The Effect of External and Internal Experience on Adopting New Business Practices: A Study of Website-related Service Outsourcing*

George Deltas
Department of Economics
University of Illinois
Urbana-Champaign
deltas@illinois.edu

Seung-Hyun Hong
Department of Economics
University of Illinois
Urbana-Champaign
hyunhong@illinois.edu

April 2025

Abstract

Using establishment level data, we document the patterns of Website-related service outsourcing and investigate possible barriers to its dissemination. Our findings suggest that website-related service outsourcing is considered by most firms, but not adopted because it is not a successful practice. Provision of these services is progressively moving from external providers or dual sourcing to in-house production. Our findings are most consistent with a negative updating of beliefs about the value of outsourcing based on information spillovers based on experience of co-located firms (and industry peers). An alternative possibility consistent with those findings is that outsourcing increases the know-how of firms to produce the services in-house and that website-related services is correlated within industries and locations. We also show that firms with high internal IT capabilities are more likely to produce the service in-house, while prior experience with outsourcing other IT services reduces the transactions costs of Website-related service outsourcing.

Keywords: Information spillovers, Insourcing, Learning by Outsourcing, Spatial effects.

JEL classification: L22, L23, L86

*We would like to thank the NET Institute for financial support. All errors are our responsibility. Correspondence can be addressed to either of the authors at 1407 West Gregory Drive, Urbana, IL 61801.

1 Introduction

The practice of outsourcing operations traditionally undertaken inside a firm is one of the major trends in business organizations since the 1980s. A voluminous literature has thus studied outsourcing to shed light on its various aspects including firm strategies, the determinants of firms' boundaries, and even the impact of international trade liberalization.[1] This literature has mostly examined the outsourcing of business activities that had been done in-house but could now be done at lesser cost and higher quality by specialized vendors, such as food catering, janitorial services, non-specialized industrial inputs, and marketing. In contrast, less attention has been given to the outsourcing of newly developed services that were historically infeasible. With significant advances in information technology (IT) in recent years, new services particularly related to IT have been and will be developed. These could be provided in-house or via outsourcing. What are the patterns of outsourcing of newly developed services? What are the key mechanisms behind these patterns? How do the outsourcing and in-house provision of these services relate to each other?

This paper intends to help fill this gap. Specifically, we study the outsourcing of IT services, focusing on website-related services. Such services became available towards the end of the 20th century, though not very prevalent or prominent until the 2000's. These services could be introduced in-house or outsourced at inception, and firms could transition from one delivery mode to another. Dual sourcing is also possible. We first document the broad pattern of provision for this new service. We then investigate the extent to which the outsourcing decision for a particular service depends on information spillovers, agglomeration economies, and the firm's prior experience with

[1] Outsourcing has been studied in a large literature on the theory of the firm, which dates back to the seminal paper by Coase (1937), and is further studied theoretically by Williamson (1979, 1985), Grossman and Hart (1986), and Homstrom and Milgrom (1994), and empirically by Baker and Hubbard (2003) and Hubbard (2000), among others. The international trade literature has also analyzed outsourcing in international trade (see, e.g., Feenstra and Hanson 2003; Grossman and Helpman 2002, 2005).

outsourcing related services. We consider spillovers and agglomeration effects with respect to location and industry, and define spatial and industry spillovers across firms as a linkage in the adoption decisions across firms. These spillovers contain the effect on the adoption decision due to the experience of other firms. Normally, spillover effects are expected to be positive: adoption of a practice leads to "demonstration effects" which in turn tend to spur their peers and neighbors to adopt it. But these demonstration effects can also provide examples to be avoided, a case that is less often encountered in the academic literature, though it does appear in the business press.[2] Additionally, for a new service, outsourcing might be the easiest and quickest way of obtaining it, before determining what would be required to produce it in-house and deciding whether it is optimal to do so. Both of these effects are less relevant for the outsourcing of established services and production processes that had been examined in prior literature.

Our study utilizes data on the provision of website-related services. In this paper, we use "website-related services" to refer to IT services related to websites or other advanced services provided over the Internet, such as business-to-business exchanges and web-based customer services. These services include (but are not limited to) traditional web services (such as software provision), web server hosting, and website management. Despite the importance of IT and the broad interest in service outsourcing,[3] the extent of outsourcing IT services has not been studied extensively.[4] In

[2] Most relevant to this paper is an article in *The Economist* that yields the same punch-line as our research: outsourcing has many pitfalls, and includes some high profile failures, which leads other firms to be more cautious about its adoption ("The Trouble with Outsourcing," *The Economist*, July 30-August 5, 2011, page 64).

[3] See, e.g., Bresnahan, et al. (2002), Brynjolfsson and Hitt (2003), and Stiroh (2002) for the importance of IT in productivity growth. With regard to the discussion on service outsourcing, see, e.g., Amiti and Wei (2005).

[4] More generally, few studies examined trends in outsourcing through the use of micro data. Most empirical studies on the "make-or-buy" decision (see, e.g., Monteverde and Teece 1982; Masten 1984; Joskow 1987) have focused on providing evidence consistent with the theory of vertical integration, and they tend to examine specific cases that are unlikely to provide general trends in outsourcing. In contrast, many papers in the international trade have examined outsourcing in a global economy, and have presented general trends in international outsourcing. However, most of them have used information on trade in intermediate inputs as indirect measures of international outsourcing (see, e.g., Amiti and Wei 2005; Crino 2010; Hummels, Rapport, and Yi 2001). See also Forbes and Lederman (2009), who show how the "make or buy" decision is tightly related to the flexibility of responding to unanticipated events and on who bears the costs of adapting to these events. This may be more relevant for the web-hosting services than the web-design services, the latter being more of the nature of procuring a well-defined intermediate input.

addition, notwithstanding the large empirical literature on make-or-buy, few papers have directly examined both outsourcing and insourcing (henceforth, we refer to in-house provision as insourcing) of IT services.[5] This paper thus intends to help fill this gap as well.

Our focus on website-related services provides at least two important advantages. First, it helps in isolating experience and informational spillovers from spillovers based on local market thickness. A common source of spatial spillovers in outsourcing is through the presence of local suppliers: if many firms outsource physical inputs, this leads to an increase in the number of third party vendors that are able to provide them. This increase in the number of vendors leads to greater supply availability and lower delivery costs, which leads to a positive feedback by making outsourcing more desirable. In contrast, website-related services are non-physical services that are delivered via the Internet. Often, there is no "delivery" as the website is hosted outside the procuring firm, and the use of various communication technologies allows vendors to work with clients remotely. Therefore, spatial spillovers, if present, are unlikely to be primarily driven by local market thickness, but are more likely to result from the diffusion of information among clients (and potential clients), in a manner analogous to the R&D and technological spillovers documented in the innovation literature (e.g., Stoneman 2002). These informational spillovers would essentially substitute for a firm's own (or internal) experience and can be thought of as constituting "external experience." These two terms will often be used interchangeably in this paper. We recognize that at the industry level there may be both agglomeration effects and information spillovers.[6]

Second, the practice of outsourcing website-related services is relatively new, and it is changing

[5]Arora and Forman (2007) examine the relationship between local supply of outsourcing and different types of IT outsourcing. They study cross-sectional variations in different types of IT outsourcing, but do not examine variations over time. Furthermore, their study does not consider firms' decision to use in-house resources.

[6]Industry market thickness spillovers would exist if the needs for websites vary across industries and if vendors of website-related services specialize in providing website-related services to clients in particular industries. In fact, there is some evidence of such spillovers in our data.

rapidly due to fast improvements in information and communication technology. For example, some business applications such as customer relationship management (CRM) were traditionally provided in-house, requiring nontrivial investment in software, hardware, and IT personnel by each firm, but advances in the Internet allowed firms to outsource these IT services.[7] Moreover, the advent of sophisticated website-related services as a major component of business has been rather recent, suggesting that the experience of potential clients with vendors may be very limited. Thus, informational issues, a firm's recent outsourcing experience (and that of other firms), and the evolution of firms capabilities (possibly driven by better understanding of the service through prior outsourcing) are all very likely to play a large role in the provision of website-related services either in-house or through outside vendors. Importantly, given our source of data, the rapid evolution of website-related services as a market-provided service suggests that a relatively short panel can provide substantial identifying power.[8]

Our analysis utilizes detailed US establishment-level data on outsourcing IT services.[9] Because our data also contain information on insourcing website-related services, we are able to distinguish insourcing from complete lack of provision as the alternative to outsourcing of website-related services. Our data show that over 60% of single-establishment firms provided website-related services using either insourcing or outsourcing. Among them, nearly three-quarters of firms relied only on in-house resources, while approximately 12% used only outsourcing to provide website-related services (the remaining firms used dual sourcing). We also find that more firms have chosen to insource over time, whereas the number of firms using outsourcing slightly increased between

[7]One of these practices is called "software as a service", in which firms subscribe to CRM services, for instance, from service providers such as Salesforce.com, instead of incurring huge fixed costs to purchase related software and hardware, and maintain them in-house.

[8]The relative recency of the development of websites and their relatively small importance at the turn of the 20th century also imply that the location of establishments can be considered exogenous. It is extremely unlikely that an establishment chose one location as opposed to another on the basis of local availability of website-related services.

[9]Specifically, we use data from the 2000-2004 *Computer Intelligence Technology Database* collected by the Harte-Hanks Market Intelligence. Section 3 provides more detailed discussion of our data.

2000 and 2001, but decreased during the period between 2002 and 2004.

To explain these observed patterns, we investigate potential factors, particularly focusing on the role of information and experience in the decision to outsource website-related services. Considering the fairly low degree of web outsourcing, we consider three factors that can lead to barriers to its diffusion. The first factor is limited information about the availability of website service outsourcing as a viable business practice, or equivalently, its complete lack of viability as an option for some firms. Effectively, outsourcing is not on the choice-set of some firms. The second factor is the experience of other firms that outsourced website-related services, which could be either positive (and thus increasing the propensity of adoption by other firms) or negative (leading to a decrease in the probability of adoption by other firms). If this "external experience" provides negative feedback about the value of the outsourcing option, then the low degree of outsourcing website-related services might reflect this negative information about such outsourcing. The third factor is the effect of internally generated information on outsourcing, particularly the effect of a firm's experience with outsourcing other IT services, excluding website-related services. A firm's own prior experience with outsourcing other IT services increases the information available to the firm about the outsourcing process and options, hence reducing the transactions costs of outsourcing in general. A negative association between this internal experience and outsourcing website-related services would suggest that IT outsourcing is not broadly successful in general, and would provide strong evidence corroborating any negative effects of external experience about website-related services in particular. A positive association would suggest that internally generated information and experience can either directly reduce a firm's reservations about website-related services outsourcing or reduce the transaction costs enough to compensate for any reservations the firm might have. Confidence in this interpretation is stronger given that we control for firm unobserved heterogeneity.

In addition to these factors, we discuss and assess the possibility that outsourcing experience (whether "internal" or "external") with this particular service can affect a firm's own ability to provide it in-house by providing the firm with useful technical and organizational information.

To assess the empirical validity of the informational effects, we use both latent and proxy variables. The latent variable separates two possible regimes: In the first regime, firms consider all possible options: insourcing, outsourcing, or forgoing either. This regime corresponds to firms which have sufficient information about outsourcing and which could outsource, if they chose to. In the second regime, firms choose only between insourcing or forgoing website-related services. This regime corresponds to firms that have no information about outsourcing, or for which outsourcing is not be a viable option under any circumstances. A high probability of the first regime suggests that firms are not outsourcing because that they do not find this choice worthwhile relative to the alternatives. A low probability of the first regime suggests that for most firms the relevant choices are to deliver website-related services in house or not to obtain them at all. The set of explanatory variables includes variables that are associated with greater regional and industry experience in outsourcing of website-related services (e.g., the fraction of firms in the same region or industry that outsource website-related services), and variables that are associated with greater own experience with outsourcing of related services (e.g., whether or not a firm outsourced other IT services in the past). In addition to these variables, we also employ a set of other controls for observed heterogeneity that is relevant for the payoff of different types of provisions of website-related services. Because unobserved heterogeneity in these payoffs could confound the sourcing decision, our estimation framework also allows for time-invariant unobserved heterogeneity at the firm level.

Our estimation results show that the probability of being in the first regime is very high, that is, most firms appear to consider the outsourcing option: thus, its low prevalence is not because it is not a relevant option. Moreover, our results show that the probability of outsourcing decreases with the fraction of other firms (in the same location or industry) that outsourced website-related services, suggesting that the experience of these firms conveys negative information and discourages their neighbors or peers from outsourcing website-related services. However, we also find prior experience with outsourcing other IT services increases the probability of outsourcing website-related services, which suggests that this prior experience lowers the transaction costs associated with outsourcing of website-related services (or otherwise increases its perceived net value). An alternative explanation that is consistent with this negative effect is that outsourcing is a first step for many firms to learn (at a low cost) the value and implementation needs of website-related services before deciding whether to develop them in house. In that case, industry-level and location-level adoption waves would yield this exact pattern, as we detail later in the paper. Our findings with respect to all other control variables conform to expectations.

This paper is closely related to Ono (2007), where she shows that outsourcing is more likely in "thicker" markets. Unlike our work, she uses exogenous measures associated with market size, such the population of an MSA and the propensity of firms located in it to outsource a particular service (which would further increase the availability of suppliers for that service). She finds that for software and data processing, the closest category to the one we analyze in our study, outsourcing is higher in MSAs with a larger population. Note that in our analysis, we effectively combine both components of market thickness into one, based on the lagged outsourcing decisions of all firms in a location. This is feasible in our data, because we only examine the outsourcing of a non-physical service where entry costs in a location are unlikely to be correlated with unobserved costs of transacting between firms. An earlier work, by Ono (2003), showed that facilities of multi-establishment firms can obtain agglomeration spillovers from the provision of services in areas where the firm's administrative headquarters are located. This is because some services can be outsourced by the headquarters on behalf of all facilities of that firm. This finding shows that it is important to consider in our analysis single establishment firms, to remove ambiguity as to where potential spillovers are occurring.[10]

The rest of the paper is organized as follows. In Section 2, we provide our theoretical framework and describe our econometric model. Section 3 describes our data and documents the patterns in website-related services outsourcing and insourcing. Section 4 presents our estimation results and discussion. Section 5 concludes the paper.

