of means t-test: Ha: diff != 0		0.06			0.25	
International materials outsourced (mat_os)						
	Obs	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
Firm Never switched to Web sales and purchases	1080	47%	38%	1196	46%	38%
Firm Switched to Web purchases [PSV]	286	50%	37%	122	49%	38%
difference	1366	48%	38%	1318	46%	38%
		-3%			-3%	
Significance of means t-test: Ha: diff != 0		0.22			0.48	

Notes: *: t-test significant at 10 percent level

.

Table 4 Differences in Key Variables by Switcher Status: (Pre-Switch Values for Switchers)

		sales per worker (Euros 100K)	Number employees	% Exports (exports/sales)	Average % foreign firms
Non-Switchers	Median	4.67	34	1%	0
	Mean	4.61	107	20%	28%
	SD	1.54	268	30%	45%
	Observations	3895	3895	3005	4287
Switchers	Median	4.43	29	2%	0
	Mean	4.34	92	23%	24%
	SD	1.61	224	33%	43%
	Observations	517	517	423	633
Total	Median	4.64	33	1%	0
	Mean	4.58	105	20%	28%
	SD	1.55	263	31%	45%
	Observations	4412	4412	3428	4920
Significance of means t-test: Ha: diff != 0		0.00	0.23	0.09	0.02

Table 5 Switching on International Outsourcing: Panel Regressions

	Internationally outsourced services (serv_os)		Internationally outsourced materials (mat_os)	
	(1)	(2)	(3)	(4)
	FE	RE	FE	RE
any_web_trans	0.0161**	0.0176**	-0.0374**	-0.0294**
	(0.00802)	(0.00755)	(0.0148)	(0.0142)
sales_pw	0.000806	0.00454*	0.00491	-0.00273
	(0.00336)	(0.00256)	(0.00861)	(0.00621)
employ1	0.00694	0.0117***	0.0213	0.00232
	(0.00696)	(0.00352)	(0.0151)	(0.00680)
wages_pw	0.0199***	0.0185***	0.0209	0.0157
	(0.00733)	(0.00542)	(0.0134)	(0.0110)
foreign	0	0.0988***	0	0.227***
	(0)	(0.0122)	(0)	(0.0216)
manuf	0	-0.0359***	0	0.0717***
	(0)		(0)	
Year dummies	yes	yes	yes	yes
Sector dummies	yes	yes	yes	yes
Observations	5139	5139	4353	4353
Number of firms	1909	1909	1646	1646
R-squared	0.010		0.010	
F	2.986		3.600	
Baseline log likelihood	6349		3922	
Log likelihood	6375		3943	

Notes: *significant at 10 percent level, ** significant at 5 percent level, *** significant at 1 percent level

Table 6 Effect of Switching on International Outsourcing: PS Matching

	No Web-based transactions (control)	Web based transactions (treatment)	Effect of treatment	Bootstrapped Standard Error	t
			Levels		
Internationally outsourced services	12.0%	14.2%	2.2%	0.008	2.865**
Internationally outsourced materials	46%	46%	0.004%	0.014	0.310
N	5,114				
N for treated	763				
N for controls	4,351				
			Difference-in-Differences		
Internationally outsourced services	0.7%	3.3%	2.5%	0.006	4.145**
Internationally outsourced materials	0.3%	-2.0%	-2.2%	0.010	-2.164**
N	5,114				
N for treated	763				
N for controls	4,351				

Notes:

Variables used in the kernel matching:
Labour productivity (sales_pw), firm size (logged employment), foreign ownership dummy, manufacturing dummy, year dummies.

**Significant at 1 percent level

Balancing tests (not reported here) passed. Number of blocks = 7. Number of repetitions for bootstrap = 50.