2 Modeling and Empirical Framework

2.1 A Stylized Model

We begin by considering a firm's decision on how to provide website-related services. There are two regimes: in the first regime, firms have information on outsourcing and it is a potentially viable option for them; in the second regime, outsourcing is not a potentially viable option for firms under any circumstances, or if for whatever reason the firm is unwilling to consider that option. Non-viability is possible, for example, if the required services by the firm cannot be provided by any vendor or if website-related services must be provided in-house (if at all) for security or proprietary reasons. An example of unwillingness to consider could be driven by managerial preferences (perhaps prior experience of managers with other types of outsourcing, possibly while employed by other firms). If firms are in the first regime, they can develop their website-related

[10]For example, it would be unclear whether we should treat an adoption by any establishment of a firm as an adoption by all firms, and also unclear which regional spillovers would be relevant, that of all establishments of the firm or that of the establishment that is reported as having the website-related activity. Nonetheless, in our analysis we take into consideration the outsourcing decisions of multi-establishment firms in computing the spillover variables, i.e., they are included on the Right-Hand Side variables, though the decisions themselves are not explained, i.e., they are not part of the Left-Hand Side.

services using in-house resources, or outsource their development to independent contractors. They can also choose a combination of insourcing and outsourcing, or choose to forgo website-related services altogether. However, if firms are in the second regime, outsourcing is not an option and they can choose only between insourcing website-related services and no website-related services. This formulation naturally leads to a mixture model, which we develop in section 2.2.

Firms have needs for website-related services of particular types. Website service types are characterized by their location on a unit (Salop) circle. A firm desires a website service of location or attribute x_d, where distance is measured clockwise from the top of the circle. Note that all variables in this section are understood to be indexed by firm i, but the subscript i will be omitted for ease of notation. A set of independent providers/vendors can provide website-related services with attributes given by locations x_ξ, with $\xi = 1, \ldots, \Xi$. The firm can develop a website service of any type by incurring a fixed cost of F, or forgo the use of a website service.

The choice of a website service with an attribute x_k is related to the firm's gross (expected) profit through the function $R(1 - r|x_k - x_d|)$, where R is a measure of the scale of the firm, and r is a measure of the sensitivity of the firm's profits to the fit of the website service with its business model and lies in the $[0, 1]$ interval.[11] We adopt such a parsimonious reduced form representation of the profit function because our data do not provide any information on the deeper constituent elements of the profit function.

To derive the optimal choice of the firms, we need to compute the payoff for each possible choice. Let x_a denote the attribute of a website service provided by the nearest vendor. Then, the firm's net payoff function from outsourcing and obtaining a website service with characteristics x_a is

$$\pi^{\mathsf{out}} = R(1 - r|x_a - x_d|) - C$$

[11] We recognize that many other factors, unknown at the time of the website service development, will affect the firm's profit. Throughout, "profit" will refer to "expected profit" with the expectation taken over all these other factors.

where C is a transaction cost which includes the costs associated with identifying the vendor, negotiating any firm-specific adaptation of the website service, and concluding the negotiations (and paying the delivery price).[12] On the other hand, if the firm uses in-house resources, it will choose to build the desired website service with attribute x_d, and its net profit is

$$\pi^{\mathsf{inh}} = R - F$$

where F is the in-house development cost. However, if it chooses to not have a website service, we assume that its profit is given by

$$\pi^{\mathsf{no}} = R(1 - r).$$

Given that the fraction of firms using both insourcing and outsourcing is not negligible, we also consider one more possibility: the firm may outsource some components of website-related services provision while producing other components in-house. In that case, the firm would incur total costs of $\lambda C + (1 - \lambda)F$ where $\lambda \in (0, 1)$, i.e., we assume that the costs of mixed sourcing are a weighted average of the costs of outsourcing and insourcing. The combination of outsourcing and insourcing then produces website service with the attribute equal to x_m, which is stochastically located somewhere between x_a and x_d. Thus, the net payoff from mixed sourcing is written as

$$\pi^{\mathsf{both}} = R(1 - r|x_m - x_d|) - \lambda C - (1 - \lambda)F.$$

Let Δx_a and Δx_m respectively denote $|x_a - x_d|$ and $|x_m - x_d|$, where $\Delta x_a > \Delta x_m$, given that x_m is closer to x_d than x_a is. We can then rewrite π^{both} as follows.

$$\begin{aligned} \pi^{\mathsf{both}} &= \lambda[R(1 - r\Delta x_a) - C] + (1 - \lambda)[R - F] + rR(\lambda \Delta x_a - \Delta x_m) \\ &= \lambda \pi^{\mathsf{out}} + (1 - \lambda)\pi^{\mathsf{inh}} + \Gamma, \qquad (1) \end{aligned}$$

[12]Note the implicit assumption that (conditional on outsourcing) in equilibrium the firm transacts with the vendor which provides the product that is the closest fit to the firm's needs.

where $\Gamma = rR(\lambda \Delta x_a - \Delta x_m)$. Note that in general $\Gamma \neq 0$, and can be either negative or positive. Thus, even though the costs from mixed sourcing are a linear combination of the costs of either insourcing or outsourcing, the value from mixed sourcing is not a weighted average of the value of outsourcing or mixed sourcing (because of the randomness in the location of x_m). Therefore, some firms will strictly prefer mixed sourcing to a "corner solution" of pure sourcing. In particular, if x_m is very close to the desired website-related services configuration, x_d, relative to the best fully outsourced alternative, x_a, then $\Gamma > 0$. In that case, it readily follows from (1) that mixed provision dominates either outsourcing, or insourcing, or both. Thus, it is possible that the firm will choose mixed provision. If instead x_m is relatively closer to the best fully outsourced alternative x_a than to the desired website-related services configuration, x_d, then $\Gamma < 0$. In that case, mixed provision is dominated by either insourcing or outsourcing (or both) and will never be chosen by the firm.[13]

Given these payoffs for the four possible choices, firms will choose the choice that generates the highest net profit. If firms are in the first regime, then they will compare all four payoffs. On the other hand, if they are in the second regime, firms will compare only π^{inh} and π^{no}. In preparation for the next section, where we incorporate all these aspects to develop our econometric model, we observe that we cannot, with the availability of only choice data, estimate the profit functions. Rather we can only estimate them up to scale relative to a base outcome. We choose to use the choice of no provision of website-related services as the base outcome, and thus normalize π^{no} to zero. This is equivalent to subtracting $R(1-r)$ from all the net payoff expressions. The normalized

[13] Positive (or negative) Γ can be interpreted as complementarity (or substitutability) between outsourcing and insourcing, but we do not attempt to identify Γ in this paper, not only because its identification is difficult, but also because it is not the focus of this paper (see Gentzkow, 2007, for further discussion of the identification of the complementarity parameter Γ).

profits for other three choices are then written as

$$
\begin{aligned}
\Pi^{\mathsf{out}} &= rR(1-\Delta x_a) - C, && (2)\\
\Pi^{\mathsf{inh}} &= rR - F, && (3)\\
\Pi^{\mathsf{both}} &= rR(1-\Delta x_m) - \lambda C - (1-\lambda)F. && (4)
\end{aligned}
$$

Some comparative statics follow readily from these expressions. A very small firm whose profit is not very sensitive to the quality or fit of its website-related services will forgo website-related services, since Π^{out}, Π^{inh} and Π^{both} are all negative for low values of rR. A large organization whose business model has a high dependence on website-related services will tend to insource, because Π^{inh} is more responsive to rR than either Π^{out} or Π^{both}. If the contractual costs of outsourcing, C, are sufficiently low and the fit of outsourced website-related services is sufficiently close to the ideal website-related services desired by an intermediate sized firm, then that firm will either outsource or use a mix of insourcing and outsourcing. As discussed above, which of these two options is profit maximizing for such a firm depends on how smaller Δx_m is relative to Δx_a. A firm that is outsourcing or uses mixed sourcing may not have done so if contracting costs were higher.[14] Additionally, if a firm insources, higher costs of providing website-related services in-house may lead it to outsource fully or in part (or potentially to forgo website-related services altogether since none of the expressions in (2)-(4) is guaranteed to be positive). Higher availability of vendor offerings can lead a firm to outsource (since Δx_a would tend to decrease), but also use mixed sourcing (since Δx_m would also tend to decrease).[15]

Note that the above discussion assumes that all four choices are available to a firm. There may be circumstances that the two options involving outsourcing are not relevant either because of high

[14]Note that Γ does not contain C and thus a change in C does not lead into a switch from outsourcing to mixed sourcing or vice versa, but only leads into switches from either of them into no sourcing or insourcing.

[15]There may also be net movement between mixed sourcing or outsourcing, but of indeterminate sign.

transaction costs or because the firm is not considering outsourcing as an option. Removing these two options leads to a very straightforward choice between forgoing website-related services and providing them in house.

Also note that the parameters in (2)-(4) are functions of observed and unobserved characteristics of a firm and a market; thus these expressions are essentially stochastic, and the comparative statics stated above are best considered in terms of probabilities. In the next section, we describe the mapping and the linkage between this simple stylized model and our econometric framework.

2.2 Econometric Framework

To describe our econometric model, we consider three groups of variables for firm i at period t: X_{it} is a vector of variables that reflect R, the scale of firm i, and r, the degree of its dependence on website-related services for its business; Z_{it} is a vector of variables that reflect F, the costs associated with developing website-related services in-house; W_{it} is a vector of variables that capture C and Δx_a (or Δx_m), that is, transaction costs associated with outsourcing website-related services, and the extent to which firms' needs are met by outsourcing (or the combination of outsourcing and insourcing).[16] Implicit in the partition of the variable set are some exclusion restrictions, which provide identification without relying on distributional assumptions. Such exclusion restrictions are always only an approximation: very rarely does a variable have zero effect on an outcome. Exclusion restrictions ensure identification with a minimum of bias, making estimation feasible while also keeping the point estimates reasonable. Note that W_{it} includes firm's own past experience with outsourcing other IT services, as well as the experience of other firms in the same region or industry that outsourced website-related services. The proxies for a firm's own experience for IT outsourcing can affect the transaction costs associated with outsourcing website-related

[16]Though conceptually distinct, we do not separate the variables that correspond to each of these two elements of the model because they always enter equations (2)-(4) together.

services, and the experience of other firms with outsourcing website-related services allows the firm to evaluate the likely payoff of using the outsourcing option to obtain the website-related services that it desires. See Section 3.2 for a description of the variables used in our analysis.

Let A_{it} denote an indicator variable for whether firm i is in the regime in which all four choices are evaluated by a firm. Consider the case where $A_{it} = 1$, that is, where outsourcing is in the choice set. Using the variables above, we write the observed part of these profits in the following reduced form.

$$\begin{aligned}
\overline{\Pi}_{it}^{\mathsf{out}} &= X_{it}\beta_1 + W_{it}\gamma_1, \\
\overline{\Pi}_{it}^{\mathsf{inh}} &= X_{it}\beta_2 + Z_{it}\delta_2, \\
\overline{\Pi}_{it}^{\mathsf{both}} &= X_{it}\beta_3 + W_{it}\gamma_3 + Z_{it}\delta_3,
\end{aligned}$$

where β_1, γ_1, β_2, δ_2, β_3, γ_3 and δ_3 are parameters to be estimated. This is effectively a linearization of the expressions (2)-(4).

Given that we examine the effect of other firms' experience in the same region and industry, it is important to account for region-level and industry-level unobservables as potential confounding factors. To this end, we include region fixed effects $\tau_{j,\mathsf{region}}$ and industry fixed effect $\tau_{j,\mathsf{industry}}$ in each equation j, where $j = 1, 2, 3$ denotes the equations in (2)-(4). Another important confounding factor is the overall market trend such as the burst of the dot-com bubble in the early 2000s and the rebound of the stock markets in the mid 2000s which could explain the overall trend in outsourcing, but are not directly related to the informational spillovers we are interested in. To account for them, we allow for year fixed effects τ_{jt} in each equation j. In addition to these fixed effects, we also consider unobserved firm-specific heterogeneity θ_{ji} ($j = 1, 2, 3$). Lastly, we include idiosyncratic error terms ϵ_{1it}, ϵ_{2it} and ϵ_{3it} for each equation. Specifically, we assume that ϵ_{jit}

$(j = 1, 2, 3)$ follows i.i.d. extreme value distribution. Given these terms, the profits are written as

$$\begin{aligned}
\Pi_{it}^{\mathsf{out}} &= \overline{\Pi}_{it}^{\mathsf{out}} + \tau_{1it} + \theta_{1i} + \epsilon_{1it}, \\
\Pi_{it}^{\mathsf{inh}} &= \overline{\Pi}_{it}^{\mathsf{inh}} + \tau_{2it} + \theta_{2i} + \epsilon_{2it}, \\
\Pi_{it}^{\mathsf{both}} &= \overline{\Pi}_{it}^{\mathsf{both}} + \tau_{3it} + \theta_{3i} + \epsilon_{3it},
\end{aligned}$$

where $\tau_{jit} = \tau_{j,\mathsf{region}} + \tau_{j,\mathsf{industry}} + \tau_{jt}$ $(j = 1, 2, 3)$.

To derive the choice probabilities, let y_{0it} denote the indicator dummy for the choice of no website-related services, y_{1it} for outsourcing, y_{2it} for in-house provision, and y_{3it} for using both outsourcing and insourcing. The extreme value distribution assumption then implies the standard multinomial logit model, where the choice probability for outsourcing is given as follows.

$$\begin{aligned}
\Pr(y_{1it} = 1 | X_{it}, Z_{it}, W_{it}, A_{it} = 1; \theta_i) &= \Pr(\Pi_{it}^{\mathsf{out}} > 0,\ \Pi_{it}^{\mathsf{out}} > \Pi_{it}^{\mathsf{inh}},\ \Pi_{it}^{\mathsf{out}} > \Pi_{it}^{\mathsf{both}}) \\
&= \frac{\exp(X_{it}\beta_1 + W_{it}\gamma_1 + \tau_{1it} + \theta_{1i})}{1 + \sum_{j=1}^{3} \exp(X_{it}\beta_j + W_{it}\gamma_j + Z_{it}\delta_j + \tau_{jit} + \theta_{ji})}, \qquad (5)
\end{aligned}$$

where $\gamma_2 = \delta_2 = 0$. Similarly, we obtain the choice probability for in-house provision as

$$\begin{aligned}
\Pr(y_{2it} = 1 | X_{it}, Z_{it}, W_{it}, A_{it} = 1; \theta_i) &= \Pr(\Pi_{it}^{\mathsf{inh}} > 0,\ \Pi_{it}^{\mathsf{inh}} > \Pi_{it}^{\mathsf{out}},\ \Pi_{it}^{\mathsf{inh}} > \Pi_{it}^{\mathsf{both}}) \\
&= \frac{\exp(X_{it}\beta_2 + Z_{it}\delta_2 + \tau_{2it} + \theta_{2i})}{1 + \sum_{j=1}^{3} \exp(X_{it}\beta_j + W_{it}\gamma_j + Z_{it}\delta_j + \tau_{jit} + \theta_{ji})}. \qquad (6)
\end{aligned}$$

Finally, the choice probability for mixed sourcing is given by

$$\begin{aligned}
\Pr(y_{3it} = 1 | X_{it}, Z_{it}, W_{it}, A_{it} = 1; \theta_i) &= \Pr(\Pi_{it}^{\mathsf{both}} > 0,\ \Pi_{it}^{\mathsf{both}} > \Pi_{it}^{\mathsf{out}},\ \Pi_{it}^{\mathsf{both}} > \Pi_{it}^{\mathsf{inh}}) \\
&= \frac{\exp(X_{it}\beta_3 + W_{it}\gamma_3 + Z_{it}\delta_3 + \tau_{3it} + \theta_{3i})}{1 + \sum_{j=1}^{3} \exp(X_{it}\beta_j + W_{it}\gamma_j + Z_{it}\delta_j + \tau_{jit} + \theta_{ji})}. \qquad (7)
\end{aligned}$$

To allow for unobserved individual heterogeneity θ_{ji}, we consider a random effects approach, in which we assume that θ_{ji} follows the normal distribution $N(0, \sigma^2)$.[17] Integrating out θ_{ji} yields the

[17] We also consider more flexible specifications in which $(\theta_{1i}, \theta_{2i}, \theta_{3i})$ follows the multivariate normal distribution $N((0, 0, 0)', \Sigma)$, where Σ is the covariance matrix. However, this requires more complicated simulation estimation, while we found that our model estimates changed only slightly. For this reason, our reported results are based on a simple specification where we assume that Σ is equal to $\sigma^2 I$, where I is the 3×3 identity matrix.

unconditional choice probabilities as

$$\Pr(y_{jit}=1|X_{it},Z_{it},W_{it},A_{it}=1,\sigma)=\int_{\theta}\frac{\exp(X_{it}\beta_j+W_{it}\gamma_j+Z_{it}\delta_j+\tau_{jit}+\theta_{ji})}{1+\sum_{l=1}^{3}\exp(X_{it}\beta_l+W_{it}\gamma_l+Z_{it}\delta_l+\tau_{lit}+\theta_{li})}dF(\theta),$$

where $F(\theta)$ is the distribution of θ. However, the integral above does not have a closed-form solution. Hence, we use a frequency estimator, taking draws from the distribution of θ, to form estimates of these probabilities. Specifically, for each firm, i, we draw S vectors of independent standard normal random variables $(u_{1i}^h, u_{2i}^h, u_{3i}^h)$, $h=1\dots S$, and then compute the simulated probabilities as

$$\Pr(y_{jit}=1|X_{it},Z_{it},W_{it},A_{it}=1,\sigma)=\frac{1}{S}\sum_{h=1}^{S}\frac{\exp(X_{it}\beta_j+W_{it}\gamma_j+Z_{it}\delta_j+\tau_{jit}+\sigma u_{ji}^h)}{1+\sum_{l=1}^{3}\exp(X_{it}\beta_l+W_{it}\gamma_l+Z_{it}\delta_l+\tau_{lit}+\sigma u_{li}^h)}, \quad (8)$$

where S is the number of simulations; σ is the common standard deviation for $(\theta_{1i},\theta_{2i},\theta_{3i})$ and is a parameter to be estimated. Note that the same draws $(u_{1i}^h, u_{2i}^h, u_{3i}^h)$, $h=1\dots S$, are used for firm i in all time periods. In our estimation, we use the simulated probabilities in (8) to compute the likelihood function.

The choice probability under the second regime can be derived as follows. In the second regime, a firm makes a binary choice between insourcing and no website service for reasons detailed at the start of section 2.1. As a result, the choice probability of insourcing is given by

$$\begin{aligned}\Pr(y_{2it}=1|X_{it},Z_{it},W_{it},A_{it}=0;\theta_i) &= \Pr(\Pi_{it}^{\mathsf{inh}}>0)\\ &= \frac{\exp(X_{it}\beta_2+Z_{it}\delta_2+\tau_{2it}+\theta_{2i})}{1+\exp(X_{it}\beta_2+Z_{it}\delta_2+\tau_{2it}+\theta_{2i})}.\end{aligned}$$

Similar to the first regime, we use a frequency simulator to integrate out θ_{2i}. The simulated unconditional probability for the second regime is then given by

$$\Pr(y_{2it}=1|X_{it},Z_{it},W_{it},A_{it}=0,\sigma)=\frac{1}{S}\sum_{h=1}^{S}\frac{\exp(X_{it}\beta_2+Z_{it}\delta_2+\tau_{2it}+\sigma u_{2i}^h)}{1+\exp(X_{it}\beta_2+Z_{it}\delta_2+\tau_{2it}+\sigma u_{2i}^h)}. \quad (9)$$

where the draws $(u_{1i}^h, u_{2i}^h, u_{3i}^h)$, $h=1\dots S$ for firm i are the same as in the first regime.

If A_{it} were observed, we could simply estimate the parameters by using (8) for observations in the first regime, and by using (9) for observations in the second regime. Because A_{it} is not observed, however, we consider a mixture model, in which firm i is assumed to be in the first regime with a probability equal to ψ, and in the second regime with a probability equal to $1-\psi$. The parameter ψ, therefore, measures the degree to which firms are informed about the outsourcing option and consider it as a possible viable source of website-related services provision.[18]

To estimate the model, we use the choice probabilities in (8)-(9) and obtain the log-likelihood

$$\begin{aligned}\ln L \;=\; \sum_{t=1}^{T}\sum_{i=1}^{N_t} \; & y_{0it} \times \ln\left[\psi \Pr(y_{0it}=1|A_{it}=1) + (1-\psi)\Pr(y_{0it}=1|A_{it}=0)\right] \\ & + y_{1it} \times \ln\left[\psi \Pr(y_{1it}=1|A_{it}=1)\right] \\ & + y_{2it} \times \ln\left[\psi \Pr(y_{2it}=1|A_{it}=1) + (1-\psi)\Pr(y_{2it}=1|A_{it}=0)\right] \\ & + y_{3it} \times \ln\left[\psi \Pr(y_{3it}=1|A_{it}=1)\right], \qquad (10)\end{aligned}$$

where X_{it}, Z_{it}, and W_{it} are suppressed to simplify the exposition, T is the numbers of years spanned by our sample, and N_t is the number of observations in year t. The model above is similar to switching regression models, e.g., as in Lee and Porter (1984) and Porter (1983). We can estimate the model by using a standard maximum likelihood estimation. If the region and industry fixed effects are based on very fine partitions (e.g. five-digit NAICS), the estimation becomes difficult. For this reason, our definition of region is the MSA and establishments located outside MSAs are not included in the analysis, while the industry partition is at the three-digit NAICS level.[19] The sourcing ratios of other firms in the same region or industry are also defined accordingly.

We conclude this section by a brief discussion of the identification of the switching probability ψ

[18]We assume that ψ is the same for all firms, but we acknowledge that it may be higher for firms co-located with other outsourcing firms or in industries where outsourcing is prevalent. Nevertheless, the estimated value of ψ is rather high, suggesting that firms consider outsourcing as an option in most markets.

[19]Moreover, a location or industry that has less than 10 establishments is not included, so that counts and ratios are obtained from meaningfully large samples. This results in a very minor reduction in our observations.

and of unobserved heterogeneity. The main source of identification of ψ is the exclusion restriction, in that W_{it} does not enter in $\overline{\Pi}_{it}^{\mathsf{inh}}$ and enters only in $\overline{\Pi}_{it}^{\mathsf{out}}$ and $\overline{\Pi}_{it}^{\mathsf{both}}$. Hence, the firm's decision in the second regime does not depend on W_{it}, which separates the regimes and helps identify ψ. Additional identification is obtained from the fact that firm and market characteristics have no impact on the probability of outsourcing if $A_{it} = 0$. Unobserved firm heterogeneity is identified by the persistence of firm choices as time varying characteristics change, relative to what one would expect from the distribution of firms to these choices in a cross-section.

3 Data and Descriptive Statistics

3.1 Data Description

We use data from the 2000-2004 *Computer Intelligence Technology Database* (CITDB) collected by the Harte-Hanks Market Intelligence. The CITDB is a yearly survey of over 100,000 establishments in the United States. It contains detailed establishment-level data on the use of a variety of information and communication technologies. This dataset has been used in several papers (e.g., Bresnahan, Brynjolfsson, and Hitt 2002; Bresnahan and Greenstein 1996; Hong and Rezende 2011). The CITDB is useful for our purpose because it contains information on both insourcing and outsourcing. The unit of observation is an establishment in a year.

Note that Harte-Hanks has attempted to survey the same establishments each year, so that the dataset contains panel information of many establishments. Because of the voluntary nature of the survey, however, some establishments did not respond to survey requests. Moreover, the CITDB has added new establishments each year. As a result, the total number of observations remains similar each year, but information is not available for some establishments every year. This issue is not particularly serious in our study because our analysis does not require complete panel data. Nevertheless, it raises a concern that the distribution of establishments over industries may be different in our sample from that of the population. To address this concern, we additionally use the number of establishments by two-digit NAICS industry in the 2000 County Business Patterns data, and weight the number of establishments in our data.[20]

In our analysis, we restrict our sample as follows. First, we drop observations that contain outdated information on computing technology. The CITDB does not have current information from all establishments each year, which means that information collected in the previous year is reused for some establishments. However, the CITDB also reports the date when the information was collected, which allows us to use only observations with up-to-date information on IT. Second, we exclude observations outside Metropolitan Statistical Areas (MSAs), because most areas outside MSAs tend to have a small number of firms, and outsourcing ratios based on a small number of firms can be noisy.[21] Third, we only consider the decisions of single-establishment firms, in order to help isolate the sourcing decisions as described in our stylized theoretical framework and avoid dealing with any firm-wide considerations. In a multi-establishment firm, it is unclear whether each establishment decides its own sourcing decision, or whether one of the facilities is providing website-related services to other facilities of the same firm (either through in-house provision or through outsourcing). Moreover, each establishment of a multi-establishment firm may contain a distinct line of business of that firm, and each line of business may make its own website-related services sourcing decision using resources that may be located on other establishments of that same firm (and possibly on top of any parent firm website-related services provision). Modeling the decisions of multi-establishment firms in a way that is conformable with our establishment level data would be complicated. Therefore, our empirical analysis does not examine the decisions of multi-

[20] See, e.g., Forman, Goldfarb, and Greenstein (2010). We follow their approach to weight the observations in the CITDB by using the Census Bureau's County Business Patterns data.

[21] For this reason, we also checked MSAs that have less than 10 firms in a year. There is a minuscule number of observations that fall in this group; we removed those as well, even though they do not have a measurable impact.

establishment firms, and we henceforth use the terms "firms" and "establishments" interchangeably.

3.2 Variable Definition

This section first describes our variables for sourcing decisions. We then discuss our variables related to spillovers and other firm characteristics.

3.2.1 Sourcing Decisions

To examine the sourcing decisions to provide website-related services, we use the following variables. First, we define `web.outsource` to be a dummy indicator variable for whether a firm outsources at least one of the following services: web server hosting, website management, or web application development. Though the CITDB separates these outsourcing activities, we combine them because they are all directly related to the provision of website-related services using outside vendors, and they are highly positively correlated, that is, firms outsourcing, say, web server hosting services tend to outsource website management and web application development as well. Because the focus of this paper is not to study complementarity between different outsourcing activities, we do not consider them separately in our main analysis.[22] Moreover, our definition of outsourcing is more robust than using each individual sub-category: a firm may misclassify any outsourcing it does, and (of even greater concern) may only report that category that fits best to the nature of its outsourcing, even though its outsourcing contract contains elements of multiple categories. However, as a robustness check, we also consider the outsourcing of each of these activities separately.

Second, we define `web.inhouse` to be an indicator variable for whether a firm uses in-house resources to provide website-related services. Though the CITDB does not provide the exact variable for this sourcing decision, it contains information that indicates insourcing.[23] Specifically,

[22]The CITDB also contains information on outsourcing routers or firewalls in the web outsourcing category, but we do not consider this information because it is not directly related to the provision of website-related services.

[23]Firms can still have websites even though they do not report having a homepage for their Internet application. Moreover, advanced website-related services are not limited to providing websites. Therefore, we also consider multiple

we consider that a firm is insourcing if it has a homepage for its Internet application, owns any Internet server, or employs web developers.[24]

Third, we define web.both to be an indicator variable for whether a firm uses both outsourcing and insourcing to provide website-related services. A firm may outsource elements of website-related services and produce others in-house by maintaining some of the capabilities described above. The number of firms using both provision methods is substantial in our data.

In our analysis, we consider the following mutually exclusive decisions as our dependent variable: web.outsource.only, web.inhouse.only, web.both, and web.none (which is the omitted category), where web.outsource.only is the indicator variable that takes the value of one if web.outsource is equal to one and web.both is equal to zero; web.inhouse.only is an indicator variable that takes the value of one if web.inhouse is equal to one and web.both is equal to zero, and web.none is an indicator that takes the value of one if web.outsource and web.inhouse are both zero.

We focus on the sourcing decisions to provide website-related services, but not other IT services, for two reasons. First, though the CITDB contains information on the outsourcing of several IT services, constructing variables for both insourcing and outsourcing is possible in our data only for the provision of website-related services. For other IT services such as help desk or system integration, we do not have sufficient information to do so, because we have no reliable way to determine whether a firm which does not outsource, for example, the help desk function, has developed a similar function in-house. Second, the growth of the Internet stems from the development and provision of advanced website-related services such as websites or web-based consumer services.

sources of information that is indicative of whether the firm provides website-related services using in-house resources.

[24]This definition of in-house provision might be considered broad. In particular, owning an internet server and installing website-related software on it may not be an indication of meaningful in-house development of website-related services. However, our definition is purposefully broad to include even the use of off-the-shelf software installed on an establishment's own IT equipment. Effectively, if an establishment does not contract with an external entity for its website-related services but has a website presence, it is considered as producing it in-house.