Figure 1 Predicted Effect: Services Offshoring for Switchers and Non-Switchers

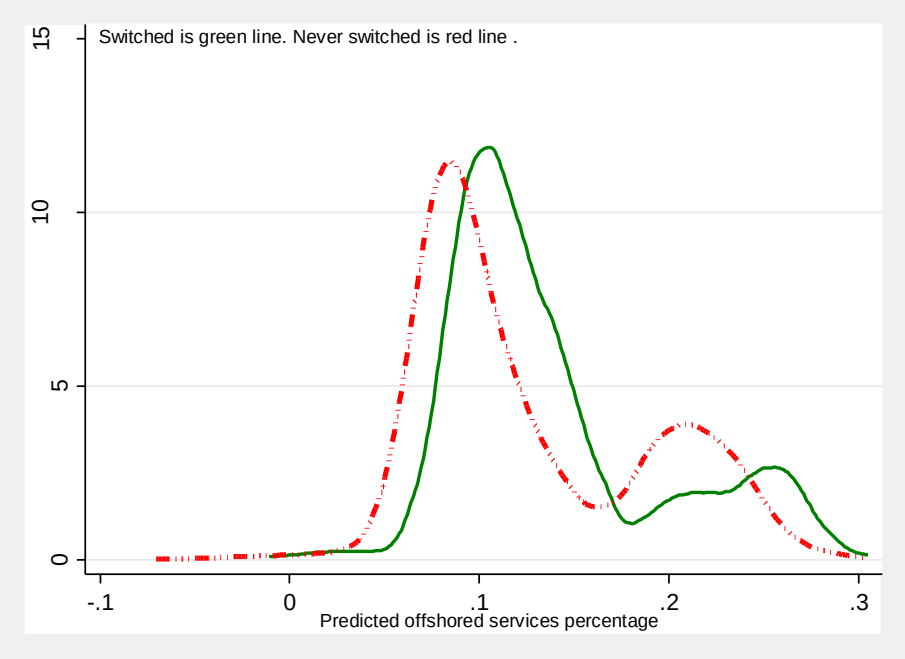
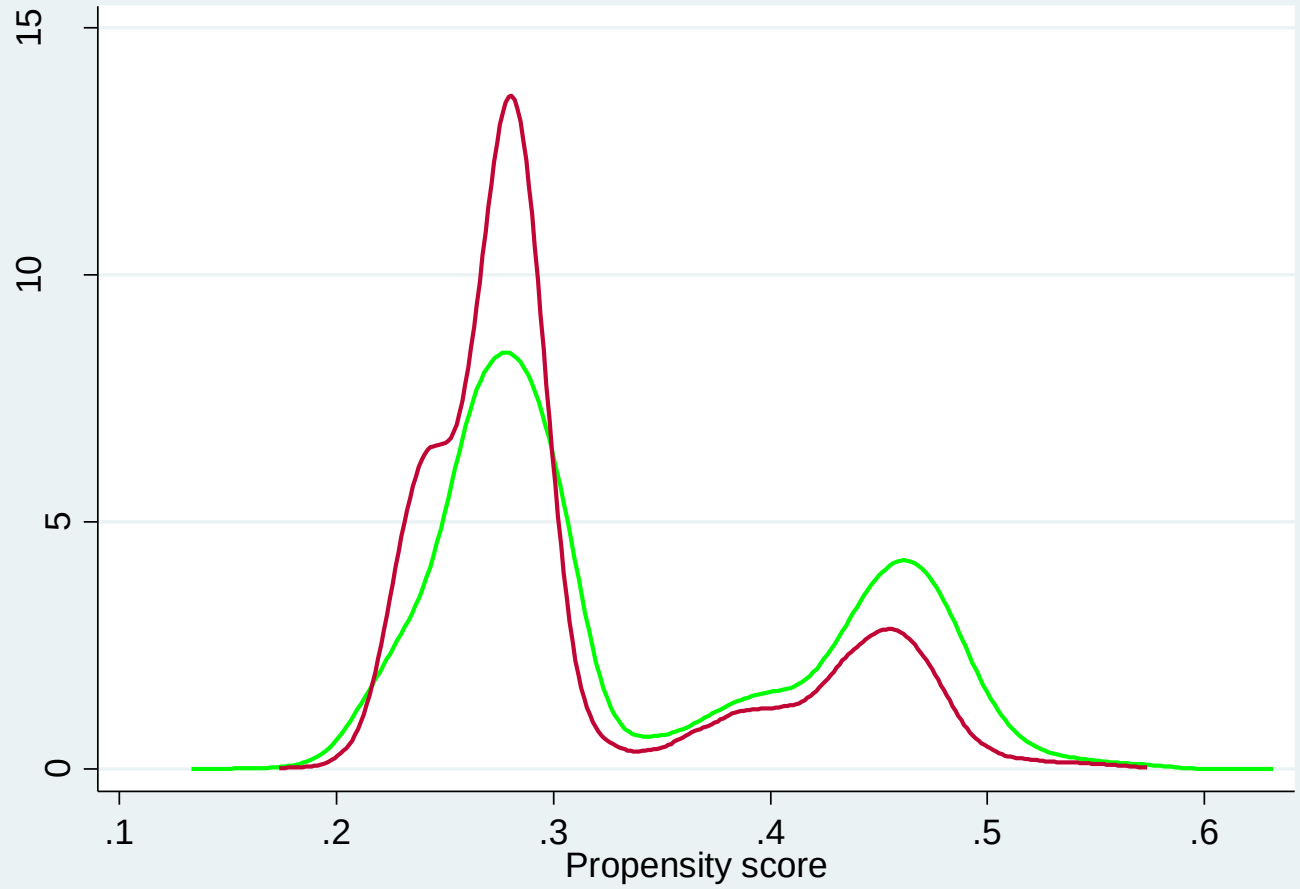


Figure 2 Distribution of Propensity Scores



Kernal Distribution of Propensity scores. Green = firm switched to Web; Red = firm never switched

Appendix 1 Variables List

any_web_trans	Web used for purchasing and sales (any_web_trans)
bisid	Firm identifier
cpi	Consumer Price Index
employ	Number of employees
employ1	Logged employment (employ1)
exp_int1	Export intensity logged
foreign	Firm is foreign owned (foreign)
int_rd_per	percentage of R&D conducted in-house as portion of total R&D bill
manuf	Firm is a manufacturer
mat_os	Materials outsourced from overseas as % of total outsourced materials (mat_os)
nacecode	4 digit nace code
nationality	Owner Nationality
owner	2 - foreign 1 - domestic
sales_pw	Sales per worker
serv_os	Services outsourced from overseas as % of total outsourced services (serv_os)
serv_os1	International services outsourcing logged
switcher	Firm switched to Web procurement during 3-year time period
wages_pw	Wages per worker
year	year is 2002, 2003 or 2004