Thus, understanding the adoption pattern of website-related services is important.

Nonetheless, we utilize information on the outsourcing of other IT services to account for the effects of prior firm experience with outsourcing and any concomitant information the firm has obtained (and to additionally control for overall propensity to outsource). We consider the following four dummy variables: (a) programming.outsource, an indicator variable for whether a firm outsources programming services, including application design, contract programming, packaged software implementation, and application development not related to Website services; (b) servicing.outsource for outsourcing services such as help desk, capacity planning, system tuning, and systems integration.; (c) lan.outsource for outsourcing IT services related to local area network (LAN) or wide area network (WAN), including LAN or WAN client/server, LAN or WAN design, LAN or WAN implementation, LAN or WAN network management; and (d) other.outsource for outsourcing any of these three types of IT services.

3.2.2 Spillovers and Other Firm Characteristics

We next turn to the description of the variable vectors X_{it}, Z_{it}, and W_{it}. The first group of variables, X_{it}, consists of #employees and #internet.users within a firm that capture the firm's scale. X_{it} also includes e-business, an indicator variable for whether Internet application includes business-to-business or business-to-consumer exchanges, and customer.service, a dummy variable for whether the Internet application covers customer services, which captures the degree of business dependence on website-related services. The second group of variables, Z_{it}, is related to the costs associated with developing website-related services in-house. We use #programmers and total.server, the number of programmers and the number of computer servers within a firm, as proxies for a firm's internal capabilities and website-related development costs, and (more broadly) strategic interest in developing the service in-house.[25]

The third group of variables, W_{it}, is related to the transaction costs of outsourcing and the extent to which firms perceive that their needs are met by outsourcing. For W_{it}, we consider two kinds of proxies. First, we use $\mathsf{programming.outsource}_{i(t-1)}$, $\mathsf{servicing.outsourcing}_{i(t-1)}$, and $\mathsf{lan.outsource}_{i(t-1)}$, and interpret their effects as described above. Second, we use variables that reflect the experience of other firms in the same region/MSA (the two terms will be used interchangeably from now on) or industry: $\mathsf{out.only.ratio.region}_{i(t-1)}$ and $\mathsf{out.only.ratio.industry}_{i(t-1)}$, where $\mathsf{out.only.ratio.region}_{i(t-1)}$ is the fraction of other firms in the same MSA that used only outsourcing to provide website-related services at the previous period, and $\mathsf{out.only.ratio.industry}_{i(t-1)}$ is defined similarly for the same industry. The experience of other firms helps a firm update the value it perceives from choosing outsourcing itself.

There are four remarks about these spillover variables. First, $\mathsf{out.only.ratio.region}_{i(t-1)}$ (or $\mathsf{out.only.ratio.industry}_{i(t-1)}$) is the fraction of web.outsource.only for all firms in the same MSA (or industry), excluding firm i. We use web.outsource.only, instead of web.outsource, because web.outsource contains both insourcing and outsourcing, and thus, this variable might reflect not only information about outsourcing, but also information about insourcing. However, our robustness check also considers $\mathsf{out.ratio.region}_{i(t-1)}$ and $\mathsf{out.ratio.industry}_{i(t-1)}$, where $\mathsf{out.ratio.region}_{i(t-1)}$ (or $\mathsf{out.ratio.industry}_{i(t-1)}$) is the fraction of web.outsource for all firms in the same MSA (or industry), excluding firm i.

Second, these variables are lagged because they might be affected by firm i's outsourcing decision at the same period (or affected by a common industry or region specific temporal shock).[26] The use

[25]Note that we are not interested in the causal impact of having an additional, say, programmer employed by a firm on the likelihood that it insources website-related activities. We are interested in how internal firm IT capabilities (including managerial attitudes towards technology) affect that likelihood. These variables are used as proxies because of their correlation with capabilities and unobserved managerial preferences.

[26]It is still conceptually possible to have simultaneity even with the lagging of these variables. Areas with a lot of

of lagged variables results in the loss of one year of data. When we compute $\mathsf{out.only.ratio.region}_{i(t-1)}$ (or $\mathsf{out.only.ratio.industry}_{i(t-1)}$) for firm i, we use all other establishments in the same MSA (or industry) with up-to-date information on IT, excluding firm i.[27]

Third, these experience spillover proxies are defined as the ratio of firms in an MSA/industry that outsource, rather than the number of firms that do so. This reflects the notion that interactions between any pair of firms (and their personnel) is likely to be higher if these firms are located in a smaller MSA (or industry) than if they were located in a larger MSA (or industry). Thus, for example, five firms with outsourcing experience in a (relatively small) locality with 11 firms are more likely to transmit information to their typical neighbor, than five firms with outsourcing experience in a large metro area with hundreds of other firms (where the typical neighbor may be physically distant). In robustness checks, we also consider out.only.number.region (or out.only.number.industry) which is the number of firms in the same MSA (or industry) that use only outsourcing to provide website-related services. We have also estimated models in which both sets of spillover variables are used. In this last setting, out.only.number.region (or out.only.number.industry) is likely to capture the "thickness" of the local (or industry-specific) market for web service outsourcing, since the number of third party vendors for website-related services is likely to depend on the number of firms that outsourced website-related services, rather than the ratio of firms.

Fourth, these outsourcing ratios are computed without using any weights, because the CITDB does not provide any sampling weights for its observations. However, in order to account for the possibility that the distribution of establishments in the CITDB may not be the same as that in the population, we additionally consider an ad hoc approach to compute a weight by using the number

outsourcing in the past may bring in a lot of IT personnel in an area, making it easier for firms to hire IT employs, and thereby increasing in-house production. This channel, however, operates through the firm level capabilities, which are controlled for (with a lag). The only source of bias, then, would occur if the extent of regional outsourcing last year affected this year's incremental hiring, a very marginal effect.

[27] For the calculation of these ratios, we include establishments of both single and multiple-establishment firms.

of establishments by two-digit NAICS industry in the 2000 County Business Patterns (CBP) data. Specifically, for the region-level ratios, the weight is given by

$$\begin{aligned}\text{CBP weight} \quad = \quad & \frac{\#\text{ establishments in industry-region from CBP}}{\#\text{ establishments in region from CBP}} \\ & \times \frac{\#\text{ establishments in region from CITDB}}{\#\text{ establishments in industry-region from CITDB}}.\end{aligned}$$

The weight for the industry-level ratios is similarly defined by using # establishments in industry (instead of region). We then compute outsourcing ratios using these weights. Summary statistics of the unweighted ratios and the CBP weighted ratios are fairly similar. The means and standard deviations of the unweighted out.only.ratio.region and the CBP weighted out.only.ratio.region are respectively 0.071 (0.024) and 0.078 (0.030), where standard deviations are in parenthesis. Similarly, the means and standard deviations of the unweighted out.only.ratio.industry and the CBP weighted out.only.ratio.industry are respectively 0.068 (0.030) and 0.066 (0.033). Most of our analysis uses the unweighted ratios, because the CBP weights are not the sampling weights for observations in our data. However, we also estimate our model using the CBP weighted ratios as a robustness check.

3.3 Outsourcing Patterns

The broad patterns of website-related services outsourcing are reported in Table 1. Panel A reports the mean of variables for IT outsourcing for the sample of both single-establishment firms and multiple-establishment firms. Panels B-C present similar means for only single-establishment firms. Panel C further restricts to the sample of single-establishment firms that are observed in the previous year as well, which is the one used in estimation given the need to use lagged variables.

Panel A shows that 59% of firms provided website-related services using either insourcing or outsourcing, with moderate variations over time.[28] Among them, about 72.5% (= 0.428/0.59) of

[28] In the table, see web.all which combines web.inhouse.only, web.outsource.only, and web.both.

firms used only in-house resources, and the fraction of these firms has increased over time. In contrast, about 10.5% (= 0.062/0.59) of firms used only outsourcing to provide website-related services, and the fraction of these firms increased slightly between 2000 and 2001, but has declined since 2001.[29] We also consider the patterns in outsourcing other services, i.e., programming.outsource, servicing.outsource, and lan.outsource. A relatively small number of firms outsourced the provision of these services, and this number declined during the 2000-2004 period. Therefore, despite the seemingly rapid growth in outsourcing in general,[30] the extent of IT outsourcing was fairly low and stable.

The summary statistics are similar in the next two panels, B and C. This suggests that our results are unlikely to change significantly even if we incorporate the decisions of multiple-establishment firms in our analysis, or do not restrict to the sample of firms that are also observed in the previous year. However, the estimation sample, which overweighs small firms and those that report consistently, exhibits somewhat accentuated trends in insourcing and away from outsourcing and mixed-sourcing. This decline in outsourcing and shift to in-house provision is one of the key features in our results. To assuage ourselves that the observed shift in the summary statistics is not driven by composition effects, i.e., by the entry into the sample of establishments that did not report in the preceding period and the departure of establishments that did, we provided the figures in Panel C calculated on the basis of a chain index based on repeat observations of the same establishments.

In particular, we calculated the percentage change in insourcing, outsourcing, or mixed sourcing between year t and $t+1$ from the change in the sourcing decision of the establishments observed in

[29]Note that the fraction of firms outsourcing, including those using both insourcing and outsourcing, can be simply computed by combining web.outsource.only and web.both. Given that the fraction of using both has increased only slightly in 2002 and then decreased since 2002, the fraction of firms outsourcing has also declined since 2001.

[30]Mankiw and Swagel (2006, p. 1051) point out that the amount of offshore outsourcing until 2006 was "fairly small except in the popular imagination".

both periods, i.e., excluding those that we observed in only one of the two years. We compute the fraction of firms that use a particular sourcing decision recursively using the previous year's level, with the level in the year 2000 being the one in Panel C. This accounts for any changes in sample selection (though not for the level effect across all years). The values in 200 and 2001 are the same as those in the same as those in our estimation sample (since we Panel C includes firms for which we observe their lagged values), but they diverge thereafter. The patterns in Panel D are not very different from those in Panel C, and to the extent that they differ, they further accentuate the shift from outsourcing to insourcing. Therefore, the key pattern identified in our estimates may in fact be conservative compared to the actual shift in sourcing decisions in the market.

Because website-related services (and IT) outsourcing was a relatively rare business practice, a low level of its diffusion might be explained by limited information. However, if limited information is the main reason, it is puzzling that the number of firms outsourcing has decreased, because more firms are likely to have learned about outsourcing this practice over time. By contrast, our data show that more firms have used in-house resources to provide Web services over time. This suggests the possibility that outsourcing IT services might not meet the needs of many firms, and as external experience accumulates, more firms have learned about the inadequacies of such outsourcing and decided to use in-house resources for the provision of website-related services.

There is also an alternative possibility. Instead of the perceived value of outsourcing decreasing, the net value of in-house provision could be increasing. This would still lead to a transition from outsourcing to insourcing. However, any such increase in the value of insourcing must be concentrated to firms that have had outsourcing experience. This is because the number of firms that have website activities is broadly constant; we only observe a reduction in outsourcing and dual sourcing with a commensurate increase in in-house provision.

In the next section, we present our results that corroborate these hypotheses, and discuss the relevant mechanisms in more detail. Our estimation proceeds using the 73,391 establishment observations in the Panel C. These observations do not form a balanced panel. Experience effects might be better identified if we had a longitudinal dataset. Unfortunately, doing so would eliminate most of the remaining sample. In brief, too many facilities are missing one or two years, out of the five years in our sample window. We believe that any selection is unlikely to correlated with the frequency of outsourcing in the industry or the region and thus will not bias the results obtained below. The comparison of summary statistics between Panels C and D provides some additional reassurance.

4 Results

4.1 Baseline Results

We begin by estimating a multinomial logit model, the results of which are reported in Table 2. Because we do not impose the exclusion restrictions discussed in Section 2.2, all variables enter the equation for each choice. The coefficient estimates for each equation are presented in Panels A-C. For comparison, we first report the results without fixed effects. Columns 1-2 show that if we do not include region and industry fixed effects, then the coefficient estimates on $\mathsf{out.only.ratio.region}_{i(t-1)}$ and $\mathsf{out.only.ratio.industry}_{i(t-1)}$ are positive and significant in the equations for $\mathsf{web.outsource.only}$ and $\mathsf{web.both}$. Though these coefficient estimates are slightly reduced by including year fixed effects in Column 2, they still indicate that firms are more likely to outsource website-related services in regions and industries where the ratio of firms that outsource has been higher.

However, the positive correlation between outsourcing decision and the ratios of other firms' outsourcing likely reflects common region-specific or industry-specific unobservables that increase the likelihood of outsourcing in the same region or the same industry. To remove this (positive) bias due to these unobservables, we include fixed effects for region and industry in Column 3. In the resulting estimates, the coefficients on $\mathsf{out.only.ratio.region}_{i(t-1)}$ and $\mathsf{out.only.ratio.industry}_{i(t-1)}$ become negative and statistically significant in the equation for web.outsource.only, whereas they are statistically insignificant in the equation for web.both. These estimates indicate that higher rates of outsourcing in a region or industry are associated with a lower probability that any given firm (in those regions/industries) will outsource in the following year (recall that outsourcing ratios for firm i excludes firm i's decisions, either current or past). For the coefficients of $\mathsf{programming.outsource}_{i(t-1)}$, $\mathsf{servicing.outsource}_{i(t-1)}$, and $\mathsf{lan.outsource}_{i(t-1)}$ which capture own experience with IT outsourcing, we find that their coefficient estimates are all positive and statistically significant, but that their magnitudes are much larger in the equations for web.outsource.only or web.both than in the equation for web.inhouse.only. Thus, a firm's own experience in outsourcing other IT services is positively associated with the use of outsourcing the provision of website-related services.

These results are suggestive of the role of experience and information in the sourcing decision to provide website-related services, but the analysis is limited in a number of ways. In particular, none of the variable exclusion restrictions suggested by the stylized model are incorporated in the specification, and therefore, the equations cannot be considered as reduced form normalized payoff functions for each delivery choice. Moreover, the simple multinomial logit model does not partition the firms that consider all possible methods of provision for website-related services from the firms that do not consider the outsourcing option at all. Finally, the standard multinomial logit analysis does not account for unobserved firm-specific heterogeneity in the payoff functions. In the remainder of this section, we describe the results of our quasi-structural analysis which includes all of the above elements. Unless we note otherwise, this analysis also includes fixed effects for year, region, and industry in all models; these are not reported in the tables for brevity.

The baseline results from this estimation are presented Table 3. Column 1 of Table 3 incorporates the exclusion restrictions described in Section 2.2, while Column 2 adds unobserved firm heterogeneity using the approach described in that same section. The results show that the estimated standard deviation for unobserved heterogeneity, $\hat{\sigma}$, is small and statistically insignificant, suggesting that this type of unobserved heterogeneity might not be important in our data. In Column 3, we incorporate the mixture model which distinguishes between firms that choose between all available options and firms that consider only insourcing and no provision of website-related services. In this specification, too, unobserved heterogeneity is not statistically significant. For this reason, we ignore unobserved heterogeneity in all subsequent analysis. In Column 4 of the table, we report the results excluding unobserved heterogeneity. In the last two columns, the regime switching probability, ψ, is estimated precisely, with an estimate of 0.793 and a standard error of less than 0.05. This suggests that about 80% of the firms are in the first regime, in which they are considering all four sourcing options.

Turning to other coefficients of interest, the estimate of $\mathsf{out.only.ratio.region}_{i(t-1)}$ is negative and statistically significant in the equation for $\mathsf{web.outsource.only}$, while it is statistically insignificant in the equation for $\mathsf{web.both}$. These estimates suggest that a firm in a region with higher $\mathsf{out.only.ratio.region}_{i(t-1)}$ is less likely to outsource. Given the quasi-structural interpretation of the parameters, an increase in this ratio is associated with a reduction in the perceived payoff from outsourcing. The coefficient estimate on $\mathsf{out.only.ratio.industry}_{i(t-1)}$ is also negative and statistically significant in the equation for $\mathsf{web.outsource.only}$, but it is positive and marginally significant in the equation for $\mathsf{web.both}$. These estimates are consistent with the negative information story as well. A firm in an industry with higher $\mathsf{out.only.ratio.industry}_{i(t-1)}$ is less likely to use outsourcing only; that firm seems to attach a higher value to mixed sourcing, because even though outsourcing alone might not meet its needs, it could still be a desirable complement to own production. In other words, the experience of other firms in the industry about the exclusive use of outsourcing as a method of website-related services provision might raise a firm's perception of the value of mixed sourcing (recall that $\mathsf{out.only.ratio.industry}_{i(t-1)}$ does not include firms that use mixed sourcing; as we show below, when the firms that use mixed sourcing are included in the construction of the ratios, this sign also becomes negative).

The coefficient estimates on $\mathsf{programming.outsource}_{i(t-1)}$, $\mathsf{servicing.outsource}_{i(t-1)}$, and $\mathsf{lan.outsource}_{i(t-1)}$ are all positive and statistically significant in the equations for web.outsource.only and web.both, though the estimated magnitudes are slightly larger in Panel A than in Panel C. These estimates suggest that own experience with outsourcing other services seems to lower the transaction costs associated with outsourcing website-related services. Given our incorporation of unobserved heterogeneity and the use of the mixture model to account for firms that do not consider outsourcing, we believe that these variables do not act primarily as proxies for other unobserved firm characteristics but instead do reflect a reduction in the costs of outsourcing website-related services. The other possibility is that outsourcing other IT services increases the value of outsourcing website-related services, but we do not believe that such direct synergies are present. All these estimates provide evidence on the importance of information and experience (either a firm's own or from that of other firms) in the sourcing decision to provide website-related services.

The sign of the remaining parameters are consistent with our expectations, as expressed in the modeling framework. Both variables that proxy for firm size have a positive sign, though #employee is not statistically significant. Similarly, the two variables that are proxies for the value of website-related services to a firm (e-business and customer.service) are positive and statistically significant in all three payoff functions. Finally, the two variables that are proxies for a firm's internal capabilities to provide website-related services (#programmers and total.server) are both positive and statistically significant for the two payoff functions that involve insourcing (these variables do not enter in the outsourcing payoff function, as they do not have a direct or indirect effect there). However, contrary to expectations, the numerical value of these parameter estimates is similar in the payoff function for mixed sourcing and that for insourcing (rather than being higher for the latter). One possibility for this finding is that, contrary to the formulation in our stylized theoretical model, mixed sourcing is not an intermediate decision relative to insourcing and outsourcing. Rather, it may indicate a higher level of sophistication of website-related services than either of these other two provision channels. In other words, mixed sourcing might be considered as delivering the capabilities of insourcing plus some additional sophisticated capabilities that a firm cannot produce itself and procures from outside vendors. Such an alternative interpretation of the nature of mixed sourcing would not affect any of our interpretations (and conclusions) with regards to the effects of information and experience.

Our interpretation of the results, however, relies on the premise that outsourcing experience (whether external or internal) only conveys information about the value of outsourcing, and does not affect the value of in-house provision. Our exclusion restrictions explicitly impose this assumption. When those restrictions are not imposed, in-house provision (whether exclusive or dual) is often increasing in the outsourcing experience in the industry and the location. Moreover, in house provision seems to experience a secular increase in net "value" over time as indicated by the positive year effects. Given these observations, an alternative possibility is that the negative coefficient may be driven by MSA-specific and industry-specific adoption waves, and not by firms learning that outsourcing of website related services is not an optimal arrangement.

This alternative interpretation is based on the point made in section 3.3 regarding learning-through-outsourcing. Suppose that some industries are "ahead" of the curve in website-related activities and are already outsourcing quite heavily. Then, firms in these industries would be well on their way to acquiring experience and ready to move this work in-house. This would readily give a negative coefficient on the proportion of firms outsourcing in year $t-1$ and the proportion outsourcing in the current year. We find this interpretation quite plausible, and complementary to the interpretation that firms learn that outsourcing is less effective than anticipated by being exposed to peers who outsource. Though we do not control for lagged outsourcing decisions at establishment level (and cannot do so credibly), this interpretation has some support from Table 1, which shows that the transition between outsourcing to in-house provision is stronger when calculated via a chain index that uses consecutive establishment observations.

Under both interpretations, the effect of a higher adoption ratio can be causal and structural. Under the first interpretation, firms obtain negative information about outsourcing and do not pursue it themselves; under the second interpretation, they learn more about website related services and how to self-provide them in-house.

4.2 Quantitative Importance

The quantitative effects of multinomial models are hard to discern from inspection of coefficients alone. The probability that an outcome is obtained is a function of the coefficients for the linear indices of all outcomes. Therefore, a positive sign of a parameter estimate of a variable in the equation for one outcome does not necessarily imply than an increase in the value of that variable will increase the probability of that outcome. To ascertain the marginal effects of the key variables, the outsourcing ratios of the preceding period, and their quantitative importance, we perform some simulations. These simulations are performed using the parameter estimates of column 4 of Table 3 and are reported in Table 4 (the results are similar if any of the other columns were used).

The top panel of Table 4 reports the predicted probabilities for a pure outsourcing provision of website related services. It shows that an increase by 10 percentage points in the ratio of firms that outsourced in the previous period in a particular MSA cuts (on average) the outsourcing probabilities in that same location by approximately half. This is a large reduction, but it also corresponds to a large increase in the ratio (the typical value of that ratio is 6 percent, so a 10 percentage point increase approximately triples it). The arc elasticity, then, is approximately minus one-third. A 10 percentage point increase in the ratio of establishments outsourcing in the same industry in the previous period results in a somewhat smaller by still large decrease in the outsourcing probabilities of establishments in that same industry, reducing them by about 40%, for an arc elasticity of approximately minus one quarter.

The middle panel reports the predicted probabilities of in-house provision. These are affected, but only to a minor extent, when the effects are expressed in elasticities, because the baseline probability of insourcing is quite high, at 40% initially and constantly rising. When expressed in probability values, however, the effects are non-trivial for changes in outsourcing ratio of facilities located in a region. These effects are approximately half the size of those in panel A. In other words, an increase in the outsourcing ratio in a region reduces the outsourcing in future years by 3.4 percentage points, but leads to an increase of insourcing by 1.9 percentage points (representing about 65 percent of these firms).

The results reported in panel C tell a similar story, this time with respect to effects of industry spillovers (spatial spillovers seem to be zero for mixed sourcing). A higher fraction of establishments outsourcing in the preceding year leads to a increase in the establishments that use dual sourcing. In fact, an increase in the ratio of firms in an industry that outsource leads to an increase in dual sourcing that fully counteracts the decline in sole outsourcing, i.e., there appears to be an approximately one-for-one shift in the sourcing decision from pure outsourcing to dual sourcing.

4.3 Robustness Checks

In this section, we consider different specifications to check the robustness of the main findings reported in Table 3. In what follows, we describe the nature of this additional analysis and the associated results, to the extent that they are different from those in the main analysis. The most important set of variations is included in Table 5. For ease of comparison, Column 1 of Table 5 replicates Column 4 of Table 3. In Column 2, we use the dummy for outsourcing any of the three IT services we consider, in order to obtain a more parsimonious specification, i.e., we replace the variables $\mathsf{programming.outsource}_{i(t-1)}$, $\mathsf{servicing.outsource}_{i(t-1)}$, and $\mathsf{lan.outsource}_{i(t-1)}$ with $\mathsf{other.outsource}_{i(t-1)}$. We find that most coefficient estimates are of similar value as in Column 1. In Column 3, we use the CBP weighted ratios defined in Section 3.2 to account for the possibility that the distribution of establishments in the CITDB dataset may not be the same as the distribution of establishments in the population. The results in Column 3 are mostly similar to those in Column 1, except that the coefficient estimate on $\mathsf{out.only.ratio.region}_{i(t-1)}$ becomes rather smaller (in absolute terms), while the coefficient estimate on $\mathsf{out.only.ratio.industry}_{i(t-1)}$ becomes much smaller (in absolute terms). However, these results are still consistent with those reported in Column 1.

In Column 4 of Table 5, we replace the outsourcing spillover measures $\mathsf{out.only.ratio.region}_{i(t-1)}$ and $\mathsf{out.only.ratio.industry}_{i(t-1)}$ with $\mathsf{out.ratio.region}_{i(t-1)}$ and $\mathsf{out.ratio.industry}_{i(t-1)}$. The latter set of measures include firms that either exclusively outsourced or used mixed sourcing. Most coefficient estimates, including ψ, are similar to those in Column 1. However, the coefficient estimates on $\mathsf{out.ratio.region}_{i(t-1)}$ is now statically significant for $\mathsf{web.both}$ as well, while the coefficient estimates on $\mathsf{out.ratio.industry}_{i(t-1)}$ are now both negative (though no longer statistically significant). These broader measures of outsourcing intensity convey information about outsourcing as an exclusive source of delivery of website-related services, and also about outsourcing as a complement to partial in-house provision of these services. It appears from our results that external experience with mixed sourcing also leads to negative updating about the value of this delivery option. The final of our "main" robustness checks involves the merging of exclusive outsourcing and mixed sourcing into a single "choice." This variation investigates the firm's decision to use outsourcing as a method of provision, whether or not it also chooses to provide some components of website-related services in-house. The coefficient estimate on $\mathsf{out.ratio.region}_{i(t-1)}$ is negative and statically significant, while the coefficient estimate on $\mathsf{out.ratio.industry}_{i(t-1)}$ is negative but statistically significant only at the 10 percent level.[31]

In the analysis to this point, industry spillovers are assumed to be independent of the location of the industry, whereas spatial spillovers are assumed to be independent of the local composition of the industry. It is possible that the composition of the local industry matters as well. We investigate this possibility in results reported in Table 6, where we incorporate a variable on the outsourcing ratios of establishments in the same industry and region. The new variable is not significant, whether it is used alone or in conjunction with the previous outsourcing ratios. We suspect the reasons are because (a) it is not particularly meaningful to define the spillover effects as coming primarily from that "intersection" of market and industry, i.e., the intersection is a poor proxy, (b) the number of firms by year in that intersection is small and thus the computation of the ratio itself noisy, and (c) the ratio is not defined when there are no other firms of the same industry in the same location in the preceding period, leading to the loss of some observations.

The overall pattern of results from this and the preceding tables suggests that outsourcing

[31] The smaller magnitudes of these coefficient estimates are partly due to the fact that $\mathsf{out.ratio.region}_{i(t-1)}$ (or $\mathsf{out.ratio.industry}_{i(t-1)}$) tends to be larger than $\mathsf{out.only.ratio.region}_{i(t-1)}$ (or $\mathsf{out.only.ratio.industry}_{i(t-1)}$).

experience at the local level conveys strong negative information about outsourcing and reduces its perceived payoff by co-located firms. This effect is smaller at the industry level. One possibility is that information spillovers are stronger at the spatial level, rather than at the industry level: firms learn from the experience of other firms that are co-located, but to a lesser extent from firms that are not co-located, even if they are in the same industry. Another possibility is that there is a strategic element to outsourcing: if a competitor outsources website-related services, a firm may find it necessary to obtain a similar web service (possibly even from the same vendor). This effect can partially mitigate any adverse experiences that some of the peer firms may have encountered.

4.4 Some Additional Analysis

In our analysis, we have used as measures for the experience spillovers the ratio of firms in a region or industry that have outsourced website-related services. The ratio better captures the information intensity that a firm located in a region or industry receives about outsourcing relative to information it receives about other delivery methods. It also automatically adjusts for the possibility that in large markets the likelihood of interaction between employees of any two firms is lower, and thus that experience of any single firm will less likely to be transmitted to any other particular firm: In, say, New York City or Chicago, the experience of a handful of firms that outsource will provide only minimal information spillovers to the other firms in those cities; in Champaign, Illinois, they would provide strong information spillovers. We would thus expect that using the number of firms that outsource in a region or industry, $\mathsf{out.only.number.region}_{i(t-1)}$ and $\mathsf{out.only.number.industry}_{i(t-1)}$, to be weaker proxies for experience spillovers. Moreover, the number of firms that outsource may also have a countervailing effect on the payoff that any other firm has from outsourcing: As the number of firms that outsource in a region or industry becomes larger, the number of local providers of website-related services may increase, providing more local options and increasing the value to outsourcing in part by reducing transaction costs. On the other hand, this "traditional" market thickness effect may be small or absent, because the provision of website-related services can be easily contracted and delivered electronically through the Internet.

We investigate these possibilities in Table 7. Column 1 reports the results of the analysis in which the number of firms outsourcing in a region or industry (as always, lagged by one year) is used instead of their ratio counterparts. The corresponding estimates are not statistically significant, and in fact are basically zero. In Column 2, we include in the payoff functions both the number and the ratios of firms that outsource. Consistent with the discussion above, the coefficients on the number of firms that outsource (in a region or industry) are generally not significant and effectively zero, and the coefficients on the ratio of firms that outsource (in a region or industry) remain generally negative and significant in the payoff equation for outsourcing and in the payoff for mixed sourcing. Table 8 repeats this analysis, but includes in the number (and ratio) of firms that outsource or use mixed sourcing. The sign of the parameter estimates is fully consistent with those of the previous table.

Our final tables focus on particular components of website-related services, and look at the outsourcing decision of each one of them. Recall that our definition of outsourcing website-related services includes the outsourcing of three different types of services: (a) software, by which we mean the decision to outsource website management versus have a homepage for Internet application or web database software; (b) hardware, which denotes the decision to outsource web server hosting versus own Internet server or web server software such as Apache; (c) development, denoting the decision to outsource web application development versus have web developers or web development application software. In Tables 9 and 10 we report the results of a disaggregated analysis in which we explain using our base specification each of these three outsourcing decision separately. Though an analysis based on the outsourcing of a single component might have smaller explanatory power and greater outsourcing error (e.g., a firm may classify some activity under one category, even though it may straddle multiple categories), it would be reassuring if we obtained similar results using the disaggregated definitions. This is indeed the case. The magnitudes of the coefficient estimates on $\mathsf{out.only.ratio.region}_{i(t-1)}$ and $\mathsf{out.only.ratio.industry}_{i(t-1)}$ are different, partly because these ratios vary across different types of outsourcing. Nevertheless, the main findings from Table 3 still remain valid. The only notable exception is that the spillover effects at the industry level, though still negative, are no longer statistically significant.[32]

5 Conclusion

In this paper, we examine the role of information and experience in the decision to adopt a new business practice. We begin by documenting the patterns in website-related services outsourcing, using detailed establishment-level data. Our data show only a small and declining proportion of firms that provide website-related services choose to outsource them to other parties. This is somewhat surprising given that IT outsourcing is a new business practice, and one that we would have expected would disseminate rapidly, once firms accumulate relevant experience. In this paper, we argue that the evidence is consistent with a firm's own broad IT outsourcing experience increasing the propensity to outsource website-related services through the reduction in transaction costs, but that the practice itself is not successful for many firms: when a firm's peers and neighbors have experience with web outsourcing, the firm itself is less likely to pick it up itself. We found no evidence that the growth of outsourcing is limited because firms are not aware of it as a option or (equivalently) because it is not compatible with a firm's business model.

[32] In this analysis, the outsourcing ratios in each column were computed using the outsourcing frequencies for each of of the disaggregate services. However, the findings are not materially affected if we used the outsourcing frequencies of any website related service, the outsourcing ratios used in the other tables.

We conclude by discussing the applicability, or external validity of our findings. In brief, we believe that our results are likely to hold when there is an introduction or development of new and specialized service that firms can use. This might, for example, be situations where firms obtain advice on how to customize the pricing of their products or how to use new media channels for promotion. For these and other similar examples, the service can be either produced in-house or obtained from external specialized providers. Firms that accumulate experience by dealing with these providers might find it desirable to move the service in-house, because their ability to do so increases faster (from a very low base) than that of the external providers, tilting the calculus towards in-house provision. In some cases, firms may find that external provision is not as efficient as initially anticipated. We expect our findings to be less relevant for some of the traditional outsourcing of the production process components that were historically done internally but for which firms have decided they are best subcontracted externally. For these services, we would not expect a negative coefficient on industry and local vendor market size because market level efficiency in provision would be non-decreasing in market thickness, whereas there would be no increase in the effectiveness of in-house provision.

References

Amiti, M. and Wei, S. "Fear of Service Outsourcing: Is It Justified?" *Economic Policy*, 2005, *12*, pp. 308-348.

Arora, A. and Forman, C. "Proximity and Information Technology Outsourcing: How Local Are IT Services Markets?" *Journal of Management Information Systems*, 2007, pp. 73-102.

Baker, G. and Hubbard, T. "Make versus Buy in Trucking: Asset Ownership, Job Design, and Information." *American Economic Review*, 2003, pp. 551-572.

Bresnahan, T., Brynjolfsson, E., and Hitt, L. "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence." *Quarterly Journal of Economics*, 2002, *117*, pp. 339-376.

Bresnahan, T. and Greenstein, S. "Technical Progress and Co-invention in Computing and in the Uses of Computers." *Brookings Papers on Economic Activity: Microeconomics*, 1996, pp. 1-77.

Coase, R. "The Nature of the Firm." *Economica*, 1937, *4*(16), pp. 386-405.

Crino, R. "Service Offshoring and White-Collar Employment." *Review of Economic Studies*, 2010, *77*, pp. 595-632.

Feenstra, R. and Hanson, G. "Global Production Sharing and Rising Inequality: A Survey of Trade and Wages," in *Handbook of International Trade*, edited by Kwan Choi and James Harrigan, Blackwell Publishing, 2003.

Forbes, S. J., and M. Lederman "Adaptation and Vertical Integration in the Airline Industry." *American Economic Review, 2009, 99, pp. 1831–1849.*

Forman, C., Goldfarb, A., and Greenstein, S. *"The Internet and Local Wages: A Puzzle." American Economic Review, 2010, forthcoming.*

Gentzkow, M. *"Valuing New Goods in a Model with Complementarity: Online Newspapers." American Economic Review, 2007, 97, pp. 713-744.*

Grossman, G. and Hart, O. *"The Costs and Benefits of Ownership: A Theory of Lateral and Vertical Integration." Journal of Political Economy, 1986, 94, pp. 691-719.*

Grossman, G. and Helpman, E. *"Integration versus Outsourcing in Industry Equlibrium." Quarterly Journal of Economics, 2002, 117, pp. 85-120.*

Grossman, G. and Helpman, E. *"Outsourcing in a Global Economy" Review of Economic Studies, 2005, 72 (1), pp. 135-159.*

Holmstrom, B. and Milgrom, P. *"The Firm as an Incentive System." American Economic Review, 1994, 84, pp. 972-991.*

Hong, S. and Rezende, L. *"Lock-in and Unobserved Preferences in Server Operating Systems Adoption: A Case of Linux vs. Windows." Journal of Econometrics, 2011, forthcoming.*

Hubbard, T. *"Contractual Form and Market Thickness in Trucking." RAND Journal of Economics, 2001, pp. 369-386.*

Hummels, D., Rapport, D., and Yi, K. *"The Nature and Growth of Vertical Specialization in World Trade." Journal of international Economics, 2001, 65, pp. 781-824.*

Joskow, P. *"Contract Duration and Relationship-Specific Investments: Evidence form Coal Markets." American Economic Review, 1987, 77, pp. 168-185.*

Lee, L. and Porter, R. *"Switching Regression Models with Imperfect Sample Separation Information – with an Application on Cartel Stability." Econometrica, 1984, pp. 391-418.*

Mankiw, N. G. and Swagel, P. *"The Politics and Economics of Offshore Outsourcing." Journal of Monetary Economics, 2–6, pp. 1027-1056.*

Masten, S. *"The Organization of Production: Evidence from the Aerospace Industry." Journal of Law and Economics, 1984, 27, pp. 403-417.*

Monteverde, K. and Teece, D. *"Supplier Switching Costs and Vertical Integration in the Automobile Industry." Bell Journal of Economics, 1982, 13, pp. 206-213.*

Ono, Y. *"Outsourcing Business Services and the Role of Central Administrative Offices." Journal of Urban Economics, 2003, 53, pp. 377-395.*

Ono, Y. *"Market Thickness and Outsourcing Services." Regional Science and Urban Economics, 2007, 37, pp. 220-238.*

Porter, R. *"A Study of Cartel Stability: The Joint Executive Committee 1880-1886." Bell Journal of Economics, 1983, pp. 301-314.*

Stiroh, K. *"Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?" American Economic Review, 2002, pp. 1559-1576.*

Stoneman, P. *The Economics of Technological Diffusion, Wiley-Blackwell, 2002.*

Williamson, O. *Markets and Hierarchies: Analysis and Antitrust Implications, New York: The Free Press, 1975.*

Williamson, O. *The Economic Institutions of Capitalism, New York: The Free Press, 1985.*

Table 1: Summary Statistics of Key Variables[a]

Variable	Total	Year 2000	2001	2002	2003	2004
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Multiple or Single Establishment Firms					
web.all	0.590	0.559	0.579	0.618	0.615	0.573
web.inhouse.only	0.428	0.387	0.379	0.420	0.463	0.483
web.outsource.only	0.062	0.062	0.079	0.075	0.058	0.034
web.both	0.101	0.110	0.121	0.123	0.094	0.056
programming.outsource	0.097	0.133	0.111	0.099	0.088	0.059
servicing.outsource	0.096	0.113	0.104	0.100	0.094	0.074
lan.outsource	0.131	0.148	0.120	0.128	0.133	0.128
	B. Only Single Establishment Firms					
web.all	0.609	0.576	0.608	0.634	0.635	0.585
web.inhouse.only	0.417	0.380	0.372	0.403	0.452	0.480
web.outsource.only	0.075	0.074	0.095	0.092	0.072	0.041
web.both	0.116	0.122	0.141	0.140	0.111	0.064
programming.outsource	0.104	0.143	0.121	0.105	0.096	0.062
servicing.outsource	0.104	0.121	0.114	0.107	0.101	0.078
lan.outsource	0.134	0.153	0.122	0.129	0.138	0.131
	C. Estimation Sample					
web.all	0.652	0.602	0.662	0.660	0.654	0.634
web.inhouse.only	0.456	0.392	0.407	0.417	0.471	0.517
web.outsource.only	0.072	0.076	0.095	0.090	0.065	0.045
web.both	0.124	0.134	0.161	0.153	0.118	0.072
programming.outsource	0.098	0.153	0.135	0.106	0.097	0.064
servicing.outsource	0.106	0.132	0.130	0.110	0.107	0.083
lan.outsource	0.157	0.184	0.168	0.143	0.167	0.157
	D. Chain Index					
web.all		0.602	0.663	0.698	0.680	0.647
web.inhouse.only		0.392	0.407	0.445	0.498	0.551
web.outsource.only		0.076	0.095	0.088	0.060	0.037
web.both		0.134	0.161	0.165	0.122	0.070

[a]The table reports the mean of each variable. The sample includes observations with up-to-date information on information technology. The number of observations in Panel A is 335,039, while the number of observations in Panel B is 209,620. Panel C uses our estimation sample that includes only single establishments that are observed in the previous year. The number of observations in the estimation sample is 73,391. The estimation sample does not include observations in 2000, but the table reports the fractions among firms in 2000 that are also included in the estimation sample in 2001. Panel D reports the outsourcing fraction using chain indexes, where the values in 2000 are the same as those in Panel C, while the values in 2001-2004 are computed as follows: we use only those observed in both the current year and the previous year, and then compute the change in the fraction from the previous year to the current year, multiplied by the fraction in 2000. As a result, the values in 2001 are the same as those in Panel C. Web.all is equal to 1 if a firm provides Web services, i.e., if web.inhouse.only, or web.outsource.only, or web.both is equal to 1.

Table 2: Descriptive Analysis: Multinomial Logit Results[a]

	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
	(1)		(2)		(3)	
A. web.outsource.only						
out.only.ratio.region$_{t-1}$	3.883**	(0.649)	2.676**	(0.698)	-7.419**	(1.035)
out.only.ratio.industry$_{t-1}$	10.604**	(0.516)	10.266**	(0.538)	-6.345**	(1.906)
#employee (in 100)	0.000	(0.001)	0.000	(0.001)	0.005	(0.004))
#internet.users (in 100)	0.003	(0.029)	0.013	(0.029)	0.046	(0.030)
e-business	0.785**	(0.052)	0.783**	(0.052)	0.692**	(0.054)
customer.service	0.156*	(0.062)	0.245**	(0.062)	0.194**	(0.063)
programming.outsource$_{t-1}$	0.620**	(0.045)	0.591**	(0.045)	0.589**	(0.046)
servicing.outsource$_{t-1}$	0.761**	(0.043)	0.767**	(0.043)	0.774**	(0.044)
lan.outsource$_{t-1}$	0.569**	(0.041)	0.569**	(0.042)	0.566**	(0.042)
#programmers	0.102**	(0.013)	0.099**	(0.013)	0.071**	(0.013)
total.server	0.032**	(0.004)	0.031**	(0.004)	0.025**	(0.004)
B. web.inhouse.only						
out.only.ratio.region$_{t-1}$	0.896*	(0.383)	0.428	(0.412)	1.703**	(0.600)
out.only.ratio.industry$_{t-1}$	-4.289**	(0.308)	-4.587**	(0.318)	-1.893	(1.159)
#employee (in 100)	-0.000	(0.001)	-0.000	(0.001)	0.005	(0.004)
#internet.users (in 100)	0.353**	(0.014)	0.352**	(0.014)	0.360**	(0.016)
e-business	0.967**	(0.034)	0.971**	(0.034)	0.894**	(0.036)
customer.service	0.828**	(0.034)	0.815**	(0.034)	0.771**	(0.035)
programming.outsource$_{t-1}$	0.241**	(0.031)	0.248**	(0.031)	0.280**	(0.032)
servicing.outsource$_{t-1}$	0.131**	(0.031)	0.134**	(0.031)	0.149**	(0.032)
lan.outsource$_{t-1}$	0.226**	(0.027)	0.233**	(0.027)	0.246**	(0.028)
#programmers	0.275**	(0.008)	0.275**	(0.008)	0.256**	(0.008)
total.server	0.062**	(0.002)	0.061**	(0.002)	0.054**	(0.002)
C. web.both						
out.only.ratio.region$_{t-1}$	4.604**	(0.543)	2.312**	(0.588)	0.681	(0.866)
out.only.ratio.industry$_{t-1}$	7.871**	(0.429)	6.949**	(0.446)	1.317	(1.621)
#employee (in 100)	0.000	(0.001)	0.000	(0.001)	0.005	(0.004)
#internet.users (in 100)	0.285**	(0.016)	0.291**	(0.016)	0.315*	(0.018)
e-business	1.289**	(0.040)	1.285**	(0.040)	1.172**	(0.042)
customer.service	0.780**	(0.044)	0.878**	(0.044)	0.827**	(0.045)
programming.outsource$_{t-1}$	0.636**	(0.038)	0.605**	(0.038)	0.613**	(0.039)
servicing.outsource$_{t-1}$	0.692**	(0.037)	0.697**	(0.038)	0.710**	(0.038)
lan.outsource$_{t-1}$	0.660**	(0.034)	0.666**	(0.034)	0.686**	(0.035)
#programmers	0.269**	(0.008)	0.268**	(0.008)	0.246**	(0.008)
total.server	0.060**	(0.002)	0.059**	(0.002)	0.053**	(0.002)
year fixed effects	No		Yes		Yes	
MSA fixed effects	No		No		Yes	
industry fixed effects	No		No		Yes	
observations	73,391		73,391		73,391	

[a]The table uses the same sample in Panel C of Table 1 which includes only single establishments that are observed in the previous year and have up-to-date information on information technologies owned by the establishment. * denotes significance at a 5% level, and ** denotes significance at a 1% level.

Table 3: Baseline Results[a]

	Estimate	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.
	(1)		(2)		(3)		(4)	
A. web.outsource.only								
out.only.ratio.region$_{t-1}$	-8.247**	(0.988)	-8.247**	(0.988)	-8.669**	(1.045)	-8.669**	(1.045)
out.only.ratio.industry$_{t-1}$	-5.508**	(1.813)	-5.509**	(1.813)	-5.524**	(1.914)	-5.523**	(1.914)
#employee (in 100)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.118**	(0.028)	0.118**	(0.028)	0.118**	(0.029)	0.119**	(0.029)
e-business	0.719**	(0.054)	0.719**	(0.054)	0.771**	(0.059)	0.771**	(0.059)
customer.service	0.201**	(0.063)	0.201**	(0.063)	0.202**	(0.066)	0.202**	(0.066)
programming.outsource$_{t-1}$	0.443**	(0.042)	0.443**	(0.042)	0.510**	(0.049)	0.510**	(0.049)
servicing.outsource$_{t-1}$	0.688**	(0.040)	0.688**	(0.040)	0.781**	(0.053)	0.781**	(0.053)
lan.outsource$_{t-1}$	0.454**	(0.039)	0.454**	(0.039)	0.516**	(0.046)	0.516**	(0.046)
B. web.inhouse.only								
#employee (in 100)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.378**	(0.016)	0.378**	(0.016)	0.378**	(0.016)	0.378**	(0.016)
e-business	0.908**	(0.036)	0.908**	(0.036)	0.906**	(0.036)	0.906**	(0.036)
customer.service	0.780**	(0.035)	0.780**	(0.035)	0.778**	(0.035)	0.778**	(0.035)
#programmers	0.240**	(0.007)	0.240**	(0.007)	0.240**	(0.007)	0.240**	(0.007)
total.server	0.051**	(0.002)	0.051**	(0.002)	0.051**	(0.002)	0.051**	(0.002)
C. web.both								
out.only.ratio.region$_{t-1}$	-0.343	(0.785)	-0.343	(0.785)	-0.723	(0.850)	-0.723	(0.850)
out.only.ratio.industry$_{t-1}$	2.445+	(1.470)	2.442+	(1.470)	2.687+	(1.594)	2.690+	(1.593)
#employee (in 100)	0.006	(0.004)	0.006	(0.004)	0.007+	(0.004)	0.007+	(0.004)
#internet.users (in 100)	0.329**	(0.018)	0.329**	(0.018)	0.327**	(0.019)	0.327**	(0.018)
e-business	1.176**	(0.042)	1.176**	(0.042)	1.230**	(0.048)	1.230**	(0.048)
customer.service	0.829**	(0.045)	0.829**	(0.045)	0.840**	(0.048)	0.839**	(0.048)
programming.outsource$_{t-1}$	0.428**	(0.032)	0.428**	(0.032)	0.500**	(0.043)	0.499**	(0.043)
servicing.outsource$_{t-1}$	0.620**	(0.033)	0.620**	(0.033)	0.717**	(0.048)	0.717**	(0.048)
lan.outsource$_{t-1}$	0.525**	(0.030)	0.525**	(0.030)	0.594**	(0.039)	0.594**	(0.039)
#programmers	0.230**	(0.007)	0.230**	(0.007)	0.229**	(0.007)	0.229**	(0.007)
total.server	0.049**	(0.002)	0.049**	(0.002)	0.048**	(0.002)	0.048**	(0.002)
D. additional coefficients								
σ (unobserved heterogeneity)			0.014	(0.024)	0.015	(0.024)		
ψ (prob. full choice set)					0.793**	(0.049)	0.793**	(0.049)
observations	73,391		73,391		73,391		73,391	

[a] All columns include year, MSA, and industry (three-digit NAICS) fixed effects. The sample includes only single establishments that are observed in the previous year. In Columns 2-3, unobserved heterogeneity is assumed to follow the normal distribution with variance equal to σ^2, and it is integrated out by using a frequency simulator. In Columns 3-4, ψ denotes the regime switching probability. * denotes significance at a 5% level, and ** denotes significance at a 1% level.

Table 4: Marginal Effects of Increasing Outsourcing Ratio[a]

Variable	Total	Year 2001	2002	2003	2004
	(1)	(2)	(3)	(4)	(5)
	A. Web Outsourcing Only				
A.1: initial value of web.outsourcing.only	0.072	0.094	0.090	0.065	0.045
A.2: predicted value if out.only.ratio.region$_{t-1}$ $\uparrow$ by 0.1	0.034	0.045	0.043	0.030	0.020
A.3: change (= A.2 − A.1)	-0.038	-0.049	-0.047	-0.035	-0.025
A.4: predicted value if out.only.ratio.industry$_{t-1}$ $\uparrow$ by 0.1	0.042	0.055	0.052	0.038	0.026
A.5: change (= A.4 − A.1)	-0.030	-0.039	-0.038	-0.028	-0.019
	B. Web Inhouse Only				
B.1: initial value of web.inhouse.only	0.456	0.407	0.417	0.471	0.517
B.2: predicted value if out.only.ratio.region$_{t-1}$ $\uparrow$ by 0.1	0.475	0.429	0.439	0.489	0.531
B.3: change (= B.2 − B.1)	0.019	0.022	0.022	0.018	0.014
B.4: predicted value if out.only.ratio.industry$_{t-1}$ $\uparrow$ by 0.1	0.451	0.401	0.411	0.465	0.514
B.5: change (= B.4 − B.1)	-0.005	-0.006	-0.006	-0.006	-0.003
	C. Web Both				
C.1: initial value of web.both	0.124	0.161	0.153	0.118	0.072
C.2: predicted value if out.only.ratio.region$_{t-1}$ $\uparrow$ by 0.1	0.125	0.165	0.156	0.118	0.070
C.3: change (= C.2 − C.1)	0.001	0.005	0.003	-0.000	-0.001
C.4: predicted value if out.only.ratio.industry$_{t-1}$ $\uparrow$ by 0.1	0.158	0.205	0.195	0.151	0.093
C.5: change (= C.4 − C.1)	0.035	0.044	0.042	0.033	0.021

[a]The table reports the mean of each variable. We use the same sample as in Table 3, and compute the predicted probability for each decision using the estimates from column 4 of Table 3. Panel A reports the predicted probabilities to choose outsourcing only. Panel B reports the predicted probabilities to choose inhouse only. Panel C reports the predicted probabilities to choose both outsourcing and inhouse. In the table, initial value refers to the predicted value of the probability for each decision. These values are almost identical to those reported in Panel C of Table 1. Predicted value for out.only.ratio.region$_{t-1}$ + 0.1 is the predicted probability when out.only.ratio.region$_{t-1}$ is increased by a 10 percentage point. Predicted value for out.only.ratio.industry$_{t-1}$ + 0.1 is defined similarly.

Table 5: Robustness Checks[a]

	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.
	(1)		(2)		(3)		(4)		(5)	
A. web.outsource.only									A. web.outsource	
out.only.ratio.region$_{t-1}$	-8.669**	(1.045)	-8.251**	(1.001)	-5.926**	(0.881)				
out.only.ratio.industry$_{t-1}$	-5.523**	(1.914)	-5.509**	(1.812)	-3.227*	(1.507)				
out.ratio.region$_{t-1}$							-3.944**	(0.735)	-5.671**	(0.631)
out.ratio.industry$_{t-1}$							-1.548	(1.132)	-1.927+	(1.002)
programming.outsource$_{t-1}$	0.510**	(0.049)			0.511**	(0.052)	0.510**	(0.049)	0.730**	(0.052)
servicing.outsource$_{t-1}$	0.781**	(0.053)			0.793**	(0.057)	0.777**	(0.052)	0.995**	(0.059)
lan.outsource$_{t-1}$	0.516**	(0.046)			0.497**	(0.048)	0.515**	(0.045)	0.755**	(0.045)
other.outsource$_{t-1}$			0.772**	(0.046)						
#employee (in 100)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)	0.035**	(0.007)
#internet.users (in 100)	0.119**	(0.029)	0.111**	(0.028)	0.149**	(0.031)	0.119**	(0.029)	0.441**	(0.021)
e-business	0.771**	(0.059)	0.724**	(0.058)	0.792**	(0.061)	0.768**	(0.059)	1.320**	(0.055)
customer.service	0.202**	(0.066)	0.196**	(0.063)	0.237**	(0.067)	0.204**	(0.065)	0.690**	(0.052)
B. web.inhouse.only									B. web.inhouse.only	
#employee (in 100)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)	0.006	(0.004)	0.022**	(0.005)
#internet.users (in 100)	0.378**	(0.016)	0.376**	(0.016)	0.392**	(0.018)	0.378**	(0.016)	0.478**	(0.017)
e-business	0.906**	(0.036)	0.908**	(0.036)	0.922**	(0.037)	0.906**	(0.036)	0.957**	(0.035)
customer.service	0.778**	(0.035)	0.779**	(0.035)	0.755**	(0.037)	0.778**	(0.035)	0.782**	(0.035)
#programmers	0.240**	(0.007)	0.240**	(0.007)	0.239**	(0.007)	0.240**	(0.007)	0.067**	(0.003)
total.server	0.051**	(0.002)	0.051**	(0.002)	0.055**	(0.002)	0.051**	(0.002)	0.021**	(0.001)
C. web.both										
out.only.ratio.region$_{t-1}$	-0.723	(0.850)	-0.367	(0.798)	-0.880	(0.723)				
out.only.ratio.industry$_{t-1}$	2.690+	(1.593)	2.443+	(1.473)	1.252	(1.272)				
out.ratio.region$_{t-1}$							-4.865**	(0.596)		
out.ratio.industry$_{t-1}$							-1.787+	(0.936)		
#employee (in 100)	0.007+	(0.004)	0.006	(0.004)	0.005	(0.005)	0.007+	(0.004)		
#internet.users (in 100)	0.327**	(0.018)	0.327**	(0.018)	0.348**	(0.021)	0.327**	(0.019)		
e-business	1.230**	(0.048)	1.180**	(0.048)	1.255**	(0.050)	1.230**	(0.048)		
customer.service	0.839**	(0.048)	0.823**	(0.045)	0.852**	(0.050)	0.840**	(0.048)		
programming.outsource$_{t-1}$	0.499**	(0.043)			0.491**	(0.046)	0.498**	(0.042)		
servicing.outsource$_{t-1}$	0.717**	(0.048)			0.744**	(0.052)	0.715**	(0.047)		
lan.outsource$_{t-1}$	0.594**	(0.039)			0.591**	(0.042)	0.590**	(0.039)		
other.outsource$_{t-1}$			0.757**	(0.044)						
#programmers	0.229**	(0.007)	0.230**	(0.007)	0.227**	(0.007)	0.229**	(0.007)		
total.server	0.048**	(0.002)	0.049**	(0.002)	0.052**	(0.002)	0.048**	(0.002)		
D. switching probability										
ψ (prob. full choice set)	0.793**	(0.049)	0.802**	(0.119)	0.793**	(0.051)	0.796**	(0.048)	0.560**	(0.021)
observations	73,391		73,391		73,391		66,008		73,391	

[a] All columns include year, MSA, and industry (three-digit NAICS) fixed effects. All columns use the same sample as in Table 3, except for column 3 that excludes observations for which we cannot compute CBP-weighted outsourcing spillover variables due to few observations in the same industry (three-digit NAICS) and region (MSAs). All models incorporate a mixture model with the regime switching probability ψ. Column 1 reproduces the estimates from column 4 of Table 3. Column 3 uses weighted ratios computed by using the number of establishments in the 2000 County Business Patterns. Columns 4-5 use the ratios of web.outsource (combining web.outsource.only and web.both). Column 5 reports the results from the model with only three choices – web.outsource, web.inhouse.only, and neither. * denotes significance at a 5% level, and ** denotes significance at a 1% level.

Table 6: Outsourcing within the Same Market and Industry[a]

	Estimate	S.E.	Estimate	S.E.
	(1)		(2)	
A. web.outsource.only				
out.only.ratio.region-industry$_{t-1}$	-0.020	(0.185)	0.282	(0.187)
out.only.ratio.region$_{t-1}$			-8.836**	(1.105)
out.only.ratio.industry$_{t-1}$			-5.871**	(1.986)
#employee (in 100)	0.006	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.119**	(0.029)	0.119**	(0.029)
e-business	0.749**	(0.059)	0.753**	(0.060)
customer.service	0.197**	(0.066)	0.195**	(0.066)
programming.outsource$_{t-1}$	0.502**	(0.050)	0.507**	(0.050)
servicing.outsource$_{t-1}$	0.779**	(0.053)	0.786**	(0.053)
lan.outsource$_{t-1}$	0.517**	(0.046)	0.519**	(0.046)
B. web.inhouse.only				
#employee (in 100)	0.006	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.378**	(0.016)	0.378**	(0.016)
e-business	0.899**	(0.036)	0.899**	(0.036)
customer.service	0.770**	(0.035)	0.770**	(0.035)
#programmers	0.236**	(0.007)	0.236**	(0.007)
total.server	0.050**	(0.002)	0.050**	(0.002)
C. web.both				
out.only.ratio.region-industry$_{t-1}$	0.179	(0.155)	0.205	(0.158)
out.only.ratio.region$_{t-1}$			-1.102	(0.898)
out.only.ratio.industry$_{t-1}$			2.722	(1.662)
#employee (in 100)	0.004	(0.005)	0.004	(0.005)
#internet.users (in 100)	0.333**	(0.020)	0.334**	(0.020)
e-business	1.223**	(0.048)	1.225**	(0.048)
customer.service	0.835**	(0.048)	0.835**	(0.048)
programming.outsource$_{t-1}$	0.491**	(0.043)	0.495**	(0.043)
servicing.outsource$_{t-1}$	0.707**	(0.048)	0.712**	(0.048)
lan.outsource$_{t-1}$	0.582**	(0.040)	0.585**	(0.040)
#programmers	0.225**	(0.007)	0.225**	(0.007)
total.server	0.047**	(0.002)	0.047**	(0.002)
D. switching probability				
ψ (prob. full choice set)	0.796**	(0.051)	0.789**	(0.050)
observations	71,967		71,967	

[a]All columns include year, MSA, and industry (three-digit NAICS) fixed effects. All columns use the same sample as in Table 3, except that those with few establishments in the same region (MSAs) and industry (two-digit NAICS) are dropped. All models incorporate a mixture model with the regime switching probability ψ. * denotes significance at a 5% level, and ** denotes significance at a 1% level.

Table 7: Market Thickness Effects from #Firms Outsourcing Only[a]

	Estimate	S.E.	Estimate	S.E.
	(1)		(2)	
A. web.outsource.only				
out.only.number.region$_{t-1}$ (in 100)	-0.359*	(0.162)	-0.017	(0.169)
out.only.number.industry$_{t-1}$ (in 100)	0.006	(0.008)	0.100	(0.087)
out.only.ratio.region$_{t-1}$			-8.643**	(1.077)
out.only.ratio.industry$_{t-1}$			-6.387**	(2.059)
#employee (in 100)	0.007+	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.119**	(0.029)	0.119**	(0.029)
e-business	0.768**	(0.059)	0.772**	(0.059)
customer.service	0.205**	(0.065)	0.203**	(0.066)
programming.outsource$_{t-1}$	0.509**	(0.049)	0.510**	(0.050)
servicing.outsource$_{t-1}$	0.777**	(0.053)	0.782**	(0.053)
lan.outsource$_{t-1}$	0.517**	(0.046)	0.517**	(0.046)
B. web.inhouse.only				
#employee (in 100)	0.006	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.378**	(0.016)	0.378**	(0.016)
e-business	0.906**	(0.036)	0.906**	(0.036)
customer.service	0.778**	(0.035)	0.778**	(0.035)
#programmers	0.240**	(0.007)	0.240**	(0.007)
total.server	0.051**	(0.002)	0.051**	(0.002)
C. web.both				
out.only.number.region$_{t-1}$ (in 100)	-0.079	(0.132)	-0.055	(0.136)
out.only.number.industry$_{t-1}$ (in 100)	0.014	(0.064)	-0.026	(0.068)
out.only.ratio.region$_{t-1}$			-0.635	(0.879)
out.only.ratio.industry$_{t-1}$			2.927+	(1.690)
#employee (in 100)	0.007+	(0.004)	0.007+	(0.004)
#internet.users (in 100)	0.327**	(0.019)	0.327**	(0.019)
e-business	1.229**	(0.048)	1.230**	(0.048)
customer.service	0.840**	(0.048)	0.839**	(0.048)
programming.outsource$_{t-1}$	0.498**	(0.043)	0.500**	(0.043)
servicing.outsource$_{t-1}$	0.715**	(0.048)	0.718**	(0.048)
lan.outsource$_{t-1}$	0.593**	(0.039)	0.595**	(0.039)
#programmers	0.229**	(0.007)	0.229**	(0.007)
total.server	0.048**	(0.002)	0.048**	(0.002)
D. switching probability				
ψ (prob. full choice set)	0.795**	(0.050)	0.791**	(0.049)
observations	73,391		73,391	

[a]All columns include year, MSA, and industry (three-digit NAICS) fixed effects. All columns use the same sample as in Table 3. All models incorporate a mixture model with the regime switching probability ψ. * denotes significance at a 5% level, and ** denotes significance at a 1% level.

Table 8: Market Thickness Effects from #Firms Outsourcing[a]

	Estimate	S.E.	Estimate	S.E.
	(1)		(2)	
A. web.outsource.only				
out.number.industry$_{t-1}$ (in 100)	-0.043	(0.001)	0.021	(0.069)
out.number.industry$_{t-1}$ (in 100)	-0.000	(0.031)	0.009	(0.032)
out.ratio.region$_{t-1}$			-3.979**	(0.744)
out.ratio.industry$_{t-1}$			-1.623	(1.163)
#employee (in 100)	0.007+	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.119**	(0.029)	0.119**	(0.029)
e-business	0.767**	(0.059)	0.769**	(0.059)
customer.service	0.204**	(0.065)	0.204**	(0.065)
programming.outsource$_{t-1}$	0.508**	(0.049)	0.510**	(0.049)
servicing.outsource$_{t-1}$	0.775**	(0.053)	0.777**	(0.052)
lan.outsource$_{t-1}$	0.516**	(0.046)	0.515**	(0.045)
B. web.inhouse.only				
#employee (in 100)	0.006	(0.004)	0.006	(0.004)
#internet.users (in 100)	0.377**	(0.016)	0.378**	(0.016)
e-business	0.906**	(0.036)	0.906**	(0.036)
customer.service	0.778**	(0.035)	0.778**	(0.035)
#programmers	0.240**	(0.007)	0.240**	(0.007)
total.server	0.051**	(0.002)	0.051**	(0.002)
C. web.both				
out.number.region$_{t-1}$ (in 100)	-0.080	(0.054)	-0.005	(0.055)
out.number.industry$_{t-1}$ (in 100)	-0.043+	(0.024)	-0.034	(0.025)
out.ratio.region$_{t-1}$			-4.852**	(0.603)
out.ratio.industry$_{t-1}$			-1.500	(0.957)
#employee (in 100)	0.007+	(0.004)	0.007+	(0.004)
#internet.users (in 100)	0.327**	(0.019)	0.328**	(0.019)
e-business	1.228**	(0.048)	1.230**	(0.048)
customer.service	0.839**	(0.048)	0.840**	(0.048)
programming.outsource$_{t-1}$	0.497**	(0.042)	0.498**	(0.042)
servicing.outsource$_{t-1}$	0.714**	(0.048)	0.715**	(0.047)
lan.outsource$_{t-1}$	0.592**	(0.039)	0.590**	(0.039)
#programmers	0.229**	(0.007)	0.229**	(0.007)
total.server	0.048**	(0.002)	0.048**	(0.002)
D. switching probability				
ψ (prob. full choice set)	0.797**	(0.050)	0.796**	(0.048)
observations	73,391		73,391	

[a]All columns include year, MSA, and industry (three-digit NAICS) fixed effects. All columns use the same sample as in Table 3. All models incorporate a mixture model with the regime switching probability ψ. * denotes significance at a 5% level, and ** denotes significance at a 1% level.

Table 9: Disaggregated Analysis for Specific Web Services Components (using out.only.ratio)[a]

	Software		Hardware		Development	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
	(1)		(2)		(3)	
A. web.outsource.only						
out.only.ratio.region$_{t-1}$	-15.898**	(2.466)	-8.571**	(1.467)	-10.819**	(1.961)
out.only.ratio.industry$_{t-1}$	-4.458	(3.002)	-3.511*	(1.731)	-3.232	(2.293)
#employee (in 100)	0.004	(0.006)	-0.005	(0.005)	0.002	(0.004)
#internet.users (in 100)	-0.140**	(0.028)	-0.031	(0.022)	0.007	(0.025)
e-business	0.470**	(0.062)	0.570**	(0.052)	0.640**	(0.061)
customer.service	0.282**	(0.072)	0.198**	(0.053)	0.194**	(0.063)
programming.outsource$_{t-1}$	0.598**	(0.061)	0.427**	(0.051)	0.557**	(0.062)
servicing.outsource$_{t-1}$	0.836**	(0.070)	0.685**	(0.058)	0.871**	(0.068)
lan.outsource$_{t-1}$	0.525**	(0.059)	0.535**	(0.047)	0.515**	(0.055)
B. web.inhouse.only						
#employee (in 100)	0.006+	(0.003)	-0.003	(0.003)	0.002	(0.003)
#internet.users (in 100)	0.153**	(0.010)	0.235**	(0.011)	0.226**	(0.012)
e-business	0.445**	(0.031)	0.889**	(0.034)	0.889**	(0.033)
customer.service	0.891**	(0.032)	0.361**	(0.037)	0.352**	(0.035)
#programmers	0.002*	(0.001)	0.010**	(0.001)	0.220**	(0.005)
total.server	0.003**	(0.001)	0.034**	(0.001)	0.011**	(0.001)
C. web.both						
out.only.ratio.region$_{t-1}$	-0.511	(3.114)	-2.524	(2.721)	-0.457	(2.856)
out.only.ratio.industry$_{t-1}$	3.124	(3.610)	-3.969	(3.499)	-1.922	(3.434)
#employee (in 100)	-0.006	(0.009)	0.000	(0.003)	-0.000	(0.007)
#internet.users (in 100)	0.070**	(0.027)	0.193**	(0.021)	0.213**	(0.024)
e-business	0.709**	(0.067)	1.127**	(0.076)	1.203**	(0.071)
customer.service	0.959**	(0.070)	0.471**	(0.088)	0.322**	(0.084)
programming.outsource$_{t-1}$	0.559**	(0.070)	0.529**	(0.080)	0.639**	(0.077)
servicing.outsource$_{t-1}$	0.853**	(0.076)	0.652**	(0.084)	0.621**	(0.085)
lan.outsource$_{t-1}$	0.651**	(0.066)	0.462**	(0.075)	0.578**	(0.072)
#programmers	-0.028**	(0.006)	0.004	(0.003)	0.212**	(0.006)
total.server	0.003*	(0.001)	0.035**	(0.001)	0.009**	(0.002)
D. switching probability						
ψ (prob. full choice set)	0.629**	(0.081)	0.732**	(0.088)	0.671**	(0.103)
observations	73,391		73,391		73,391	

[a]All columns include year, MSA, and industry (three-digit NAICS) fixed effects. All columns use the same sample as in Table 3. All models assume the mixture model with the regime switching probability ψ. Column 1 considers the souring decision for Web service software (e.g. outsourcing Web site management or having Web sites in-house); Column 2 considers the sourcing decision for Web service hardware (e.g. outsourcing Web server hosting or owning Internet servers); Column 3 considers the sourcing decision for Web application development (e.g. outsourcing Web application development or having Web developers in-house). In each column, out.only.ratio.region$_{t-1}$ and out.only.ratio.industry$_{t-1}$ are computed by using only the corresponding sourcing decision (e.g., outsourcing Web service software for column 1). * denotes significance at a 5% level, and ** denotes significance at a 1% level.

Table 10: Disaggregated Analysis for Specific Web Services Components (using out.ratio)[a]

	Software		Hardware		Development	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
	(1)		(2)		(3)	
A. web.outsource.only						
out.ratio.region$_{t-1}$	-9.669**	(2.008)	-6.630**	(1.307)	-8.590**	(1.772)
out.ratio.industry$_{t-1}$	-2.822	(2.277)	-2.083	(1.466)	-1.475	(2.098)
#employee (in 100)	0.003	(0.006)	-0.005	(0.005)	0.002	(0.004)
#internet.users (in 100)	-0.140**	(0.028)	-0.031	(0.021)	0.008	(0.025)
e-business	0.470**	(0.061)	0.566**	(0.051)	0.642**	(0.061)
customer.service	0.284**	(0.071)	0.198**	(0.052)	0.194**	(0.064)
programming.outsource$_{t-1}$	0.597**	(0.061)	0.422**	(0.051)	0.561**	(0.062)
servicing.outsource$_{t-1}$	0.832**	(0.069)	0.677**	(0.057)	0.877**	(0.068)
lan.outsource$_{t-1}$	0.523**	(0.058)	0.530**	(0.047)	0.520**	(0.056)
B. web.inhouse.only						
#employee (in 100)	0.006+	(0.003)	-0.003	(0.003)	0.002	(0.003)
#internet.users (in 100)	0.153**	(0.010)	0.235**	(0.011)	0.226**	(0.012)
e-business	0.445**	(0.031)	0.889**	(0.034)	0.889**	(0.033)
customer.service	0.891**	(0.032)	0.361**	(0.037)	0.352**	(0.035)
#programmers	0.002*	(0.001)	0.010**	(0.001)	0.220**	(0.005)
total.server	0.003**	(0.001)	0.034**	(0.001)	0.011**	(0.001)
C. web.both						
out.ratio.region$_{t-1}$	-11.098**	(2.561)	-8.418**	(2.464)	-5.955*	(2.640)
out.ratio.industry$_{t-1}$	-3.844	(2.732)	-5.796+	(2.957)	-3.520	(3.083)
#employee (in 100)	-0.006	(0.009)	0.000	(0.003)	-0.000	(0.007)
#internet.users (in 100)	0.071**	(0.027)	0.193**	(0.021)	0.213**	(0.024)
e-business	0.706**	(0.067)	1.122**	(0.076)	1.206**	(0.072)
customer.service	0.957**	(0.070)	0.470**	(0.087)	0.321**	(0.084)
programming.outsource$_{t-1}$	0.556**	(0.070)	0.523**	(0.079)	0.643**	(0.077)
servicing.outsource$_{t-1}$	0.846**	(0.076)	0.642**	(0.083)	0.625**	(0.085)
lan.outsource$_{t-1}$	0.647**	(0.065)	0.454**	(0.074)	0.581**	(0.072)
#programmers	-0.028**	(0.006)	0.004	(0.003)	0.212**	(0.006)
total.server	0.003*	(0.001)	0.035**	(0.001)	0.009**	(0.002)
D. switching probability						
ψ (prob. full choice set)	0.634**	(0.082)	0.750**	(0.092)	0.660**	(0.100)
observations	73,391		73,391		73,391	

[a]All columns include year, MSA, and industry (three-digit NAICS) fixed effects. All columns use the same sample as in Table 3. All models assume the mixture model with the regime switching probability ψ. Column 1 considers the souring decision for Web service software (e.g. outsourcing Web site management or having Web sites in-house); Column 2 considers the sourcing decision for Web service hardware (e.g. outsourcing Web server hosting or owning Internet servers); Column 3 considers the sourcing decision for Web application development (e.g. outsourcing Web application development or having Web developers in-house). In each column, out.ratio.region$_{t-1}$ and out.ratio.industry$_{t-1}$ are computed by using only the corresponding sourcing decision (e.g., outsourcing Web service software for column 1). * denotes significance at a 5% level, and ** denotes significance at a 1% level.